450

Falex Thermal Fouling Tester (FT^2)

** Refinery Process Analyzer **

OPERATION & MAINTENANCE MANUAL

Version 2.5

Falex Corporation
1020 Airpark Drive
Sugar Grove, IL 60554
www.falex.com
Phone: (630) 556-3669

450 Refinery Process Analyzer Instruction Manual

Table of Contents

Forward - How to Use This Manual, Safety, Safety Label Descriptions, Hazardous Areas of Test Machine

This manual provides information and procedures to safely install, operate, and maintain the Falex 450 Thermal Fouling Test machine (FT^2). For your own safety and protection from injury, carefully read, understand and observe the safety instructions described in this manual.

Keep this manual with the machine. If you lose this manual or need an additional copy, please contact Falex Corporation.

The information contained in this manual was based on machines in production at the time of publication. Falex Corporation reserves the right to change any portion of this information without notice.

This operation manual is divided into sections and addenda as listed in the "Table of Contents".

Safety Introduction

The following safety precautions are published for your information. This manual does not purport to detail all of the safety concerns, if any, associated with the equipment's use. It is the responsibility of the operator of this equipment to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

This machine is built with operator safety in mind; however, it can present hazards if improperly operated and serviced. Follow operating instructions carefully! If you have questions about operating or servicing this equipment, please contact Falex Corporation.

Note: This equipment should only be operated by personnel trained by Falex or a Falex approved distributor.

This manual may contain DANGER, WARNING, CAUTION, and NOTE callouts (as designated by a  symbol), which must be followed to reduce the possibility of personal injury, damage to the equipment, or improper service. This machine must be electrically grounded. Do not change the grounding requirements of the instrument.

DANGER indicates a hazardous situation, which if not avoided, will result in death or serious injury.

WARNING indicates a potential hazardous situation, which if not avoided, could result in death or serious injury.

CAUTION indicates a hazardous situation, which if not avoided, could result in minor or moderate injury.

NOTE brings attention to a specific recommendation or comment.

Safety Labels

The following are safety labels placed in areas on the test machine that may be hazardous to the operator. Please take caution and understand what these labels indicate before operating the test equipment.

This label indicates hot surface areas on the test machine. Use caution when working in these areas where components could be hot.

This label indicates hazardous voltage is present when opening the electrical cabinet. This unit is to be serviced by trained personnel only.

This label indicates that the system is under pressure. Use caution when working in this area and make sure that the system has been completely depressurized prior to loosening any tubing connections.

Hazardous Areas of Test Machine:

There are specific areas on the Falex 450 (FT^2) machine that could be potential operational hazards. These areas are listed here:

1. Warning! ELECTRIC SHOCK HAZARD. Do not remove any cabinet covers without removing power connection. Covers should not be removed without proper training by Falex or a Falex approved distributor. These are areas containing hazardous voltages

which can cause electrocution. This equipment to be serviced by trained personnel only.

2. Warning! SPRAY HAZARD. Do not loosen reservoir lid or lines when a test is active. Always make sure pressure has been completely released prior to removing reservoir lid or disconnecting any pressurized lines.

3. Warning! Test lubricants and solvents are flammable and may cause irritation to the eyes or skin. Wear protective goggles, gloves, and an apron; avoid contact with skin, eyes, and clothing. Use in well ventilated areas and keep **away** from heat or flame. Follow all Safety Data Sheet (SDS), Material Safety Data Sheet (MSDS), Hazardous Materials Identification System (HMIS), ISO 9000-2, Lab Safety Operating Procedures (SOP), and related instructions. Failure to comply may result in serious injury.

4. Caution! BURN HAZARD. The heater tube holder assembly can reach high temperatures of 650 °C during a test based upon test configuration. Always place test area safety cover over the heater tube test area when running a test to prevent contact with the test section. When the cover is removed, always assume the heater tube holder assembly is hot and use caution when operating around this area.

5. Caution! PINCH POINT. Keep hands and fingers clear.

<u>Operation Recommendations:</u>

WARNING: ***For your own safety and protection from injury, running high temperature and/or high pressure tests while unattended is not recommended.***

It is the responsibility of the operator of this equipment to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

1. General Information

The Falex 450 Thermal Fouling Test Machine (FT^2) is designed to evaluate the coking propensity of process fluids under single phase flow conditions.

This machine uses Falex heater tube specimens (refer to section 8). Falex certifies the 316 stainless steel tubes meet all of the SAE ARP5996 requirements for dimensions, surface finish and material and the aluminum heater tubes meet all ASTM D3241 requirements for dimensions, surface finish and material.

Note: Falex Corporation does not guarantee any specific test results or desired functionality of this equipment outside of its intended usage.

Figure 1-1 shows the location of various components and connections (shown with the bolted flange reservoir). The safety cover system is not shown so that other components are visible. Refer to figure 1-2 to see the safety cover system.

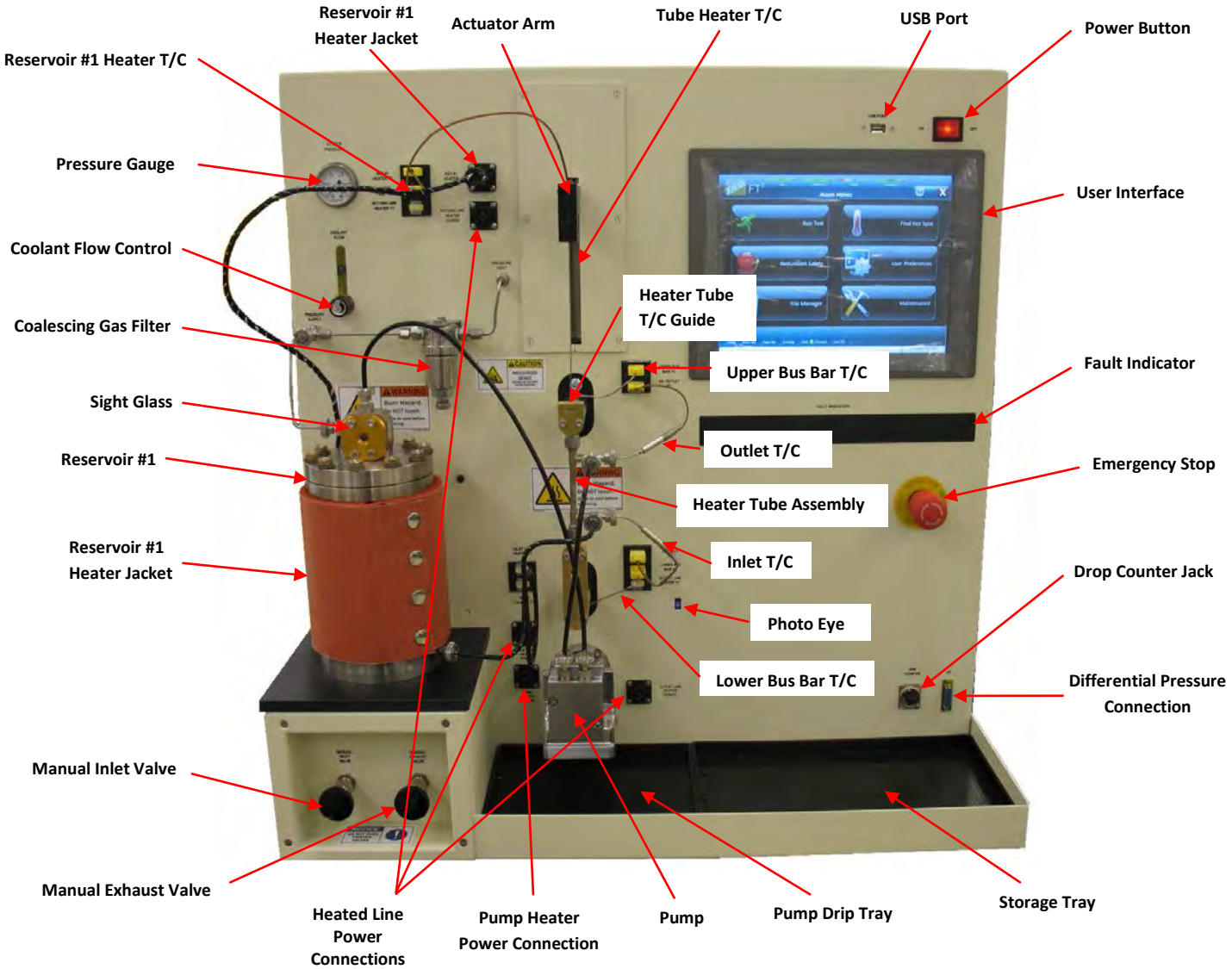


Figure 1-1 – Falex 450 (FT^2) Test Machine

The safety cover system consists of two (2) parts, the safety cover and the base. The base fits into the pump drip tray and supports the safety cover when it is placed into position.

WARNING: ***Always place the safety cover over the heater tube test area when running a test to prevent contact with the test section. Failure to do so could result in serious injury to the operator.***

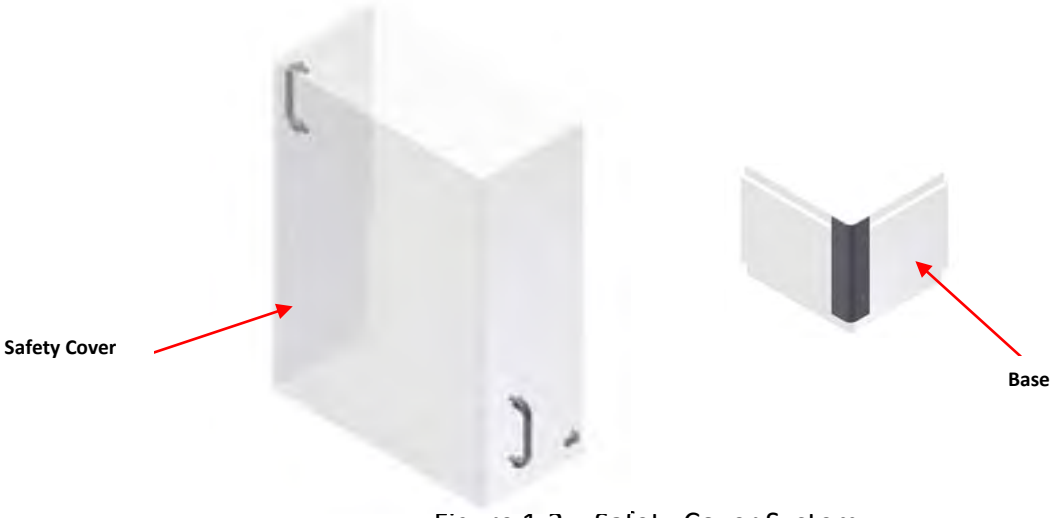


Figure 1-2 – Safety Cover System

There are two (2) types of reservoir systems that can be used with the Refinery Process Analyzer, bolted flange and split ring clamping collar. The 2 reservoir systems cannot be mixed. There are different options that can be ordered, depending on the type of reservoir system being used. The following options are available for the Refinery Process Analyzer and are to be ordered separately:

- Remote Emergency Stop assembly (450-109-006)
- Pump Heater assembly (450-106-002)

<u>Bolted Flange Reservoir System</u>

- Heated Line set (flow in 'pull' configuration) (450-097-004)
- Heated Line set (flow in 'push' configuration) (450-097-010)
- Single Pass Flow assembly (450-200-004)
- Differential Pressure assembly (450-200-003)

<u>Split Ring Clamping Collar Reservoir System</u>

- Heated Line set (flow in 'pull' configuration) (450-097-017)
- Heated Line set (flow in 'push' configuration) (450-097-018)
- Single Pass Flow assembly (450-200-008)
- Mechanical Stirrer assembly (450-200-007)

Some of these options must be activated within the software application in order for them to function. Refer to associated addendums at the end of this manual for information related to the setup and configuration of these options.

Note: Contact your local Falex representative for ordering any of the options.

2. Setup

2.1 Space & Leveling

The standard Falex 450 (FT^2) requires bench space of approximately 36”W x 30”D to comfortably operate the test machine. These dimensions will increase depending upon the options that are attached (refer to the associated option addendum at the end of this manual for detailed dimensions). The table should be reasonably level (1/32 in. per foot) and should be able to support the test equipment, while being free of external vibrations. The machine weighs approximately 180 lbs (82 kg). Access to the rear of the machine is necessary to allow for the air line connections, the external cooler connections and allow the operator access to the USB ports, network connections and breakers. It must be located in close proximity to a properly secured air cylinder. It is recommended that the machine be placed in an area free from drafts, air currents and within a stable temperature environment (preferably away from windows and air vents). This machine uses various test lubricants and cleaning solutions, so adequate ventilation is required.

The supplied external cooler (figure 2-1) requires a bench space of approximately 9”W x 16.5”D x 24”H and is to be located in close proximity to the Falex 450 (FT^2) machine on an even surface. The location should provide sufficient air ventilation. Approximately 9’ of hose is included to allow flexibility in its location. Refer to Addendum D for External Cooler Overview as it pertains to the Falex 450 (FT^2) machine.

Note: To ensure safe operation of the external cooler, it is recommended that its ‘Operating Manual’ be reviewed. It has been provided with the Falex 450 (FT^2) machine and can be found in the component manual directory of the supplied Falex 450 (FT^2) manual CD.

Figure 2-1 – External Cooler Unit

If a printer is to be connected to the machine, it can be positioned on either side of the machine or on top of the machine, as long as it will fit between the ventilation fans.

Note: Blocking the ventilation fans will cause damage to internal components.

2.2 Installation

Note: Refer to figure 1-1 for device locations. For installation of ordered options, refer to the associated addendum at the end of this manual.

1. Carefully remove packing materials protecting the machine and the heater tube thermocouple.
2. The machine comes equipped with a startup kit, which includes all the necessary items required to run the standard machine. Unpack the startup kit and verify its contents (see listing at the end of this section).
3. If the mechanical stirrer option was ordered, refer to Addendum J for installation.
4. Install storage tray in its proper location (next to pump drip tray).
5. Install reservoir #1 using the locator pins. If the mechanical stirrer was ordered, reservoir #1 is to be positioned on the attachable reservoir stand.
6. Install the heater jacket around reservoir #1 so that the thermocouple sensing tip on the inside of the heater jacket is located towards the bottom of the reservoir.
7. Connect the reservoir #1 heater jacket power cable to the power connector on the front of the machine.
8. Connect the reservoir #1 heater jacket thermocouple to its associated connector on the front of the machine.
9. The heater tube thermocouple was installed at the factory. Verify that the thermocouple is straight and is secure in the actuator arm (front and side set screws use a 0.050" Allen wrench). If the heater tube thermocouple is bent, carefully straighten while still installed in the actuator.
10. Plug inlet/outlet thermocouples into their respective connectors. These are identical thermocouples. Initially, it does not matter which one is used for inlet and which one is used for outlet. However, for consistent temperature readings, they should be plugged into the same connector from this point on.
11. Place new O-rings (620-006-004) on all tubing ends and inlet/outlet thermocouples.
12. Connect all tubing lines to their respective locations. Make sure all connections are hand tight. Standard 'pull' tubing lines are shipped with the machine. Refer to figure 1-1 for their placement.

13. Connect a cylinder of compressed gas (dry grade oxygen/nitrogen mix or nitrogen to the air inlet port on the rear of the machine (figure 2-2). The supplied air should be regulated not to exceed 1000 psi (6895 kPa).

Figure 2-2 – Air Connection

Note: For safety reasons, it is recommended that a pressure gauge be installed on the outlet of the tank. Always make sure system is completely depressurized prior to removing reservoir lid or tubing lines.

Note: It is recommended that a filter be installed on the air inlet port to prevent any debris from the air tank from entering the system.

Note: It is recommended to cover the vent port on the rear of the machine to catch any fluid mist that may be vented when pressure is released.

14. Connect the external cooler's inlet/outlet ports and the temperature sensor connection to the rear of the Falex 450 (FT^2) machine (figure 2-3). Make sure the inlet/outlet connections are tight. Refer to Addendum D for connections to the external cooler.

Figure 2-3 – FT^2 External Cooler Connections

15. Fill the external cooler fluid reservoir with approximately 1.2 gal (4.5 l) of fluid.

Note: Recommended bath fluids are soft/decalcified water or a water/glycol mixture (1:1 ratio). For further details, refer to the manufacturers operating manual.

Note: Recommended maximum filling level: 30mm below the tank rim.

16. The power cord is to be connected into the power connector located on the back of the machine. If the remote Emergency Stop assembly was ordered, refer to Addendum E for installation.
17. Plug the Falex 450 (FT^2) power cord into a 220 volt, single phase, 50/60Hz power source.
18. Power up the Falex 450 (FT^2) by toggling the power button (located on the front of the machine) to the 'on' position.
19. Plug the external cooling system power cord into a 220 volt, single phase, 50/60Hz power source.
20. Power-up the external cooling system by toggling the power button on the circulator (top switch) and cooling unit (bottom switch) to the illuminated 'on' position (refer to Addendum D).

Note: It is recommended to turn on/off the circulator and cooling unit together. If the circulator is turned off while the cooling unit is on, the potential exists for the fluid in the reservoir to freeze.

Prior to running a test for the first time, the following should be done:

- Clean the reservoir and tubing lines to flush any dust or debris that may have accumulated during shipment. Refer to section 3.3 for proper cleaning techniques.
- Verify the heater tube thermocouple position offset. Refer to section 4.4.7.6 for details.
- Setup for a test per section 3.4 (heater tube preparation) and 3.5 (machine setup).

Note: Do not run pump dry. Doing so will damage the pump.

Do not disassemble the pump. Contact your local Falex representative for any service issues.

****disassembling the pump without factory direction could void the factory warranty.***

Note: It is recommended that a hot spot determination test be conducted prior to running a timed test for the first time.

If the machine was shipped with a printer, the user interface is already configured for the printer. If the machine was not shipped with a printer and a printer is to be configured, refer to section 4.4.5.2 for printer configuration details. The printer can be connected to any of the available USB ports on the back of the machine (figure 2-4). However, it is recommended that the printer be connected to the lowest available USB port. This will keep all

remaining available USB ports open above it for easy access when connecting other USB devices.

If the machine is to be connected to a local network, plug the network cable into the upper network connection (network) on the rear of the machine (figure 2-4). The lower network connection is for factory use only. Refer to section 4.4.5.3 for network configuration details.

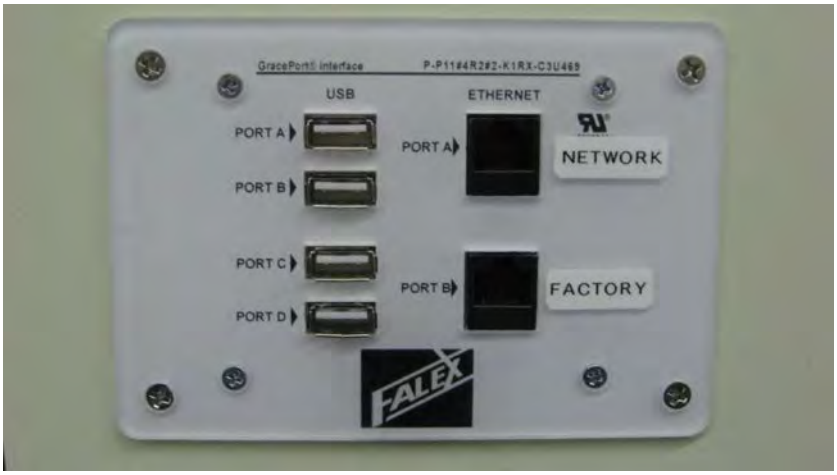
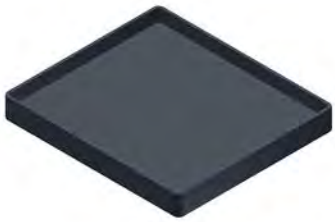
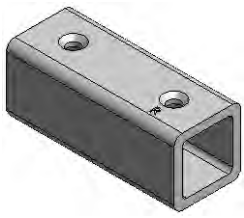


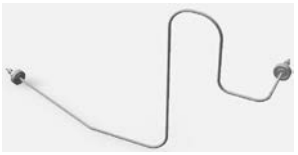
Figure 2-4 – Convenience Port

2.3 Startup Kit Contents (standard)

Note: Startup kit contents will differ based on type of reservoir used. Differences are noted in the part # and/or description column.

QTY	PART #	DESCRIPTION	PICTURE
1 pack	400-018-003	Insulation bushing (2 pairs/pack)	
1	400-108-004	Lead calibration holder with melted lead	
1 box	400-560-003	Heater tubes (316SS) (12 tubes/box)	
1	450-021-005	Pump drip tray (mounted on unit when shipped)	
1	450-041-005	Tube Holder (for oven and balance)	
1 pack	450-097-003	O-Ring kit, standard 20 tests (220 tubing, 45 heater tube)	

QTY	PART #	DESCRIPTION	PICTURE
1	450-099-001	Heater tube holder assembly	
1	450-103-004	Reservoir insulation top plate (mounted on unit when shipped)	
1	650-009-061	Thermocouple - heater tube (mounted on unit when shipped)	
1	450-105-005	Storage tray assembly	
1	450-105-060 (bolted flange reservoir) 450-105-085 (split ring clamping collar reservoir)	Pressurization tube assembly (recycle configuration)	
1	450-105-020 (bolted flange reservoir) 450-105-007 (split ring clamping collar reservoir)	Tube assembly (pull) (reservoir return)	

QTY	PART #	DESCRIPTION	PICTURE
1	450-105-009 (bolted flange reservoir) 450-105-069 (split ring clamping collar reservoir)	Tube assembly (pull) (inlet)	 or 
1	450-105-010	Bypass cleaning line assembly	
1	450-105-014 (bolted flange reservoir) 450-105-074 (split ring clamping collar reservoir)	Reservoir (1000ml) assembly Reservoir (1.5L) assembly	 or 
1	450-105-021	Tube assembly (pull) (outlet)	
1	450-105-017 (bolted flange reservoir) 450-105-072 (split ring clamping collar reservoir)	Safety cover top (mounted on unit when shipped) ***see note at end of section***	
1	450-105-018	Safety cover bottom (mounted on unit when shipped)	

QTY	PART #	DESCRIPTION	PICTURE
1	450-106-006 (bolted flange reservoir) 450-106-008 (split ring clamping collar reservoir)	Reservoir heater jacket	
2	450-109-004	Thermocouple assembly- inlet/outlet	
1	Manual	Manual-CD / Flash Drive	
1	648-400-007	Hex Socket wrench	
1	648-400-009	Ceramic insulator removal tool	
1	648-450-001	Heater tube cleaning brush	

QTY	PART #	DESCRIPTION	PICTURE
1	648-450-002	Beaker, 400 ml, tripour	
1	650-030-150	Power Cord 220V	
1 pack	450-097-012	Pump gasket kit (2/pack)	
1	659-025-005	20 - 200 in-lb torque wrench (1/4” drive) *** for bolted flange reservoir systems only **	
1	659-025-007	1/2" socket (1/4" drive) *** for bolted flange reservoir systems only **	
1	659-050-002	7/16" x 1/2" open end wrench *** for bolted flange reservoir systems only **	

QTY	PART #	DESCRIPTION	PICTURE
1	450-105-064	Reservoir return line cleaning extension	
1	100-200-052	External Cooler	
1	669-450-003	Disposable Filter for Coalescing Gas Filter	
1	669-040-004	Viton O-Ring for Coalescing Gas Filter	
1	659-040-001	Ball Point, Hex Allen Wrench Set, Long Arm w/Caddy	

Note: For bolted flange reservoir systems, the standard safety cover top (450-105-017) is shown in the startup kit contents. Should the single pass flow option (450-200-004) be purchased with the FT^2 unit, the extended safety cover top (450-105-038) will be shipped in place of the standard safety cover top.

3. Typical Test Procedure

3.1 Overview

The following is a general description of a typical test (hot spot determination test and a standard Refinery Process timed test) process.

The components are to be cleaned (refer to section 3.3) and a new heater tube prepared (refer to section 3.4) prior to starting a test. A minimum of 100ml of test fluid is placed into reservoir #1 and the reservoir is to be sealed. Using the user interface, the test parameters are to be configured by the operator and a startup process is to be completed. For a hot spot determination test and a Refinery Process timed test, the startup process is configurable. Depending on the configuration, the startup process could heat reservoir #1 and heat soak the reservoir to allow the temperature to equalize, will pressurize the reservoir, purge the system and allows the operator to set the pump flow rate. For the standard machine, the pump pulls the test fluid from the reservoir, through the heater tube holder assembly containing the heater tube, through the pump and back to the reservoir. When the startup process has been completed, the test (hot spot determination or timed test) is initiated from the user interface by the operator.

<u>Hot Spot Determination Test</u>

The heater tube thermocouple initializes to the top of the heater tube and moves to the 10mm position. The tube temperature is ramped to a configured temperature over a configured time period. When at temperature, the test duration time is initiated and a configured heat soak period ensues, allowing the heater tube temperature to equalize. A temperature profile of the heater tube is initiated and the hottest spot within the heater tube is determined (i.e. hot spot). Once the test profile is complete, the heater tube temperature ramps down over a configured time period, the pump is stopped and the pressure is released. The outlet temperature is cooled (< 40 °C) and the heater tube thermocouple is returned to its home position. The machine is now safe to be broken down and cleaned in preparation for a timed test.

<u>Timed Test (Refinery Process)</u>

The heater tube thermocouple initializes to the top of the heater tube, moves to the 10mm position and then moves to the current 'A' position (hot spot of the tube or operator enterable hot spot override position). The hot spot is previously determined from a hot spot determination test. The tube temperature is ramped to the configured temperature over a configured time period. When at temperature, the test duration time is initiated and a configured heat soak period ensues, allowing the heater tube temperature to equalize. A temperature profile of the heater tube can be taken (if enabled) during the 1st hour. The test will then continue operating at the configured control temperature setpoint for the test duration with the heater tube

thermocouple positioned at its 'A' position. As the heated test fluid flows over the hot heater tube, deposits are formed on the heater tube. A 2nd temperature profile of the heater tube can be taken (if enabled) during the last hour of the test. Once the test duration has completed, the heater tube temperature ramps down over a configured time period, the pump is stopped and the pressure is released. The outlet temperature is cooled (< 40 °C) and the heater tube thermocouple is returned to its home position. The machine is now safe to be broken down and the heater tube deposit can be analyzed.

Note: New oil, new heater tube, new heater tube O-rings, new inlet/outlet thermocouple O-rings and new tubing line O-rings are required for every hot spot test or timed test.

Note: It is not uncommon for the pressurization system to leak 2 – 4% of the configured pressure setpoint over the course of the test duration.

Note: For split ring clamping collar reservoirs, should the oil in the reservoir be used for multiple tests (not recommended), the clamping collar is to be removed and re-clamped after each test to allow the reservoir lid to reseat. If this is not done, the reservoir lid will not seat properly and a pressure leak could occur.

WARNING: For your own safety and protection from injury, running high temperature and/or high pressure tests while unattended is not recommended.

It is the responsibility of the operator of this equipment to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

3.2 Equipment and Materials

The following is a listing of equipment and materials that are recommended to successfully run a test and to accurately determine the resulting deposit.

- Falex 450 (FT^2) machine
- External cooling system
- Laboratory oven capable of maintaining a temperature of 100 °C (±5 °C), for drying of test tubes
- Desiccator filled with suitable desiccant for storing of test heater tubes
- Laboratory balance capable of weighing heater tubes to 0.01 mg (5 decimal places)
- 100ml or 250ml graduated cylinder for measuring of test fluids
- 10ml graduated cylinder for heater tube soaking

- Compressed air supply (oxygen/nitrogen mix or nitrogen), clean, dry and oil free, capable of pressurizing the reservoir to up to 1000 psi (6895 kPa) maximum
- Reference heater tube for test verification of cleaning process (to be of same material of heater tube used for test)
- Heater tube (316 stainless steel heater tube is recommended)
- O-rings (heater tube, inlet thermocouple, outlet thermocouple, tubing lines, reservoir, sight glass, pump inlet/outlet, reservoir outlet fitting)
- Ceramic insulator bushings
- Solvents (Acetone and Petroleum Ether) for cleaning of light oil (i.e. turbine oil) soaked parts and preparation of heater tube
- Solvents (Toluene) for safe cleaning of heavy oil (i.e. crude oil) soaked parts
- Gloves for safely handling of the heater tubes and for safely cleaning the apparatus
- Hex wrench for heater tube holder assembly installation/removal
- ½" wrench for reservoir top installation/removal
- Test fluid

3.3 Component Cleaning

Note: Prior to cleaning, always verify that the system has been completely depressurized before removing reservoir lid or any tubing lines.

Note: Use proper cleaning solvent for the test fluid being used.

<u>Inlet/Outlet Thermocouples</u>

1. Clean thermocouple ends with cleaning solvent.
2. Allow the thermocouple ends to dry.
3. Replace O-rings.

<u>Reservoir/Pump/Tubing Lines</u>

1. After reservoir has cooled, disconnect inlet tubing line (top of sight glass), disconnect outlet tubing line from the heater tube assembly and unbolt the reservoir top. Remove the reservoir top.

Note: Do not disconnect outlet tubing line from reservoir base with oil in the reservoir. Otherwise, oil will run out.

Note: If the reservoir lid incorporates the mechanical stirrer assembly, removing the reservoir lid will be difficult due to the height and weight of the assembly. Be prepared to catch the fluid that will drip off of the impeller blades.

2. Remove the reservoir from the machine and pour out remaining used test fluid and rinse the interior of reservoir with cleaning solvent. Pour

out accumulated cleaning solvent. Wipe dry with a paper towel, making sure no pieces of paper towel remain.

Note: For high viscosity fluids, it is recommended that this be done when the reservoir is warm. The reservoir may need to be manually heated to accomplish this.

Note: Properly dispose of test fluid and cleaning solvent per safety procedures designated by local facility

3. Place the reservoir back on its base using the locating pins.
4. Flush the system by pouring a minimum of 350ml of cleaning solvent into the reservoir. Do not attach the reservoir lid. Install the bypass cleaning line (figure 3-1) in place of the heater tube holder assembly.

Figure 3-1 – Bypass cleaning line installation

5. Place a 400ml plastic beaker inside the reservoir to catch the fluid being flushed (lip of beaker will rest on reservoir edge) (figure 3-2). Manually start the pump at a high flow rate (20 – 30 %) using the Maintenance portion of the user interface. Flush until no more fluid is being pumped into the catch beaker. The cleaning solvent should run clear. Manually stop the pump.

Note: It is recommended to attach the reservoir return line cleaning extension (450-105-064) to the end of the reservoir return line when cleaning high viscosity fluid. This will extend the cleaning line into the beaker and keep the fluid from spraying outside of the beaker.

Figure 3-2 – Catch beaker placement

6. Properly dispose of the fluid accumulated in the catch beaker.
7. Remove the reservoir from the machine and empty the reservoir of the remaining cleaning solvent. Wipe dry with a paper towel, making sure no pieces of paper towel remain. Blow dry with compressed air.
8. Place the reservoir back on its base using the locating pins.
9. Flush the system again, this time with test fluid. Pour a minimum of 150ml of the fluid to be tested into the reservoir. Do not attach the reservoir lid. Make sure the bypass line is still installed in place of the heater tube holder assembly. Place a 400ml plastic beaker inside the reservoir to catch the fluid being flushed (lip of beaker will rest on reservoir edge). Manually start the pump at a higher flow rate (20 – 30 %) using the Maintenance portion of the user interface. Flush until no more fluid is being pumped into the catch beaker. Manually stop the pump.
10. Remove the reservoir from the machine and clean the interior with cleaning solvent. Squirt cleaning solvent through the supply line. Pour out accumulated cleaning solvent. Wipe dry with a paper towel, making sure no pieces of paper towel remain. Place the reservoir upside down on a paper towel and blow clean compressed air through the supply line to dry.
11. Remove the large O-ring from the reservoir lid and check for signs of wear. Replace if necessary.
12. Clean the underside of the reservoir top with cleaning solvent and blow dry with air. Do not let the O-ring come in contact with the cleaning solvent.

Heater Tube Holder

Note: the following is to be done once the heater tube has been removed from the heater tube holder (section 3.7).

1. Flush the inside of the heater tube holder with cleaning solvent.
2. Push the heater tube cleaning brush through the heater tube holder to dislodge any debris.
3. Rinse the inside and outside of the heater tube holder with cleaning solvent.
4. Rinse ceramic insulator bushings and tube holder end nuts with cleaning solvent.
5. Blow dry heater tube holder, ceramic insulator bushings and end nuts with a clean oil free air supply.
6. Inspect ceramic insulator bushings for damage. Replace if cracked or chipped.

3.4 Heater Tube Preparation

For heater tubes that require the deposit to be weighed, follow steps 1 – 9 below. If the heater tube is not required to be weighed, follow steps 1 – 3 below.

Note: Reference tube required to undergo same preparation for timed test only. Reference tube to be reused, but must be properly prepared for each test.

Note: For hot spot determination or hot spot validation tests, only follow steps 1 – 6 (disregard any instruction regarding reference tube).

1. Remove a new heater tube from its container. Wear gloves and handle the heater tube by the ends only. Do not touch the center section of the heater tube.
2. Inspect new heater tube for scratches, corrosion or other visible defects and discard should any be found.
3. Clean the new heater tube with acetone. Rinse the outside of the heater tube with acetone, wipe with an acetone soaked lint free paper towel. Re-rinse with acetone. Flush the inside of the heater tube with acetone.

Note: It is recommended to rod the heater tube by pushing a 0.062" rod through the center of the tube to dislodge any debris prior to flushing with acetone.

Note: Do not wipe the heater tube in a twisting motion, only wipe along the axis of the heater tube.

4. Clean the reference tube with acetone using the same procedure defined in step 3.

5. Dry both heater tubes in a preheated laboratory oven set at 100 °C (±5 °C) for 30 minutes. Set heater tubes in a holder vertically.
6. Remove heater tubes from oven and cool in the desiccator for at least 30 minutes.
7. Remove the heater tube that will be used for the test from the desiccator. Using the laboratory balance, weigh the new heater tube to 0.01 mg a minimum of three (3) times. Record the average of three (3) successive weights within 0.02 mg of each other on a test sheet.
8. Remove the reference tube from the desiccator. Using the laboratory balance, weigh the reference tube to 0.01 mg a minimum of three (3) times. Record the average of three (3) successive weights within 0.02 mg of each other on a test sheet.

Note: If the reference tube varies by more than 0.12 mg from its previous reading, the acetone used in the cleaning process may be contaminated. Both the new heater tube and the reference tube should be re-cleaned with fresh acetone.

9. When reference tube is not needed, it is to be stored in the desiccator.

3.5 Machine Setup

Note: The following setup instructions are for setting up a standard Refinery Process Analyzer machine. For details on setup and configuration of available options, refer to the associated addendums.

1. Attach inlet line to fitting near bottom of reservoir using a new O-ring and place the reservoir on its base using the locating pins. For machines that incorporate the mechanical stirrer assembly, reservoir #1 is the supply reservoir and is to be placed on the attachable stand.
2. For tests configured for recycling the test fluid, fill clean graduated cylinder with a minimum of 100ml of new test fluid.
3. For tests configured for single pass flow option (requires 2nd reservoir), the operator must make sure sufficient test fluid is placed in reservoir #1 to complete the configured test duration with the configured pump flow rate. For machines that incorporate the mechanical stirrer assembly, reservoir #2 is the catch reservoir and is to be placed on the machine.

Note: Do not run pump dry. Doing so will damage the pump.

Do not disassemble the pump. Contact your local Falex representative for any service issues.

****disassembling the pump without factory direction could void the factory warranty***

4. Pour new test fluid from graduated cylinder into clean reservoir (reservoir to be cleaned per section 3.3).
5. Bolt/clamp the reservoir top into place. If the reservoir is a bolted flange type, making sure all bolts are tight (50 – 60 inch pounds). Tighten bolts in a star pattern (tightening bolts placed on opposite sides from each other) to allow even compression of the sealing O-ring.
6. Connect all tubing lines to the reservoir using new O-rings.
7. Install the reservoir heater jacket on the reservoir making sure that the reservoir thermocouple and power plug are connected to the machine.

Note: Make sure the thermocouple sensor on the inside of the reservoir heater jacket is towards the bottom of the reservoir.

8. Assemble the heater tube holder assembly (figure 3-3) with clean components and new O-rings.

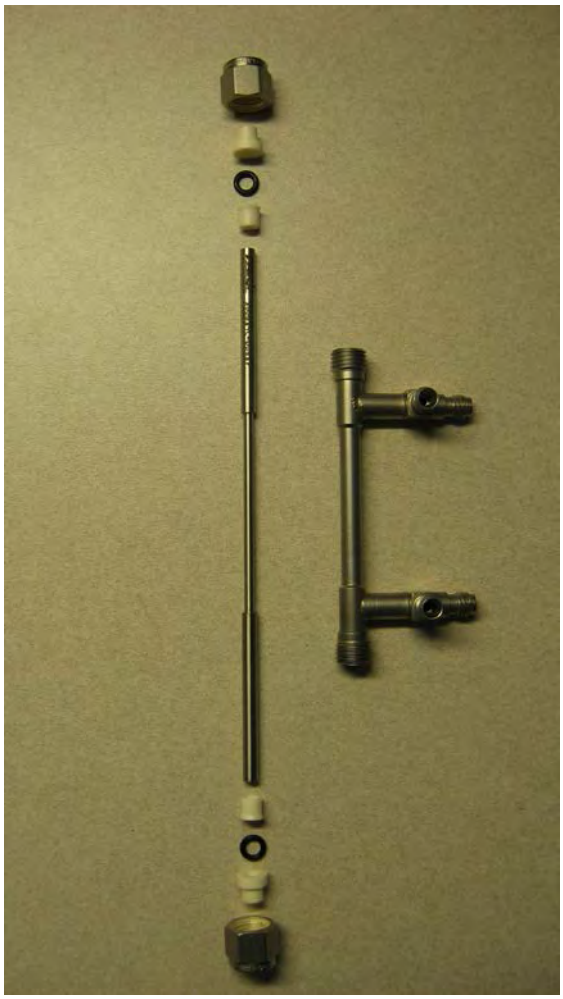


Figure 3-3 – Heater tube holder assembly

Place heater tube into the heater tube holder with serial number at the top. The heater tube is properly positioned within the heater tube holder when the tube shoulders are visible within the upper and lower thermocouple ports.

Heater tube holder end nuts are only to be hand tightened. Over tightening could crack the ceramic insulator bushings.

Note: It is recommended that the heater tube be positioned in the heater tube holder the same way for each test for consistent results. For example, with the serial number always at the top.

9. Remove the bypass cleaning line.
10. Install the heater tube holder assembly on the Falex 450 (FT^2) machine into the bus bars using the hex screws. The heater tube holder assembly should be positioned so that the top of the tube is even with the top of the bus bar (figure 3-4). Make sure that the end of the heater tube thermocouple is inserted into the heater tube thermocouple guide (figure 3-5) before tightening down the upper bus bar cap.

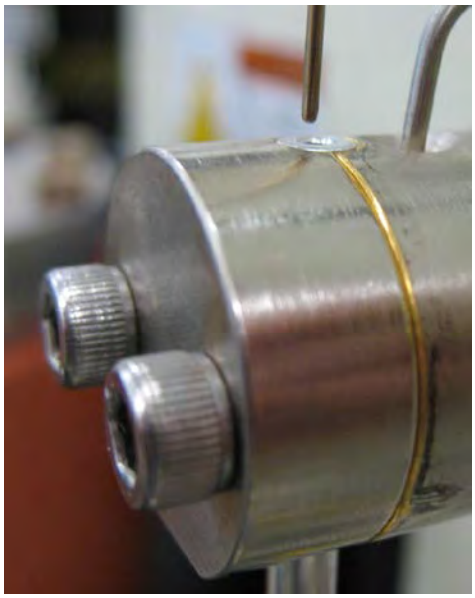


Figure 3-4 – Heater tube holder assembly positioning

Figure 3-5 – Heater tube thermocouple inserted into heater tube thermocouple guide

Note: The bus bar caps are a matched to the bus bar. If the bus bar caps get mixed up, they can be matched to the associated bus bar by the numbers stamped inside or on the side of the bus bar cap and on the end or side of the bus bar.

Note: Make sure bus bar hex screws are tight. Failure to tighten the bus bar hex screws will cause the heater tube to not properly heat to the required setpoint.

Note: Manually run the actuator down to verify that the heater tube thermocouple properly locates into and out of the heater tube. Do this carefully to prevent the thermocouple from bending at the start of a test.

11. Attach all tubing lines and thermocouples to the test section using new O-rings. Inlet thermocouple is attached to the bottom of the heater tube holder assembly and the outlet thermocouple is attached to the top of the heater tube holder assembly. All tubing lines are to be hand tightened only.
12. It is recommended to initiate a leak test, which will start the pump and pressurize the system to determine if any of the connections are leaking. Refer to section 4.4.7.6 for more details. This is an optional procedure and is not a requirement.

3.6 Starting A Test

WARNING: It is the operator's responsibility to determine the correct temperature/pressure combination for the particular fluid being tested to prevent the fluid from vaporizing. Failure to do so could cause the fluid to combust, causing serious injury to the operator.

WARNING: For your own safety and protection from injury, running high temperature and/or high pressure tests while unattended is not recommended.

It is the responsibility of the operator of this equipment to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

1. On the user interface, select the Run Test button (for a refinery process timed test) or the Find Hot Spot button (for a hot spot test).
2. Fill in the associated test information on the Test Configuration display. For a timed test, configure the test parameters using the associated configuration displays (refer to section 4.4.2.1). For a hot spot test, configure the test parameters using the associated configuration displays (refer to section 4.4.3.1). Select the Continue to Test button.

3. If the mechanical stirrer assembly is installed and intended to be used, turn on the mechanical stirrer and adjust the speed accordingly. For details on the operation of the mechanical stirrer, refer to Addendum J.
4. A startup process is to be completed to initialize the machine for the test. The startup process is based on operator configuration. Follow the on screen instructions to complete. Verify that the external cooling system is powered up (circulator and cooling unit). Initiate cooling flow to the Falex 450 (FT^2) unit by pressing the 'OK' button on the circulator display keypad (actual bath temperature will appear on the circulator display). Adjust cooling water flow on the Falex 450 (FT^2) machine so that it is set to the 10 GPH position (flow gauge ball is in the center of the green area). The startup process will take approximately 1 - 3 hours to complete (with configuration setpoints set at their defaults). It may take longer depending upon test configuration. Refer to section 4.4.2 for details.

Note: Some configured temperature setpoints may not be attainable due to the test configuration and associated parameters.

5. Once the startup process has been completed, select the Continue to Test button on the Continue display. Select the Start button on the Run Test display to initiate the test. Everything is automatic from this point on.
6. A series of actuator moves will occur to correctly position the heater tube thermocouple into the heater tube. The actuator moves will differ based upon the type of test that is to be executed. The actuator will move as follows:

    - Heater tube thermocouple is initialized, where it is moved the distance from the home position to the top of the heater tube
    - Heater tube thermocouple is moved to the 10mm position

    If the test that is to be executed is a refinery process test, the heater tube thermocouple is moved to its current 'A' position (or operator entered hot spot override position). If the test that is to be executed is a hot spot validation, the heater tube thermocouple is moved to its current 'A' position. If the test that is to be executed is a hot spot determination, the heater tube thermocouple is not moved, but left at the 10mm position.
7. The heater tube temperature will ramp to the configured temperature setpoint (operator configured ramp).
8. The test time will be initiated and the heater tube temperature will equalize for 30 minutes. Flow rate can be adjusted during the equalization time.
9. If the test to be executed is a timed test, follow steps 9 – 12. If the test to be executed is a hot spot determination or hot spot validation, the temperature profile will be captured (skip to step 13).
10. Temperature profile #1 will be captured (if enabled).

11. The test will continue controlling at the configured temperature setpoint.
12. Temperature profile #2 will be captured (if enabled) in the last hour of the test.
13. The test will continue until time duration has completed controlling at the configured temperature setpoint temperature at the 'A' position.
14. Heater tube temperature will ramp down to ambient temperature (operator configured ramp).
15. Pump will stop, reservoir heating will stop, line heating will stop for a timed test (if enabled) and pressure will be released.
16. When outlet temperature is <40 °C, the cooling is stopped and the heater tube thermocouple will go to the home position.
17. Test is complete.
18. Stop coolant flow to the Falex 450 (FT^2) machine by pressing the 'OK' button on the circulator display keypad (message on the circulator display will indicate 'OFF').

Note: It is ok to leave the coolant flow circulating through the Falex 450 (FT^2) when he test has been completed if desired.

3.7 Disassembly/Deposit Determination

Note: Deposit determination not required for a hot spot determination, hot spot validation test or operator determined timed tests.

1. Verify test is complete, system is depressurized (0 psi / 0 kPa), tube temperatures are at a safe value and heater tube thermocouple is in the home position.
2. Loosen heater jacket from reservoir to allow cooling.
3. Disconnect inlet/outlet thermocouples from the heater tube holder assembly.
4. Disconnect tubing lines from heater tube holder assembly.
5. Carefully remove the heater tube holder assembly from the bus bars.
6. Un-bolt/un-clamp the reservoir top and disconnect all reservoir tubing lines. Remove the reservoir top and allow air to circulate inside the reservoir to allow cooling.

**** For heater tubes that require the deposit to be weighed, follow steps 7 – 18 below.*

7. Carefully wash the inside of the heater tube holder assembly (heater tube still installed) with petroleum ether.
8. Carefully remove heater tube from heater tube holder assembly so that the formed deposit is not disturbed. This should be done over a beaker to catch any of the deposit, should it break off. Wear gloves when handling the heater tube.
9. Place heater tube into a clean graduated cylinder (boiling tube). Fill graduated cylinder with petroleum ether so that fill line is at least 10mm

above the top of the center section of the heater tube. Refer to SAE ARP5596 method for loose debris handling.

10. Let the heater tube soak for at least 15 minutes and then gently agitate the heater tube in the solution.
11. Remove heater tube from graduated cylinder. While holding the heater tube over the beaker, gently rinse the outside of heater tube with petroleum ether and rinse through the center with petroleum ether. Do not wipe heater tube. Collect any loose debris per SAE ARP5996 method.
12. Rinse reference tube with petroleum ether in the same manner.
13. Dry both heater tubes in a preheated laboratory oven set at 100 °C (±5 °C) for 30 minutes. Set heater tubes in a holder vertically.
14. Remove heater tubes from oven and cool in the desiccator for at least 30 minutes.
15. Remove the heater tube that was used for the test from the desiccator. Using the laboratory balance, weigh the new heater tube (plus any deposit collected from the wash) to 0.01 mg a minimum of three (3) times. Record the average of three (3) successive weights within 0.02 mg of each other on a test sheet.
16. Remove the reference tube from the desiccator. Using the laboratory balance, weigh the reference tube to 0.01 mg a minimum of three (3) times. Record the average of three (3) successive weights within 0.02 mg of each other on a test sheet.
17. Calculate the difference in mass using the weight from before and after the test for each tube. Record to 0.01 mg on a test sheet.
18. Store the used heater tube in its plastic case for future reference. Return the reference tube to the desiccator.

4. Description of Equipment

4.1 Principal of Operation

The Falex 450 (FT^2) test machine is a very versatile and flexible bench test machine. It incorporates an external cooling system to help regulate heater tube temperatures. It also incorporates an automatic actuator that moves the heater tube thermocouple to its required positions with precision, thus increasing data repeatability. From the heater tube thermocouple positions, temperature profiles are created (if enabled). These temperature profiles are captured heater tube temperatures at the various heater tube thermocouple positions. All heater tube temperature thermocouple moves are based from the 'A' position, which is the determined hottest point on the heater tube. The hottest point on the tube is determined by running a 'Hot Spot Determination' test. Refer to section 4.4.3 for detail on the hot spot test functionality. Heater tube timed test temperature profiles contain captured temperatures at the following heater tube thermocouple positions:

- A - 12
- A - 8
- A - 4
- A
- A + 4
- A + 8
- A + 12

For example, if the determined hot spot position is 14mm on the heater tube, the 'A' position would be 14mm, the 'A – 4' position would be 10mm, the 'A + 4' position would be 18mm, etc.

Once the machine has been setup, configured, and the startup process has been completed by the operator, the test will run to completion without any additional operator intervention. Two (2) controllers are used within the machine. One is used as the main controller for all control functionality and one is used as a safety backup. The safety controller will abort the test and stop all devices to protect the machine should the main controller fail.

This machine is capable of running many types of tests that meet many commercial and military specifications and can simulate a broad range of field applications. It can run the following types of tests:

- Hot Spot Determination
- Hot Spot Validation
- Refinery Process test

The refinery process test allows the operator to configure the test parameters to meet specific requirements.

The following options are available for the Refinery Process Analyzer and are to be ordered separately:

- Remote Emergency Stop assembly (refer to Addendum E)
- Heated Line sets (refer to Addendum F)
- Differential Pressure assembly (refer to Addendum G)
- Single Pass Flow assembly (refer to Addendum H)
- Pump Heater assembly (refer to Addendum I)
- Stirrer assembly (refer to Addendum J)

Warning: ***For your own safety and protection from injury, running high temperature and/or high pressure tests while unattended is not recommended.***

It is the responsibility of the operator of this equipment to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

Refer to section 4.3 for a detailed description of the user interface functionality and section 4.4 for detailed functionality of the individual displays.

4.2 Electrical Features, Controls, Inputs & Outputs

Several connectors are located on the front and back of the machine. These include:

- Reservoir #1 heater jacket connector & thermocouple
- Heater tube thermocouple
- Upper/Lower bus bar thermocouples
- Inlet/Outlet thermocouples
- Pump heater connector & thermocouple
- Return line heater connector & thermocouple
- Inlet line heater connector & thermocouple
- Outlet line heater connector & thermocouple
- Differential Pressure connector
- Reservoir #2 heater jacket connector & thermocouple (back of machine)
- Fluid temperature thermocouple (back of machine)

All thermocouple connectors are 'K' type connectors.

Note: The return line heater, inlet line heater, outlet line heater, differential pressure assembly, pump heater and single pass flow assembly are options to the Falex 450 (FT^2) refinery process analyzer and are not shipped with the machine unless ordered. The fluid temperature thermocouple is only included with the mechanical stirrer assembly option. The line and pump heaters are intended to be used with high viscosity fluids. The differential pressure assembly is intended only for low viscosity fluids. These options must be activated within the software application in order to function. Contact your local Falex representative for ordering these options.

Note: All thermocouples fail high and will display 32768.0 when failed or not connected.

Reservoir #1 Heater Jacket Connector

This connector provides power to the heater jacket for reservoir #1, used in the standard 'recycle flow' configuration. It is located on the front of the machine above the reservoir. The output of the heater is controlled in software. Refinery process tests will allow a temperature range from 50 °C to 150 °C. The heater jacket is controlled through feedback from the heater reservoir thermocouple located within the heater jacket.

Reservoir #2 Heater Jacket Connector

This connector provides power to the heater jacket for reservoir #2, used with the 'single pass' option. It is located on the back of the machine next to the external cooler connections. The output of the heater is controlled in software. Refinery process tests will allow a temperature range from 50 °C to 150 °C. The heater jacket is controlled through feedback from the heater reservoir thermocouple located within the heater jacket.

Return Line Heater/Inlet Line Heater/Outlet Line Heater Connectors

These connectors provide power to the individual heaters associated with a refinery process test. They are intended to be used with high viscosity fluids and are located on the front of the machine in the area of the pump. Refinery process tests will allow a temperature range from 50 °C to 150 °C. These heaters are controlled through feedback from their associate thermocouple.

Pump Heater Connector

This connector provides power to the pump heater. The pump heater is intended to be used with high viscosity fluids. It is located on the front of the machine left of the pump. The output of the heater is controlled in software. Refinery process tests will allow a temperature range from 50 °C to 150 °C. The heater is controlled through feedback from the pump heater thermocouple.

Reservoir #1 Heater Jacket Thermocouple

This thermocouple is used to control the heater jacket temperature used on reservoir #1 and for alarm monitoring. The thermocouple connector is located above the reservoir (top position). This thermocouple output is split internally. One output is wired to the main controller for temperature control and one output is wired to the safety controller for backup protection. The thermocouple sensing tip is designed into the inside of the heater jacket. The main controller temperature reading is monitored for alarm purposes, shown on the display and recorded in the data file. The safety controller temperature reading is monitored for alarm purposes and shown on the display. The two (2) readings should read the same (+/- 2 °C). If they aren't, verify calibration data (refer to section 4.4.7.5).

Reservoir #2 Heater Jacket Thermocouple

This thermocouple is used to control the heater jacket temperature used on reservoir #2 and for alarm monitoring. The thermocouple connector is located on the back of the machine next to the external cooler connections. This thermocouple output is split internally. One output is wired to the main controller for temperature control and one output is wired to the safety controller for backup protection. The thermocouple sensing tip is designed into the inside of the heater jacket. The main controller temperature reading is monitored for alarm purposes and shown on various displays. The safety controller temperature reading is monitored for alarm purposes and shown on the display. The two (2) readings should read the same (+/- 2 °C). If they aren't, verify calibration data (refer to section 4.4.7.5).

Heater Tube Thermocouple

This thermocouple is used to control the heater tube temperature and record the temperature at various heater tube thermocouple positions. The thermocouple connector is located above the reservoir (middle position). The thermocouple is to be mounted into the actuator arm assembly. This thermocouple output is split internally. One output is wired to the main controller for temperature control and one output is wired to the safety controller for backup protection. The main controller temperature reading is monitored for alarm purposes, shown on the display and recorded in the data file. The safety controller temperature reading is monitored for alarm purposes and shown on the display.

Return Line Heater Thermocouple

This thermocouple is used to monitor the return tubing line temperature when using high viscosity fluids. The thermocouple connector is located above the reservoir (bottom position). This thermocouple is located within the custom heating wrap for this tubing assembly. The temperature reading is monitored for alarm purposes and is shown on the Instrument Status display. It is not recorded in the data file.

Upper Bus Bar Thermocouple

This thermocouple is used to monitor the upper bus bar temperature. The thermocouple connector is located to the right of the upper bus bar (top position). The thermocouple is to be inserted into the thermocouple hole located on the top of the upper bus bar. The temperature reading is not shown on any display, but is monitored for alarm purposes and recorded in the data file.

Outlet Thermocouple

This thermocouple is used to monitor the fluid outlet temperature from the heater tube holder assembly. The thermocouple connector is located to the right of the upper bus bar (bottom position). The thermocouple is to be inserted into the upper thermocouple port on the heater tube holder

assembly. The temperature reading is monitored for alarm purposes, shown on the display and recorded in the data file.

Inlet Thermocouple

This thermocouple is used to monitor the fluid inlet temperature to the heater tube holder assembly. The thermocouple connector is located to the right of the lower bus bar (top position). The thermocouple is to be inserted into the lower thermocouple port on the heater tube holder assembly. The temperature reading is monitored for alarm purposes, shown on the display and recorded in the data file.

Lower Bus Bar Thermocouple

This thermocouple is used to monitor the lower bus bar temperature. The thermocouple connector is located to the right of the lower bus bar (middle position). The thermocouple is to be inserted into the thermocouple hole located on the underside of the lower bus bar. The temperature reading is not shown on any display, but is monitored for alarm purposes and recorded in the data file.

Outlet Line Heater Thermocouple

This thermocouple is used to monitor the outlet tubing line temperature when using high viscosity fluids. The thermocouple connector is located to the right of the lower bus bar (bottom position). This thermocouple is located within the custom heating wrap for this tubing assembly. The temperature reading is monitored for alarm purposes and is shown on the Instrument Status display. It is not recorded in the data file.

Inlet Line Heater Thermocouple

This thermocouple is used to monitor the inlet tubing line temperature when using high viscosity fluids. The thermocouple connector is located to the left of the lower bus bar (top position). This thermocouple is located within the custom heating wrap for this tubing assembly. The temperature reading is monitored for alarm purposes and is shown on the Instrument Status display. It is not recorded in the data file.

Pump Heater Thermocouple

This thermocouple is used to monitor the pump heater temperature. The thermocouple connector is located to the left of the lower bus bar. This thermocouple is to be placed under the pump heater (between the pump heater and the pump face). The temperature reading is monitored for alarm purposes and is shown on the Instrument Status display. It is not recorded in the data file.

Fluid Temperature Thermocouple

This thermocouple is used to monitor the fluid temperature inside the reservoir. This thermocouple only exists when the mechanical stirrer assembly is used. The thermocouple connector is located on the back of the

machine next to the external cooler connections. This thermocouple is to be placed into the thermowell located on the mechanical stirrer reservoir lid. The temperature is for monitoring only and is not associated with any alarms. It is shown on the Instrument Status display. It is not recorded in the data file.

Power Button

The red illuminated power button on the front of the machine enables power to the entire machine.

User Interface

The user interface is a PC and uses touchscreen functionality. No keyboard or mouse are required (a USB mouse/keyboard can be connected if desired). Refer to section 4.3 for more details.

Fault Indicator

A fault indicator strip is located on the front of the machine below the user interface. It will illuminate various system faults, should one exist. The possible system faults that can be illuminated are:

- 24 VDC
- Encoder
- 5 VDC
- T/C Actu
- Filter DP
- System Press
- ESD 24 VDC
- Tube Htr SCR
- Cooler 12 VDC
- Vent Vlv
- N2 Vlv
- Bypass Vlv
- Pos DP Vlv
- Neg DP Vlv
- Fans
- Pump Speed
- Switch

Emergency Stop

Push in to turn off power to the machine in an emergency situation. Twist to release and restore power to the machine.

Coolant Flow Control

Coolant flow can be controlled using the flow control knob on the flow meter, once coolant flow has been established from the external cooling system. The flow meter is located on the front of the machine above the reservoir. The standard flow setting is 10 GPH (39 L/Hr). Each tic mark on the flow meter is 2 GPH. Adjust flow so that the ball float is within the recommended range shown on the flow meter.

Drop Counter

Not used on the Refinery Process Analyzer unit.

Differential Pressure (DP) Connector

The DP connector connects the DP assembly to the test machine. It is located on the lower right of the front of the machine. Special tubing lines

are required to allow fluid flow to the DP assembly. The DP reading is monitored for alarm purposes, shown on select displays and recorded in the data file.

Circuit Breaker

The circuit breaker is located on the back of the machine next to the power plug. It is a 10 amp device for protection of the machine. It can be reset by pushing the button.

Device Breaker Reset

Various devices have individual power protection associated with them (figure 4-1). There are individual breaker reset buttons for the following devices:

- Pump
- Tube heater
- Reservoir #1 heater
- 24V power
- Reservoir return line heater*
- Inlet line heater*
- Outlet line heater*
- Reservoir #2 heater*
- Pump heater*

Note: * designates optional equipment.

They can be reset individually by pushing the associated button.

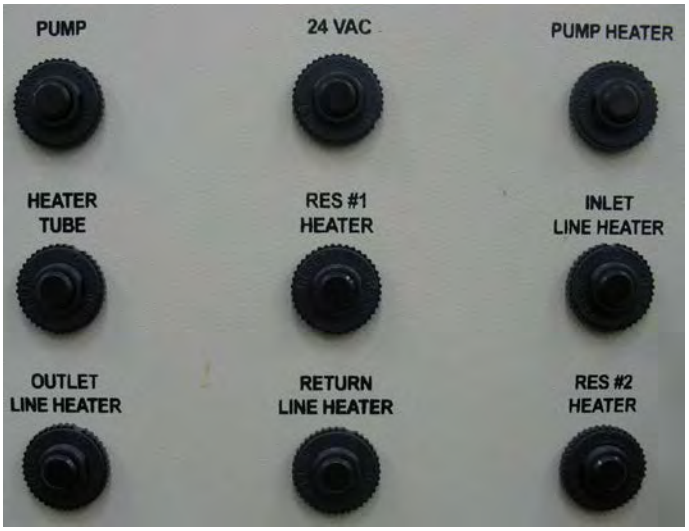


Figure 4-1 – Device Breaker Reset Location

4.3 User Interface

4.3.1 Overview

The F450 (FT^2) user interface makes testing easy to setup, repeat and control. It is operated entirely under a Windows® operating system environment and is completely menu driven. It utilizes touchscreen functionality that allows items to be selected by simply touching the item to be selected with ones finger, stylus, or selecting it with a mouse (if a mouse is connected). Live signal values are displayed, even when a test is not running. During testing, test data is displayed both numerically and graphically.

Software functionality monitors various inputs (i.e. heater tube temperature, heater power, inlet temperature, outlet temperature, reservoir temperature, system pressure, heater tube thermocouple position) and their values are saved into a data file at a selectable interval. The data file created is saved in a format that can be opened with a standard spreadsheet or document application, once transferred to an external PC.

Besides running the various types of tests, the user interface is capable of the following functionality:

- Data transfer
- Data retrieval
- Printing
- Alarming/Alarm log update
- Manual device control
- Device calibration
- Runtime statistics logging
- Safety backup monitoring
- User preference customization
- Network capability
- Date/Time setting

The user interface software application is automatically started when the machine is powered up. Should the display go to sleep, it can be reawakened by touching somewhere on the touchscreen surface.

4.3.2 Display Architecture

The displays are made up of four (4) areas (figure 4-2), with each area having special functionality. The various display areas are:

- Header
- Main display area
- Status/navigation bar
- Message bar

Figure 4-2 – Display component areas

Header

The header area contains safety controller temperature information, the display title and various icons that when pressed, initiate additional functionality.

Depending on the machine configuration, up to four (4) temperature readings are shown at the top of the header area that are monitored by the safety controller as backup protection. They are: tube temperature (high alarm/abort), reservoir #1 temperature (high alarm/abort), outlet temperature (low alarm/abort) and reservoir #2 temperature (high alarm/abort). The standard machine only monitors three (3) temperatures (figure 4-3). Reservoir #2 temperature is only shown when the single pass option has been activated on the machine (figure 4-4).

Figure 4-3 – Monitored Safety Temperatures (standard machine)

Figure 4-4 – Monitored Safety Temperatures (with single pass option)

The current value is displayed within the temperature bar. The temperature bar is color oriented with the green area representing the safe level, the yellow area represents approaching alarm limits and the red area represents approaching abort limits. A vertical white line represents where the current reading is on the color temperature bar.

The display title is shown in the center of the header area.

The upper right side of the header area has various icons that have functionality associated with them when selected. Icon availability can differ between displays. They can call up a help screen for the particular display (figure 4-5), return to the Main Menu (figure 4-6), exit from current display or exit out of the Falex 450 (FT^2) user interface application (figure 4-7), or initiate printing (figure 4-8).


Figure 4-5 – Current display 'Help' information icon


Figure 4-6 – Return to Main Menu 'Home' icon


Figure 4-7 - 'Exit' from display application icon


Figure 4-8 - 'Print' current page icon

Main Display Area

The main display area contains graphs, numeric data, buttons, and enterable fields to allow the operator to configure, run and manage tests.

Status/Navigation Bar

The status/navigation bar contains information regarding the operation status of important devices and can also contain display navigation arrows (figure 4-9). It will also show the type of test that has been selected to run or is running. Various key values will also be shown here during specific startup sequences.

Current device operational status information is shown for: fluid pump, reservoir heater, tube heater, cooling pump, inlet valve, exhaust valve and line heater. A green status light to the left of each device indicates that it is 'on' or 'open' (in the case of the inlet/exhaust valves). If the device status is not green, then it is 'off' or 'closed'.

Navigation arrows will open up additional displays associated with the button category selected on the Main Menu. They navigate forward (→) or backward (←) through the additional displays. They are not available on all displays.

Figure 4-9 – Status bar contents

Message Bar

The message bar is divided into three (3) tabular areas that keep the operator informed on what the machine is doing (figure 4-10).

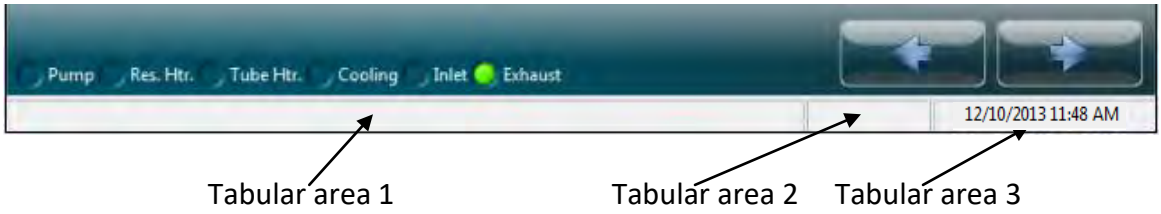


Figure 4-10 – Message bar tabular areas

Tabular area 1 shows current messages on what operation the machine is trying to perform or will display an active alarm message. Tabular area 2 is used for miscellaneous notifications (it is not always shown). Tabular area 3 shows the current date and time utilized by the 'user interface'.

4.3.3 Functionality

As described earlier, buttons, icons and enterable fields can be selected by simply touching the item to be selected with ones finger, stylus, or selecting it with a mouse (if a mouse is connected).

Buttons, enterable fields, values and text that are grayed out are not enabled (figure 4-11). If a grayed out item is selected, nothing will happen. Various

conditions must be met within the control software before particular buttons or enterable fields are enabled.

Figure 4-11 – Disabled functionality

Enterable fields are shown as white rectangular areas. These fields allow the operator to enter alpha-numeric information or to enter numeric information. If an alpha-numeric field is selected, a full keyboard will appear on the screen so that the information can be entered (figure 4-12). If a numeric field is selected, a keypad will appear so that the numeric value can be entered (figure 4-13). If a keyboard is connected to the machine, information can be entered from the keyboard for the selected enterable field.

Figure 4-12 – Alpha-numeric keyboard

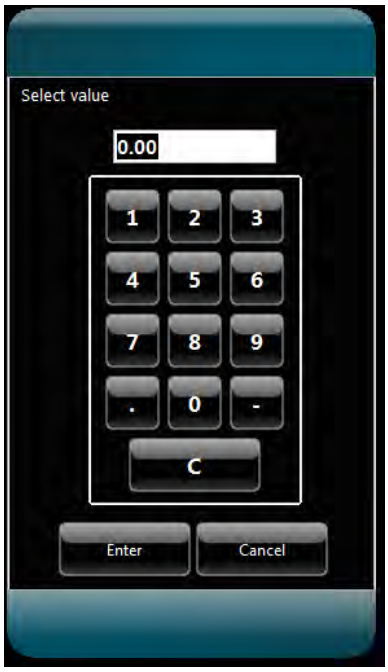


Figure 4-13 – Numeric keypad

Actions taken by the operator require a secondary operator verification before the action is executed (figure 4-14). This will prevent accidental selection of critical functionality. Such actions requiring secondary verification are saving changes, file deletion, aborting a test and exiting the user interface application.

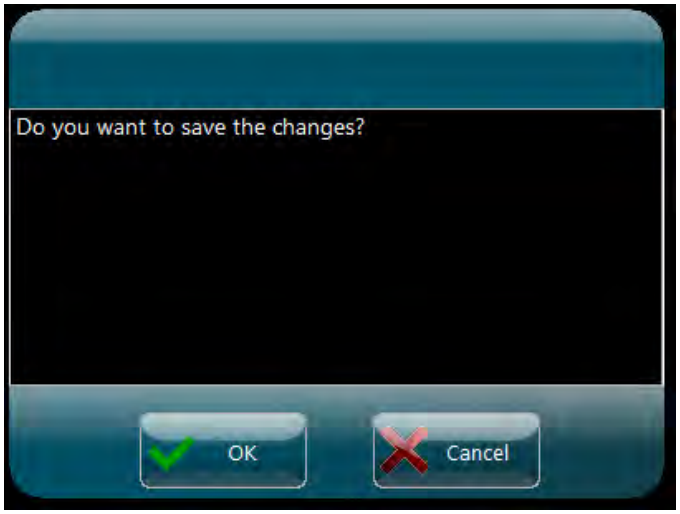


Figure 4-14 – Operator verification pop-up

4.3.4 Password Level

The user interface incorporates a level 1 password, which enables additional functionality.

Level 1 is for supervisor access. It enables the following additional functionality:

- Access to Windows® Explorer interface
- Ability to change network settings
- Enable calibration functionality

The machine is delivered with the default level 1 password of '123456'. It can be changed in the 'User Preferences' area and periodically should be changed for security purposes (the department supervisor is the intended facilitator of this functionality). Should the level 1 password be forgotten, it can be determined by contacting your local Falex representative.

When/where the level 1 password is required will be detailed as it applies to a particular display.

4.4 Display Functionality

The following sections will describe the functionality of each display.

4.4.1 Main Menu

The Main Menu display is the 'home' position for the user interface application and is the active display that appears upon a system power-up. From the Main Menu, the operator can run a timed duration test, run a hot spot test, set the redundant safety alarm/abort limits, configure user preferences, conduct file management and initiate maintenance functionality (figure 4-15). In addition, one can safely shutdown the user interface application prior to a machine power down. Select what operation is desired by touching the button with your finger, a stylus, or clicking on it with a mouse (if a mouse is connected).

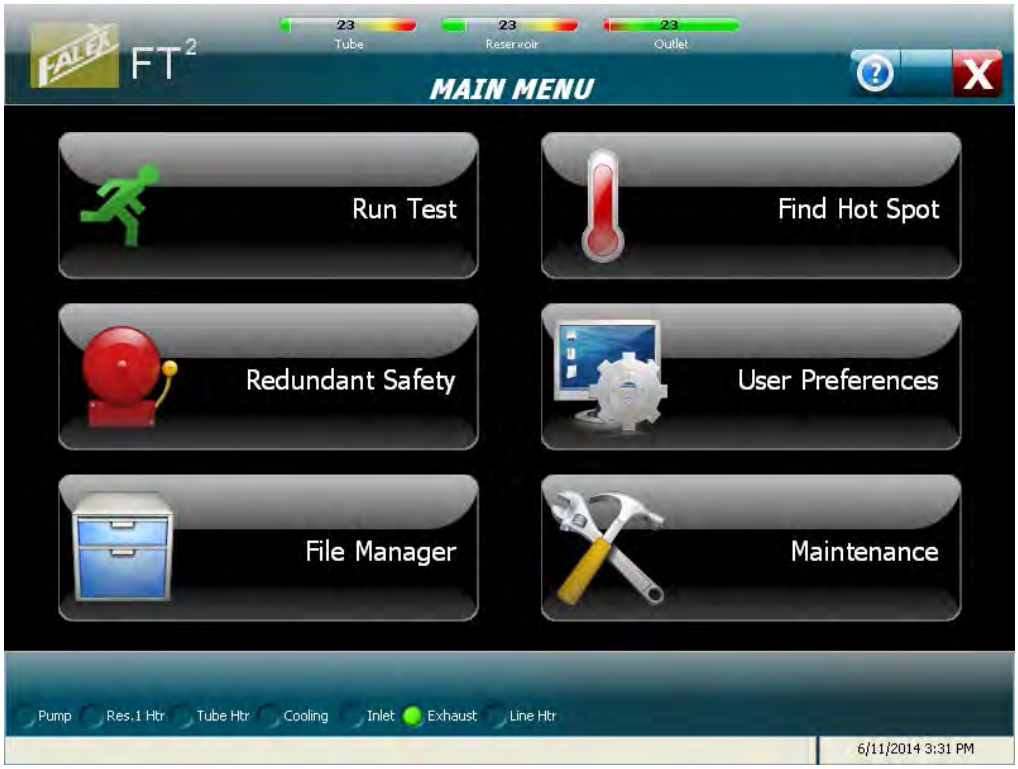


Figure 4-15 – Main Menu

Run Test

This selection allows the operator to enter test information and configure the refinery process test parameters. Refer to section 4.4.2 for more detail.

Find Hot Spot

This selection allows the operator to enter hot spot test information, select the desired hot spot type to initiate (hot spot determination or a hot spot validation) and configure the hot spot test parameters. Refer to section 4.4.3 for more detail.

Redundant Safety

This selection allows the operator to enter 'operator' abort levels for the four (4) temperatures monitored by the safety controller: outlet temperature, tube temperature, reservoir #1 temperature and reservoir #2 temperature (if activated). Please note that there are hardcoded temperature limits set in the software outside the enterable limit. Refer to section 4.4.4 for more detail.

User Preferences

This selection allows the operator to customize various parameters to meet their preferences and/or requirements. Parameters such as trend colors, graph scales limits and data collection options can be configured. Additional functions such as user table configuration (operators, test fluids, tube IDs), printer setup, network setup and the level 1 password can also be configured. Refer to section 4.4.5 for more detail.

File Manager

This selection allows the operator to copy data files, test profiles and test configuration files to an external device. It also allows the operator a way to get into Windows® Explorer (with level 1 password) and displays user interface disk usage. Refer to section 4.4.6 for more detail.

Maintenance

This selection allows the operator to manually initiate machine functionality and view data manually when the machine is not running a test. The many functions that can be done here are:

- View raw values
- View/print alarm log
- View test statistics
- View last hot spot data
- View machine serial #
- Set time/date in controller
- Enable system calibration*
- View calibration data
- Calibrate touchscreen
- Manually control devices
- Set heater tube thermocouple position offset

Note: system calibration can be enabled with the level 1 password.

Refer to section 4.4.7 for more detail.

Miscellaneous Functionality

There is miscellaneous functionality associated with the Main Menu. From the Main Menu, the operator also can:

- View software versions
- Exit user interface application

Software Versions

Selecting the help button on the Main Menu will call up a pop-up window showing the software version numbers (figure 4-16). Separate software version numbers exist for the user interface (HMI) application, main controller software application and the safety controller software application.

Figure 4-16 – Software version pop-up

Exit User Interface Application

Selecting the from the header portion of the display will safely exit the user interface application before the machine is powered down. This will properly save and close any open files and/or tables before power is removed.

Note: It is recommended that the user interface application be properly shutdown prior to removing the machine from power. Powering down the machine without doing so could cause data loss and should only be done in an emergency.

4.4.2 Run Test

The 'Run Test' selection initiates the process of configuring, initializing and starting a refinery process timed test. There are many steps that must be completed before the actual test is started. Once the test configuration parameters have been entered, a 'startup' process is initiated. This 'startup' process initializes the machine and its various devices to required pretest conditions. When the various operator configured 'startup' conditions have been met, the actual test can then be started.

Once the test is complete, the heater tube temperature is cooled (ramp down time based on operator configuration), the system pressure is released, the pump is stopped and reservoir heating is stopped. The heater tube temperature thermocouple will go to the home position once the outlet temperature is <40 °C. Once the heater tube thermocouple is in the home position, a test complete pop-up display will appear notifying the operator that the test is complete. The machine can now be broken down for cleaning and weighing of the heater tube (if required).

The 'startup' process can take up to several hours to complete depending on the test configuration, before the 'start' button can be pressed. It consists of a series of displays that require the operator to initiate specific functionality so that required pretest conditions can be achieved. The pretest conditions are based off of the operator's test configuration. The operator also has the ability to determine the order that some of the various functions are to execute.

Note: The test cannot start unless <u>all</u> conditions are met.

Figure 4-17 is a typical 'startup' process showing the conditions that must be met before a test can be initiated (reservoir heating and line heating are

enabled). The startup criteria display will change based upon the test configuration.

Figure 4-17 – Test startup conditions (based on test configuration)

The condition is satisfied when the indicator next to the condition is green.

The available startup conditions are:

- Cooling Enabled
- Redundant Safety OK
- Safety Cover in Position
- Purge Cycle Complete*
- Res. Temp. Achieved*
- Res. Soak Time Complete*
- Line Heater Temp. Achieved*
- Pressure Achieved*

Note: * designates items that are operator configurable.

Not all the conditions have a separate process associated with them requiring operator/user interface interaction. 'Redundant Safety OK' condition is achieved internally (the safety controller is checked to see if it is functioning properly), once the 'Continue to Test' button has been selected from the Test Configuration display. The external cooling system will need to be turned on and the flow initiated at the external cooling unit manually by the operator to establish flow (ball should be floating within coolant flow meter) to satisfy the 'Cooling Enabled' condition.

Note: If no flow is detected internally, an alarm message will pop-up alerting the operator to turn on the external cooler (figure 4-18).

Figure 4-18 – No Coolant Flow Warning pop-up

The 'Safety Cover in Position' condition will be satisfied once the safety cover has been correctly placed over the heater tube holder assembly and has been detected (photo eye is located to the right of the lower bus bar). The safety cover can be placed at any time during the startup process.

An audible 'beep' will sound when the time consuming startup conditions have been met (purge, reservoir heating, reservoir heat soak, line heating, pressurization). This is to alert the operator that the step has been completed and allows the operator to perform other duties while the particular startup sequence completes.

Once the 'startup' process has been completed, the main test display will appear, where test can be started and variables can be monitored. Navigation buttons exist that allow the operator to access additional displays while a test is active.

Note: If a thermocouple is not plugged in or one fails during the startup process, an alarm message will pop-up alerting the operator (figure 4-19).

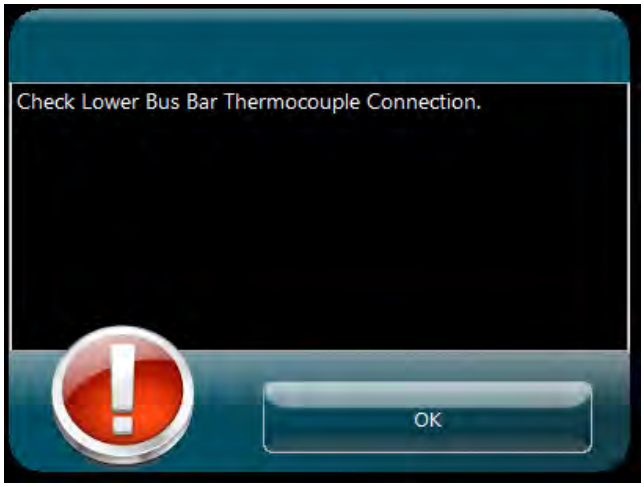


Figure 4-19 – Thermocouple Fail pop-up

All of the displays associated with the ‘Run Test’ button are discussed in the sub sections below.

4.4.2.1 Test Configuration

When the ‘Run Test’ button is selected from the Main Menu, the ‘Test Configuration’ display appears (figure 4-20). This display allows the operator to enter test information for the test and also configure parameters associated with the test (tube material). The tube material (316 stainless, 1018 steel, aluminum) must be selected in order to navigate to the remaining configuration displays. It is not mandatory that the other test information be entered. However, it is recommended that this information be entered to help in distinguishing test parameters and associated data for future reference. The test information entered on this display is stored in the data file.

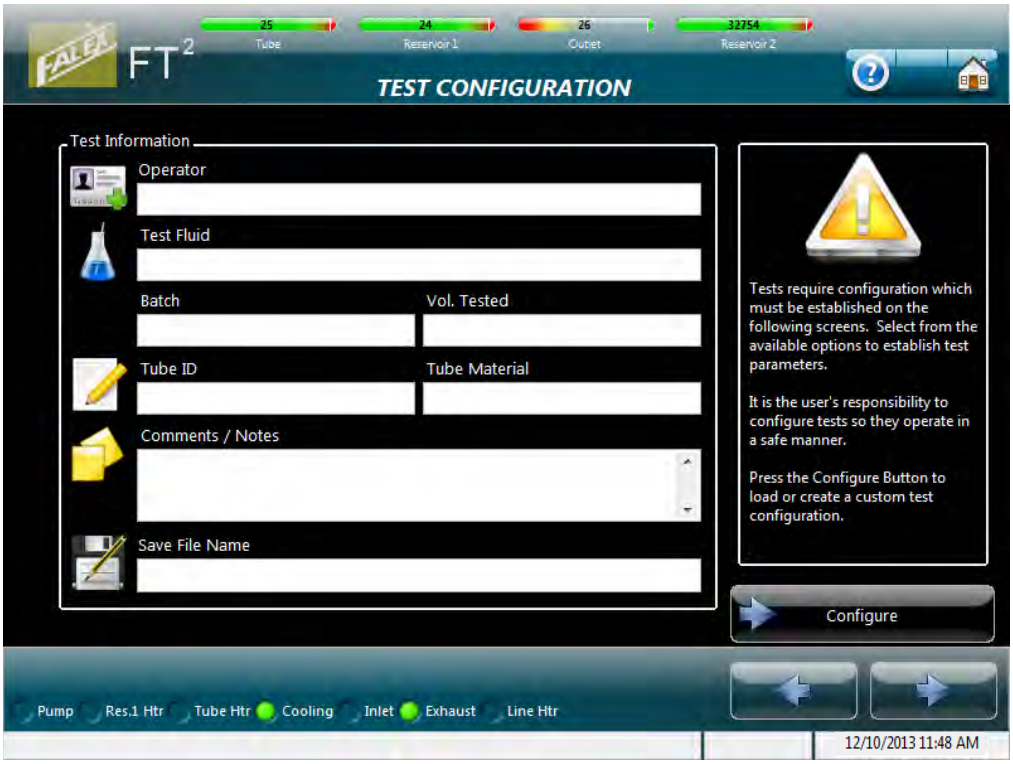


Figure 4-20 – Test configuration display

Test information that can be entered is:

- Operator Name
- Test Fluid
- Fluid Batch ID
- Volume Tested
- Heater Tube ID
- Tube Material*
- Test Comments
- Data File Name

Note: *designates the field(s) that must be configured. Tube material must be selected in order to navigate to the remaining configuration displays.

Entered information is stored in the Name, Test Fluid and Tube ID fields for quick retrieval for future tests. Previous Tube ID numbers can be called up and quickly modified using the back space key and replacing the required numbers. Select the white field to call up the available names already entered and select the desired name. If the name is not entered, select 'Add…' and enter the required name via the alpha-numeric keyboard. Always hit the 'Enter' key on the keyboard to enter the data into the proper field.

Information entered in the data file name field (if anything) will be contained in the data file name structure. Data file names are defaulted with the current date & time stamp along with a test type designation.

The data file name structure is as follows:

YYYYMMDD_TTTT_X_Z.csv, where
Y = year
M = month
D = day
T = time (24 hour clock format)
X = operator entered information
Z = test type designation. The various test type designations are:

RPAData	*(refinery process analyzer test data file)*
RPAProfiles	*(refinery process analyzer test temperature profile)*

Example of refinery process test data file without operator entered information:

20140429_1413__RPAData.csv

Example of refinery process test data file with operator entered information:

20140429_1413_Tuesday_RPAData.csv

Selecting the 'Configure' button will advance to the refinery process test configuration series of four (4) displays, where the test options and parameters can be defined (figures 4-21, 4-22, 4-23, 4-24). Each of the configuration displays has an 'Options' area (where the required options for the test are enabled/disabled) and an 'Overall Parameters section' (where the specific parameter settings can be defined). Selecting the  button or  button (located on either side of the Overall Parameters section) advances backward or forward through the configuration displays to allow the refinery process test options and parameters to be defined. Anytime an option is checked, the associated configuration display will appear so parameters related to the option can be configured.

The various options and parameter settings are discussed after the configuration display depictions.

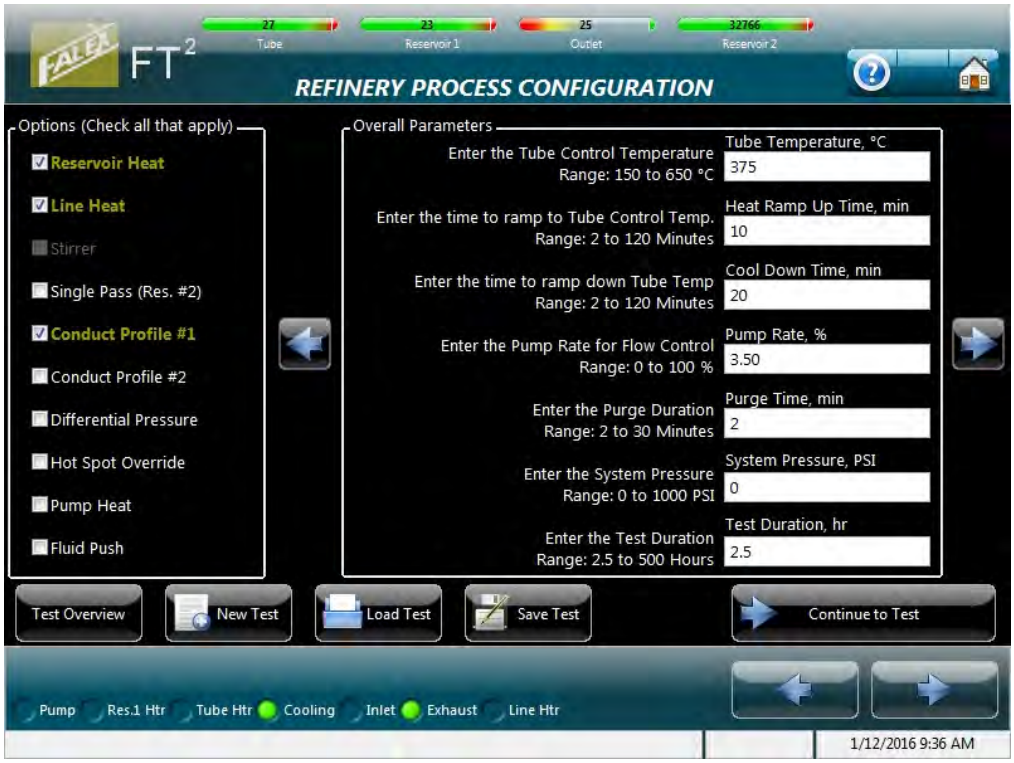


Figure 4-21 – Refinery Process test configuration (standard parameters)

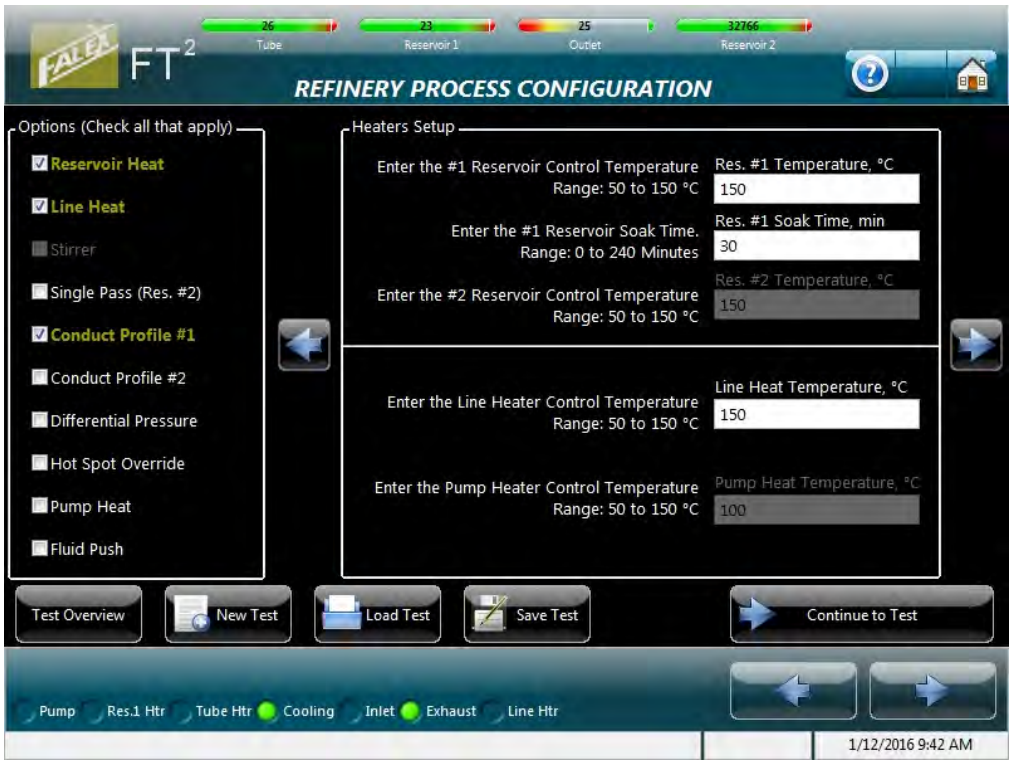


Figure 4-22 – Refinery Process test (optional parameters)

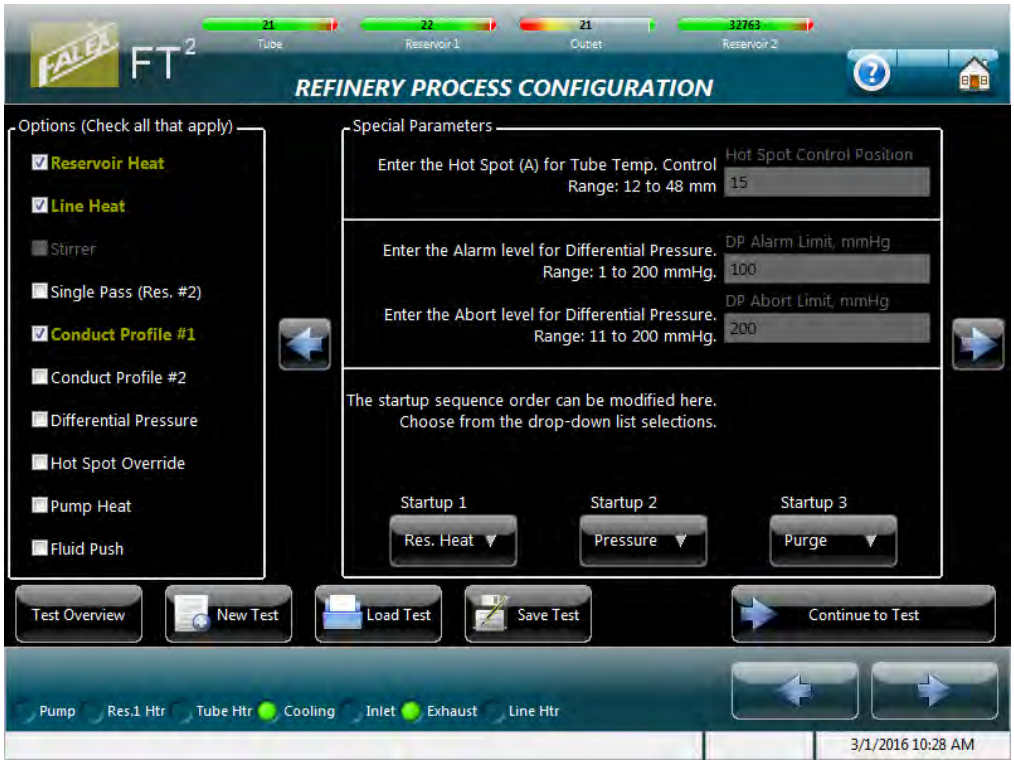


Figure 4-23 – Refinery Process test configuration (special parameter/sequence order)

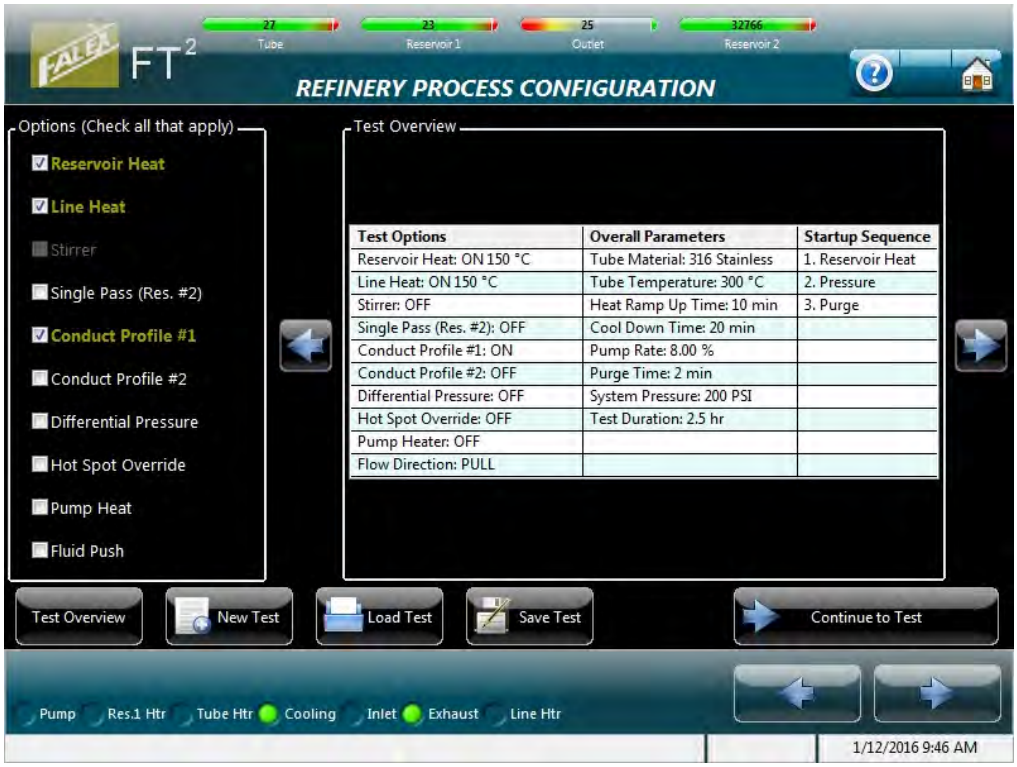


Figure 4-24 – Refinery Process test configuration (summary)

Note: The refinery process test requires the startup procedure to be completed before test duration is started.

Test options that can be selected are as follows (figures 4-21, 4-22):

- Reservoir heat
- Line heat
- Stirrer
- Single pass (requires reservoir #2)
- Conduct temperature profile #1 (captured in 1st hour)
- Conduct temperature profile #2 (captured in last hour)
- Differential pressure (DP)
- Hot spot override
- Pump heat
- Fluid Push

Note: Hot spot override values are limited to 12 – 48mm when a temperature profile is selected. This is to prevent the thermocouple from being in the tube shoulder during a profile or the actuator from bottoming out during actuator movement of a profile (should a large override value be entered). If the hot spot override option is selected without a temperature profile being selected, the hot spot override value range is limited to 0 – 60mm.

Note: Line heat, Stirrer, Single Pass, Pump heat, Fluid push and Differential Pressure are options to the standard FT^2 Refinery Process Analyzer machine and are to be ordered separately. Many of these options will need to be 'activated' within the software in order for their associated functionality to be enabled.

<u>Reservoir Heat</u>
Process that heats the primary reservoir to a determined temperature so that the test fluid's viscosity decreases and it can be pumped through the system. Requires temperature setpoint and soak time entered values.

<u>Line Heat (must be activated)</u>
Process that heats the tubing lines to eliminate any test fluid heat loss as it flows through the system and keeps the test fluid's viscosity constant so that it can be pumped through the system. This option is to be used with high viscosity fluids and requires that the standard tubing lines be removed and the optional heated lines be installed. Requires a temperature setpoint entered value. Refer to Addendum F for details regarding setup and configuration of this option.

<u>Stirrer System (must be activated)</u>
Independent system that allows for stirring of the test fluid within the reservoir. The speed of the stirrer is controlled manually. The

mechanical stirrer does not interface with the electronic control system of the Falex 450 (FT^2) machine. Check box only designates whether the mechanical stirrer was used or not for the test, as shown in the test data file header. Refer to Addendum J for details regarding setup and configuration of this option

Note: This option is only available for the split ring clamping collar reservoir assembly.

Single Pass (must be activated)

System where the test fluid is pumped through the system only once and is deposited into a 2nd reservoir. This requires standard tubing to be removed and the optional 2nd reservoir tubing lines and 2nd reservoir assembly to be installed. The standard reservoir heat option must be selected in order for the single pass option to be enabled (single pass option must be activated). Requires a temperature setpoint entered value. Refer to Addendum H for details regarding setup and configuration of this option.

Note: Single pass option (2nd reservoir) cannot be configured without the standard reservoir heat option also being configured.

Conduct Temperature Profile #1

A sequence of captured heater tube temperatures at various heater tube thermocouple positions. Profile conducted during the 1st hour of the test. When selected, the minimum allowable test duration is 2.5 hours to allow for the time to conduct the temperature profile. The hot spot or hot spot override value must be between 12 – 48mm.

Conduct Temperature Profile #2

A sequence of captured heater tube temperatures at various heater tube thermocouple positions. Profile conducted during the last hour of the test. When compared with profile #1, it can be determined how the heater tube deposit affects the temperatures at the various locations of the heater tube. When selected, the minimum allowable test duration is 2.5 hours to allow for the time to conduct the temperature profile. The hot spot or hot spot override value must be between 12 – 48mm.

Differential Pressure (DP) (must be activated)

System that allows the differential pressure to be determined and is designed to be used with ***low*** viscosity fluids only.

Note: Use of high viscosity fluids with the DP assembly will cause damage to the equipment.

This option requires an additional DP test assembly and associated tubing lines to be attached to the FT^2 cabinet. Refer to Addendum G for details regarding setup and configuration of this option.

Hot Spot Override

Process that allows the operator to enter a heater tube thermocouple position that the thermocouple will move to and the heater tube temperature will be controlled at. Requires a thermocouple position to be entered. Only entries between 0 – 60mm are allowed, when a temperature profile is not selected. When a temperature profile is selected, only entries between 12 – 48mm are allowed. When used, this will override the existing determined hot spot location with the operator entered position. The determined hot spot location (calculated from the last hot spot determination test) will be reinstated at the completion of the test.

Pump Heat (must be activated)

Process that heats the pump to eliminate any test fluid heat loss as it flows through the pump and keeps the test fluid's viscosity constant so that it can be pumped through the system. This option is to be used with high viscosity fluids and requires that the pump heater and thermocouple be installed. Requires a temperature setpoint entered value. Refer to Addendum I for details regarding setup and configuration of this option.

Fluid Push

Fluid flow through the heater tube assembly can be configured depending on the tubing line assemblies that were supplied. The standard tubing line assemblies allow the fluid to be 'pulled' through the heater tube assembly (figure 4-25). With optional 'push' line assemblies, the fluid will be 'pushed' through the heater tube assembly (figure 4-26). When the 'Fluid Push' configuration box is checked, the flow direction is shown in the test summary of the data file as 'Push'. When left unchecked, the flow direction is shown in the test summary of the data file as 'Pull'.

Note: Reservoir and inlet tubing lines shown in figures 4-25 and 4-26 may not be representative of the reservoir type used in your system (reservoir type shown is the bolted flange). The diagrams purpose is to show the fluid flow differences through the system.

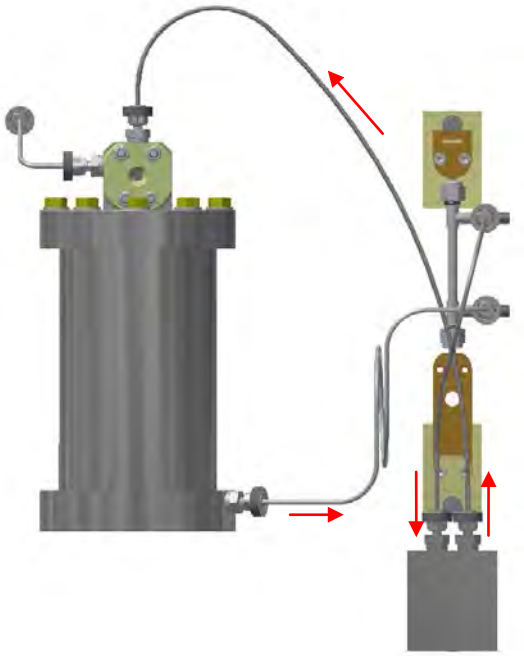


Figure 4-25 – Pull configuration

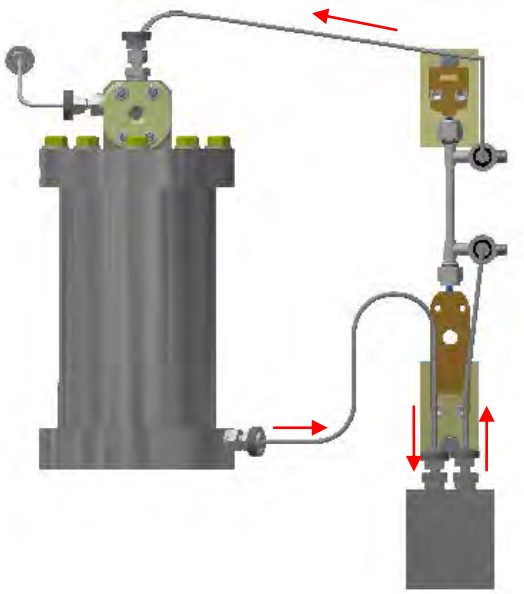


Figure 4-26 – Push configuration

Standard test parameters can be modified as follows (figure 4-21):

- Heater tube control temp. setpoint (150 – 650 °C)
- Heater tube control temp. ramp up time (2 – 120 min)
- Heater tube control temp. ramp down time (2 – 120 min)
- Pump rate (0 – 100%)
- Purge time (2 – 30 min)
- Pressure setpoint (0 - 1000 psi / 0 – 6895 kPa)
- Test duration time
  - 1 – 500 hours without a temperature profile selected
  - 2.5 - 500 hours with a temperature profile selected

Optional test parameters can be modified as follows (figure 4-22):

- Reservoir #1 temperature setpoint (50 – 150 °C)
- Reservoir #1 temperature soak time (0 – 240 min)
- Reservoir #2 temperature setpoint (50 – 150 °C)
- Heated line temperature setpoint (50 – 150 °C)
- Pump heater temperature setpoint (50 – 150 °C)

Special parameter/sequence order configuration can be modified as follows (figure 4-23):

- Hot spot location (0 – 60mm) without a temperature profile selected or (12 – 48mm) with a temperature profile selected
- Differential pressure high alarm limit (1 – 200 mmHg)
- Differential pressure high abort limit (11 – 200 mmHg)
- Startup sequence order (based on selected options). Available options are selectable from a drop down list for each step.

WARNING: ***It is the operator's responsibility to determine the correct temperature/pressure combination for the particular fluid being tested to prevent the fluid from vaporizing. Failure to do so could cause the fluid to combust, causing serious injury to the operator.***

WARNING: ***For your own safety and protection from injury, running high temperature and/or high pressure tests while unattended is not recommended.***

It is the responsibility of the operator of this equipment to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

Note: Prior to running a Refinery Process test, verify the graph scales and redundant safety abort limits are set correctly for the desired test parameters. Graph scales can be modified by selecting the 'User Preferences' button on the Main Menu. See section 4.4.5 for more details. Redundant safety abort limits can be modified by selecting the 'Redundant Safety' button on the Main Menu. See section 4.4.4 for more details.

Once the refinery process test has been configured, the test configuration can be saved for future recall. Select the 'Save Test' button at the bottom of the display and enter a name for the test configuration.

A saved test configuration can be recalled by selecting the 'Load Test' button at the bottom of the display. A listing of saved tests will be

shown. Select the desired test and select the 'Load' button. Refer to section 4.4.6 regarding how to delete a saved test from the list.

Selecting the 'New Test' button will reset the current test configuration to the default configuration template.

Selecting the 'Test Overview' button will call up a test summary of configured test (figure 4-24).

Once all test information has been entered and the test configuration has been completed, selecting the 'Continue to Test' button will advance to the 'Test Startup' sequence series of displays.

4.4.2.2 Heat Reservoir

One of the first three (3) displays in the startup process (depending on configuration) is the Heat Reservoir display (figure 4-27). The purpose of this process is twofold, heating the primary reservoir (reservoir #1) to a desired temperature and allowing the primary reservoir to heat soak for the configured amount of time to allow the temperature to equalize.

The ability exists for the operator to initiate the line heater heating (if enabled) and reservoir #2 heating (if single pass option enabled) from this display (figure 4-28). It is up to the operator to determine when these heating sequences are to be initiated. If the line heater option is enabled (configured for the test) but never initiated, the startup process will not complete. When enabled, reservoir #2 heating does not affect the startup sequence criteria. If the heating for these options has already been initiated, their associated start button will be gold but not selectable.

Note: For machines that use the bolted flange reservoir system, the primary reservoir (reservoir #1) is located on the machine and the secondary reservoir (reservoir #2) that is used with the single pass option is located on the attached reservoir stand.

For machines that use the split ring clamping collar reservoir system, the primary reservoir (reservoir #1) is located on the attached reservoir stand and the secondary reservoir (reservoir #2) that is used with the single pass option is located on the machine.

Refer to Addendum H for details on the single pass option.

Figure 4-27 – Heat Reservoir display (with heating already initiated)

Figure 4-28 – Heat Reservoir display (with heating already initiated and line heaters enabled and already initiated)

(Please note that the 'Single Pass (res#2)' option is not enabled in figure 4-28).

This process is initiated by selecting the 'Start Reservoir Heater' button. It could take approximately 1 – 3 hours to attain the maximum reservoir temperature of 150 °C. The temperature that is to be attained is defined in the test configuration process. The reservoir temperature setpoint is shown on the display and cannot be changed.

Note: Reservoir temperature must be 6 °C below the temperature setpoint before the reservoir will start heating. This is important should an abort occur during the startup process and the process is restarted. The reservoir heating sequence must see a 4 °C temperature rise in 10 minutes to confirm heating is occurring.

When the heating to temperature sequence is complete, the following will occur:

- An audible 'beep' is sounded notifying the operator that the reservoir temperature is within 3% of the configured setpoint and the configured temperature soak period has started.
- In the 'System Verification' section of the display, the indicator next to the 'Reservoir Temp. Achieved' will turn green.
- The heat soak sequence will start automatically.

When the heat soak period is complete, the following will occur:

- An audible 'beep' is sounded notifying the operator that the sequence is complete.
- In the 'System Verification' section of the display, the indicator next to the 'Res. Soak Time Complete' will turn green.
- The 'Continue' button will become enabled.

Three (3) progress bars are displayed to keep the operator informed on the startup process status. They are:

- *Res. #1 Temp* – current reservoir jacket temperature (entire progress bar represents reservoir jacket temperature setpoint)
- *Soak* - elapsed soak time (entire progress bar represents the configured time in minutes)
- *Overall* - overall startup process progress

Selecting the 'Abort Startup' button will abort the startup process and stop any devices that may be running.

The 'Continue' button is not enabled until the primary reservoir temperature soak condition has been satisfied. Once enabled, selecting the 'Continue' button will advance the startup process to the next configured step. If this is the last step, a 'Startup Completed Successfully' pop-up display will appear (refer to section 4.4.2.5).

4.4.2.3 Pressurize System

One of the first three (3) displays in the startup process (depending on configuration) is the Pressurize System display (figure 4-29). The purpose of this process is to slowly pressurize the system with a compressed gas (dry grade oxygen/nitrogen mixture or nitrogen) to the desired pressure. System pressure will reduce the ability of the fluid to vaporize. Once pressurized, check for leaks (carefully tighten connection if a leak is found).

Warning: ***Always wear safety glasses/goggles and protective gloves when tightening any connection when the system is under pressure. Use caution and always tighten in the clockwise direction. Turning the tightening nut in the wrong direction will cause the system to depressurize rapidly, spraying test fluid.***

Note: ***It is up to the operator to determine what the correct pressure is to be set to for the given test fluid to prevent vaporization from occurring.***

The ability exists for the operator to initiate the line heater heating (if enabled) and reservoir #2 heating (if single pass option enabled) from this display (figure 4-30). It is up to the operator to determine when these heating sequences are to be initiated. If the line heater option is enabled (configured for the test) but never initiated, the startup process will not complete. When enabled, reservoir #2 heating does not affect the startup sequence criteria. If the heating for these options has already been initiated, their associated start button will be gold but not selectable.

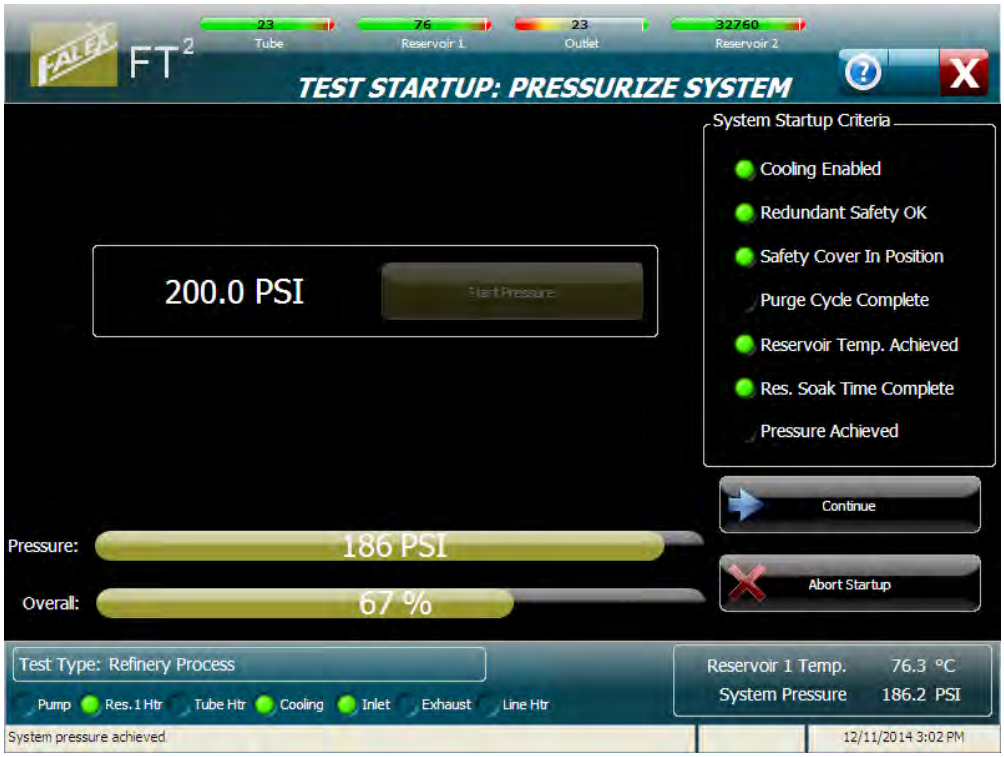


Figure 4-29 – Pressurize System display (with pressurization already initiated)

Figure 4-30 – Pressurize System display (with pressurization already initiated and line heaters enabled and already initiated)

(Please note that the 'Single Pass (res#2)' option is not enabled in figure 4-30).

This process is initiated by selecting the 'Start Pressure' button. The vent valve will close, the inlet valve will open and a pop-up display will appear reminding the operator to set the air tank regulator to the desired pressure (figure 4-31). Once the air tank valve is opened, the system will begin to pressurize. The pressure setpoint is shown on the display and cannot be changed.

Note: The manual inlet valve must be opened and the manual vent valve is closed for the system to pressurize. These are located on the front of the machine, under the reservoir.

Note: Do not over-tighten the manual inlet valve or manual vent valve. Over-tightening these valves will damage the valve seat resulting in pressure leaks. Only tighten valves until tension is determined.

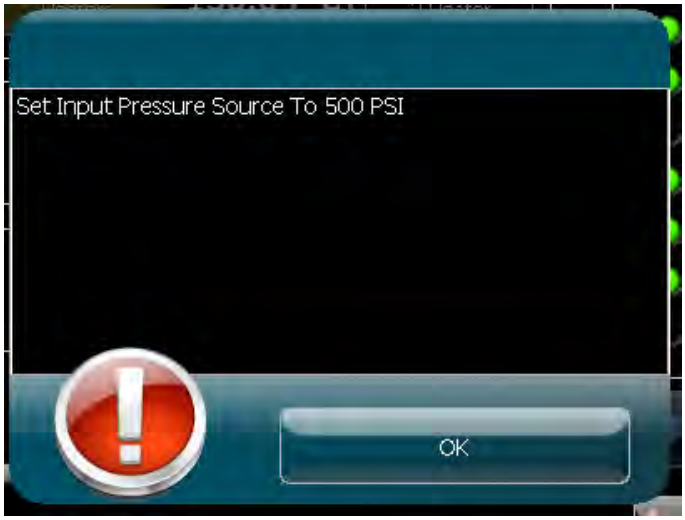


Figure 4-31 – Pressurization pop-up

When the sequence is complete, the following will occur:

- An audible 'beep' is sounded notifying the operator that pressure is within 3% of the configured setpoint and the sequence is complete.
- In the 'System Verification' section of the display, the indicator next to the 'Pressure Achieved' will turn green.
- The 'Continue' button will become enabled.

Note: Once the system has been pressurized, close the manual inlet valve to prevent possible pressure leakage through the solenoid valve.

Two (2) progress bars are displayed to keep the operator informed on the startup process status. They are:

- Pressure value as system is pressurizing (entire progress bar represents system pressure setpoint).
- Overall startup process progress.

Selecting the 'Abort Startup' button will abort the startup process and stop any devices that may be running.

The 'Continue' button is not enabled until the condition has been satisfied. Once enabled, selecting the 'Continue' button will advance the startup process to the next configured step. If this is the last step, a 'Startup Completed Successfully' pop-up display will appear (refer to section 4.4.2.5).

4.4.2.4 Purge System

One of the first three (3) displays in the startup process (depending on configuration) is the Purge System display (figure 4-32). The purpose of this process is to pump test fluid through the system to displace any air being held within the tubing lines and to achieve a constant stream of drops visible in the sight glass window.

The ability exists for the operator to initiate the line heater heating (if enabled) and reservoir #2 heating (if single pass option enabled) from this display (figure 4-33). It is up to the operator to determine when these heating sequences are to be initiated. If the line heater option is enabled (configured for the test) but never initiated, the startup process will not complete. When enabled, reservoir #2 heating does not affect the startup sequence criteria. If the heating for these options has already been initiated, their associated start button will be gold but not selectable.

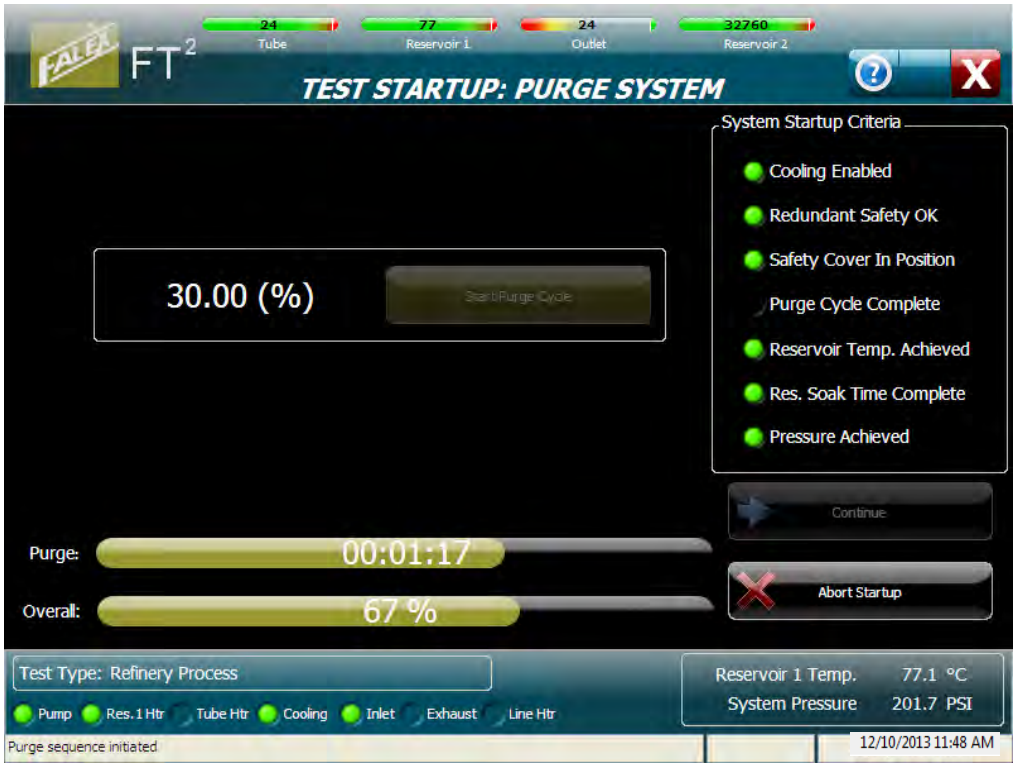


Figure 4-32 – Purge System display (with purge already initiated)

Figure 4-33 – Purge System display (with purge already initiated and line heaters enabled and already initiated)

(Please note that the 'Single Pass (res#2)' option is not enabled in figure 4-33).

This process is initiated by selecting the 'Start Purge Cycle' button. The sample pump will start at a higher than normal speed and will run at this speed for the configured purge duration. The pump speed is shown on the display as a percentage and cannot be changed.

When the sequence is complete, the following will occur:

- Pump speed is automatically changed to the value defined in the test configuration.
- An audible 'beep' is sounded notifying the operator that the sequence is complete.
- In the 'System Verification' section of the display, the indicator next to the 'Purge Cycle Complete' will turn green
- The 'Continue' button will become enabled.

Two (2) progress bars are displayed to keep the operator informed on the startup process status. They are:

- *Purge* - purge sequence progress (entire progress bar represents the configured time in minutes)
- *Overall* - overall startup process progress

Selecting the 'Abort Startup' button will abort the startup process and stop any devices that may be running.

The 'Continue' button is not enabled until the condition has been satisfied. Once enabled, selecting the 'Continue' button will advance the startup process to the next configured step. If this is the last step, a 'Startup Completed Successfully' pop-up display will appear (refer to section 4.4.2.5).

4.4.2.5 Startup Completed

Once the startup sequence has been satisfied (all criteria have been met), selecting the 'Continue' button will cause the 'Startup Completed Successfully' pop-up display to appear (figure 4-34).

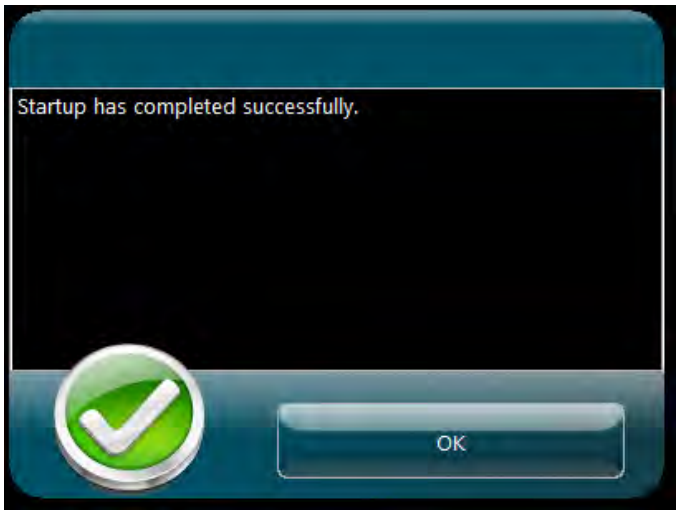


Figure 4-34 – Startup Completed Successfully pop-up

Selecting the 'OK' button will cause a 'Continue' display to appear (figure 4-35).

Figure 4-35 – Continue to Test display

Selecting the 'Continue to Test' button will advance the operator to the Run Test display, where the actual test can be started.

4.4.2.6 Run Test

The Run Test display is the display that will be active for the duration of the timed test (figure 4-36) and has the following functionality:

- Test can be started by selecting the ‘Start’ button
- Pump flow can be adjusted (only during temperature ramp and heat soak equalization periods)
- Test data can be viewed both graphically and numerically
- Trend pens can be enabled/disabled
- Trend can be manipulated using trend tools
- Test can be aborted by selecting the ‘Abort’ button
- Add pressure (to keep test from aborting)
- Access other displays associated with test

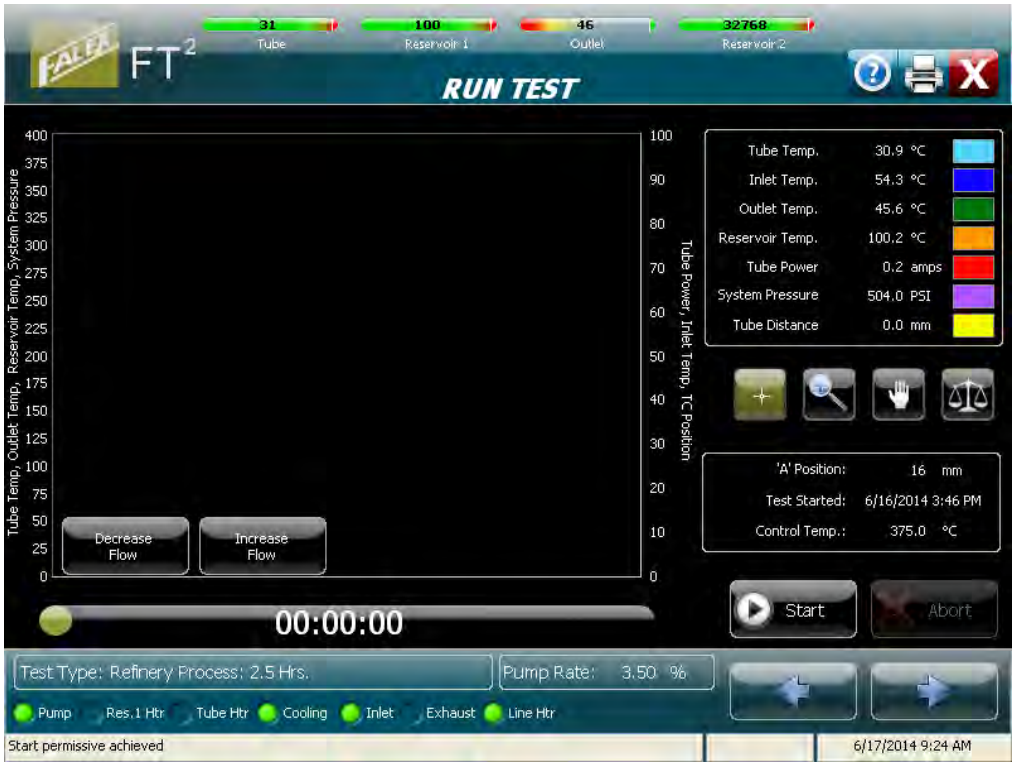


Figure 4-36 – Run Test display

Because the fluid viscosity will change as the heater tube heats up, the flow rate may no longer be equivalent to the desired rate (1 ml/min is the standard) per the pump rate configured for the test. Therefore, increase/decrease buttons can be utilized to adjust the flow rate to the desired flow rate (standard 1ml/min flow rate is equivalent to 20 drops in 30 seconds) during the heating sequence. Selecting the increase/decrease button will change the pump flow rate percentage by 0.01%. These buttons are only available during the temperature ramp and the 30 minute heat soak equalization period. Refer to section 4.4.7.6 for manually determining pump speed for various flow rates.

Note: If a custom flow rate is required, it is not known what the equivalent drip count should be.

The ability exists to add pressure during an active test from the standard Run Test display, should a pressure leak exist that could cause the test to abort on low pressure. When the pressure drops 5 psi (34 kPa) below the operator configured pressure setpoint, the 'Increase Pressure' button appears. Pressing this button will open the inlet solenoid valve. To successfully add pressure, open the pressure regulator on the supply tank, open the manual inlet valve and then press and hold the 'Increase Pressure' button to hold the inlet solenoid open. Once the pressure has been restored to the original pressure setpoint, release the button and close the manual inlet valve. When the pressure is within 5 psi (34 kPa) of the operator configured setpoint, the button will become disabled. Similar functionality also exists on the Instrument Status display (refer to section 4.4.2.8).

Trend pens can be enabled/disabled by selecting the color box next to the particular parameter.

The graph window represents approximately 30 minutes of data. The following trend tools are available to manipulate the graph:

Selecting this button is the 'No tool selected' button. This is the default trend tool. When this tool is selected, selecting anywhere on the graph will not do anything.

Selecting this button will open up a collection of 'zoom' tools to allow one to zoom in on the trend.

This is the 'Grab' tool. It allows the operator to grab the trend and move it around.

Selecting this button will return the trend to its original appearance.

Note: For aluminum tubes the power trace may go off of the display depending on the tube temperature setpoint. To rescale the chart so that the power trace is visible, select the 'zoom' tool button  ***and then select the 'auto scale'***  ***tool.***

The progress bar displays elapsed test duration time and represents the total test duration.

The following additional information is also displayed:

- Current hot spot position ('A' position) or entered hot spot override position (if the hot spot override option is enabled in the test configuration)
- Time/date stamp when test was started
- Control temperature (temperature the test is running at during main portion of test). This is what the heater tube temperature setpoint was configured to

Navigation buttons at the bottom of the display allow access to other displays while the test is active. The available displays are:

- Test information
- Instrument Status
- Alarm Log

4.4.2.7 Test Information

The Test Information display shows the current test information associated for the running test (figure 4-37). This information is for reference only (nothing can be changed). The test configuration parameters and alarm limits can also be viewed from this display. Selecting the 'View Test Parameters' button will show the test configuration summary for the current test (figure 4-38). Selecting the 'View Alarm Limits' button will show the alarm/abort limits for the particular test (figure 4-39). Whatever has been selected to be displayed (test information, alarm limits) will be retained.

Figure 4-37 – Test Information display

Figure 4-38 – Test Configuration Summary

Figure 4-39 – Alarm/Abort Limits

Note: Alarm/abort limits for heater tube temperature, reservoir temperature, line heater temperatures, pump heater temperature and system pressure are determined from their respective setpoints selected for the particular test.

The test information and test configuration parameters can be toggled between by selecting their respective button (View Test Information or View Test Parameters).

The test information and alarm/abort parameters can be toggled between by selecting their respective button (View Test Information or View Alarm Limits).

The progress bar displays elapsed test duration time and represents the total test duration.

Use the navigation buttons to view additional displays or return to the Run Test display.

4.4.2.8 Instrument Status

The Instrument Status display is an overview of current key values and their location on the machine in the standard ‘pull’ configuration (figure 4-40).

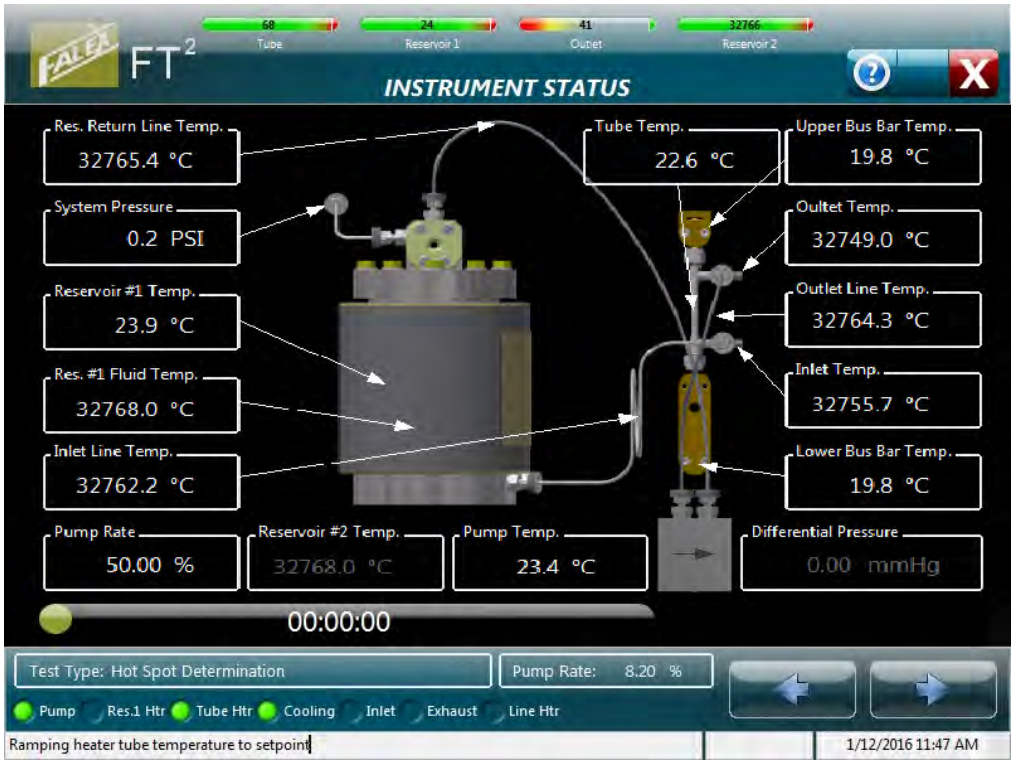


Figure 4-40 – Instrument Status display (pull configuration)

Note: Temperatures showing 32768.0 designate that the associated thermocouple has failed or is not connected.

Note: Reservoir #1 fluid temperature only available with the mechanical stirrer option.

The ability exists to add pressure during an active test, should a pressure leak exist that could cause the test to abort on low pressure. When the pressure drops 5 psi (34 kPa) below the operator configured pressure setpoint, the system pressure area becomes an invisible button. Pressing in the area around the system pressure value will open the inlet solenoid valve. To successfully add pressure, open the pressure regulator on the supply tank, open the manual inlet valve and then press and hold the area around the pressure value to hold the inlet solenoid open. Once the pressure has been restored to the desired pressure, release the invisible inlet solenoid button and close the manual inlet valve. When the pressure is within 5 psi (34 kPa) of the operator configured setpoint, the invisible button will become disabled. Similar functionality also exists on the standard Run Test display (refer to section 4.4.2.6).

The progress bar displays elapsed test duration time and represents the total test duration.

Use the navigation buttons to view additional displays or return to the Run Test display.

4.4.2.9 System Alarm Log

The System Alarm Log display shows the last fifty (50) alarms/aborts that have occurred (figure 4-41). They are shown with the most recent alarm/abort at the top and the oldest at the bottom. A date and time stamp of when the alarm/abort happened and a short description are shown. Refer to Addendum A to see all available alarm/abort conditions and their associated messages.

Figure 4-41 – System Alarm Log display

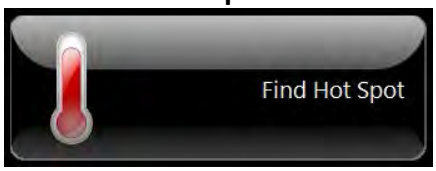
When more alarms/aborts exist than are shown on the display, selecting the slider bar on the right of the display and sliding it down will show the older alarms/aborts.

Note: Only the last fifty (50) alarms are viewable.

The progress bar displays elapsed test duration time and represents the total test duration.

Use the navigation buttons to view additional displays or return to the Run Test display.

4.4.3 Find Hot Spot



The ‘Hot Spot’ is the location within the heater tube where the hottest temperature is found and is typically in the 10 – 18mm range (for a standard test using a 316 stainless heater tube). It is the key factor utilized in capturing the test profiles, as it is the base value from where all of the thermocouple moves start from. The hot spot is typically referred to as the ‘A’ position.

The ‘Find Hot Spot’ selection initiates the process of configuring, initializing and starting a hot spot test. Just like running a timed test, there are many steps that must be completed before the actual hot spot test is started. Once the hot spot test configuration parameters have been entered, a ‘startup’ process is initiated. This ‘startup’ process initializes the machine and its various devices to required pretest conditions. When the various operator configured ‘startup’ conditions have been met, the actual hot spot test can then be started.

Once the hot spot test is complete, the heater tube temperature is cooled (ramp down time based on operator configuration), the system pressure is released, the pump is stopped and reservoir heating is stopped. The heater tube temperature thermocouple will go to the home position once the outlet temperature is <40 °C. Once the heater tube thermocouple is in the home position, a test complete pop-up display will appear notifying the operator that the test is complete. The machine can now be broken down for cleaning.

The ‘startup’ process can take up to several hours to complete depending on the test configuration, before the ‘start’ button can be pressed. It consists of a series of displays that require the operator to initiate specific functionality so that required pretest conditions can be achieved. The pretest conditions are based off of the operator’s test configuration. The operator also has the ability to determine the order that some of the various functions are to execute.

Note: The test cannot start unless <u>all</u> conditions are met.

Figure 4-42 shows a ‘startup’ process showing the conditions that must be met before a hot spot test can be initiated (reservoir heating and line heating are enabled). The startup criteria display will change based upon the test configuration.

Figure 4-42 – Hot Spot test startup conditions (based on test configuration)

The condition is satisfied when the indicator next to the condition is green.

The available startup conditions are:

- Cooling Enabled
- Redundant Safety OK
- Safety Cover in Position
- Purge Cycle Complete*
- Res. Temp. Achieved*
- Res. Soak Time Complete*
- Line Heater Temp. Achieved*
- Pressure Achieved*

Note: * designates items that are operator configurable.

Not all the conditions have a separate process associated with them requiring operator/user interface interaction. 'Redundant Safety OK' condition is achieved internally (the safety controller is checked to see if it is functioning properly), once the 'Continue to Test' button has been selected from the Test Configuration display. The external cooling system will need to be turned on and the flow initiated at the external cooling unit manually by the operator to establish flow (ball should be floating within coolant flow meter) to satisfy the 'Cooling Enabled' condition.

Note: If no flow is detected internally, an alarm message will pop-up alerting the operator to turn on the external cooler (figure 4-43).

Figure 4-43 – No Coolant Flow Warning pop-up

The 'Safety Cover in Position' condition will be satisfied once the safety cover has been correctly placed over the heater tube holder assembly and has been detected (photo eye is located to the right of the pump, above the safety cover collar. The safety cover can be placed at any time during the startup process.

An audible 'beep' will sound when the time consuming startup conditions have been met (purge, reservoir heating, reservoir heat soak, pressurization). This is to alert the operator that the step has been completed and allows the operator to perform other duties while the particular startup sequence completes.

Once the 'startup' process has been completed, the hot spot test display will appear where test variables can be monitored. Navigation buttons exist that allow the operator to access additional displays while a test is active.

Note: If a thermocouple is not plugged in or one fails during the startup process, an alarm message will pop-up alerting the operator (figure 4-44).

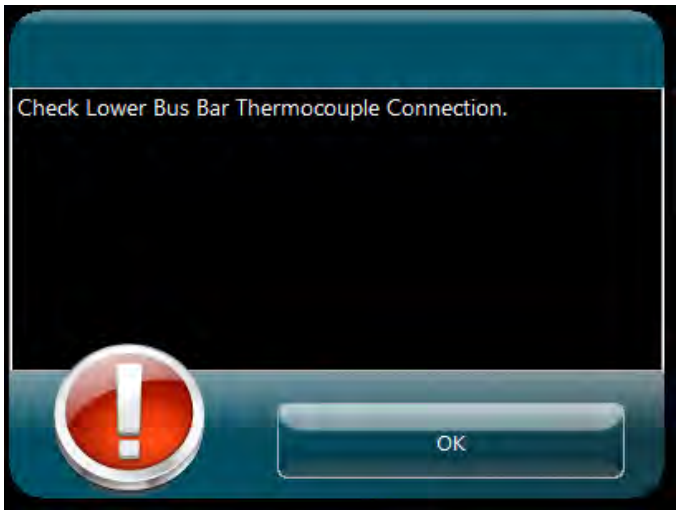


Figure 4-44 – Thermocouple Fail pop-up

All of the displays associated with the 'Find Hot Spot Test' button are discussed in the sub sections below.

4.4.3.1 Test Configuration

When the 'Find Hot Spot' button is selected from the Main Menu, the 'Test Configuration' display appears (figure 4-45). This display allows the operator to enter test information for the test, configure parameters associated with the test (tube material) and also select the type of test that is to be initiated. The tube material (316 stainless, 1018 steel, aluminum) and hot spot test type (determination or validation) must be selected in order to navigate to the remaining configuration displays. It is not mandatory that the other test information be entered. However, it is recommended that this information be entered to help in distinguishing test parameters and associated data for future reference. The test information entered on this display is stored in the data file.

Figure 4-45 – Test Configuration display

Test information that can be entered is:

- Operator Name
- Test Fluid
- Fluid Batch ID
- Volume Tested
- Heater Tube ID
- Tube Material*
- Test Comments
- Data File Name

Note: *designates the field(s) that must be configured. Tube material must be selected and test selection must be selected in order to navigate to the remaining configuration displays.

Entered information is stored in the Name, Test Fluid and Tube ID fields for quick retrieval for future tests. Previous Tube ID numbers can be called up and quickly modified using the back space key and replacing the required numbers. Select the white field to call up the available names already entered and select the desired name. If the name is not entered, select 'Add…' and enter the required name via the alpha-numeric keyboard. Always hit the 'Enter' key on the keyboard to enter the data into the proper field.

Information entered in the data file name field (if anything) will be contained in the data file name structure. Data file names are defaulted with the current date & time stamp along with a test type designation.

The data file name structure is as follows:

YYYYMMDD_TTTT_X_Z.csv, where
Y = year
M = month
D = day
T = time (24 hour clock format)
X = operator entered information
Z = test type designation. The various test type designations are:

HSDData	*(hot spot determination data file)*
HSDProfile	*(hot spot determination temperature profile)*
HSVData	*(hot spot validation data file)*
HSVProfile	*(hot spot validation temperature profile)*

Example of a Hot Spot Determination test data file without operator entered information:
20131217_1413__HSDData.csv

Example of a Hot Spot Determination test data file with operator entered information:
20131217_1413_Tuesday_HSDData.csv

HSD/HSV profiles will also have the tube type material added to the end of the file name. Examples are:
20160202_1055_HSDProfile_316_Stainless.csv
20160203_1130_HSVProfile_Aluminum.csv

The available tube material selections are:

- 316 stainless steel
- 1018 steel
- aluminum

The type of hot spot test that is to be run is to be selected. Hot Spot test types that can be selected are:

- Hot Spot Determination
- Hot Spot Validation

(Individual test details are discussed further down in this section).

The operator cannot advance to the next configuration display unless a tube material is selected and a hot spot test type is selected. Should the 'Continue to Test' button be pressed without either of these items being selected, associated notification pop-up displays will appear alerting the operator (figure 4-46, 4-47).

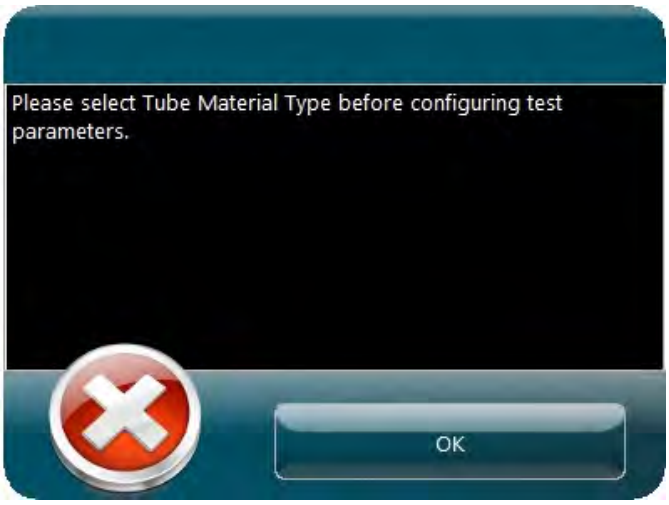


Figure 4-46 – Tube Material selection notification

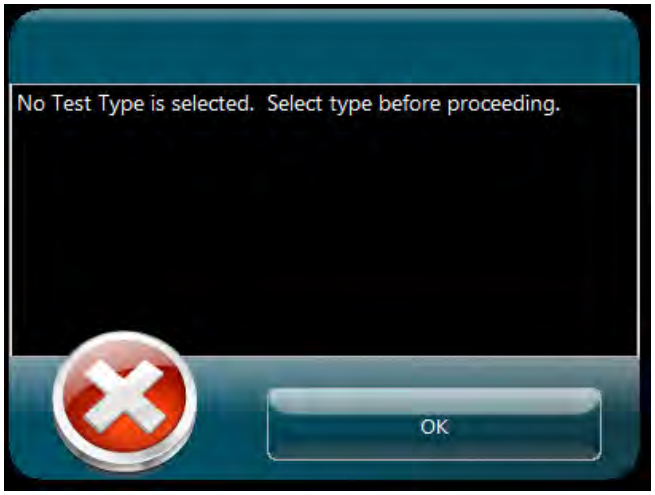


Figure 4-47 – Test selection notification

<u>Hot Spot Determination</u>

This test determines where the hottest position (A) in the heater tube is located. The test starts using the 10mm position as its base position to determine the hot spot temperature profile. It is from the determined hot spot that all timed test profiles are derived. Most of the test parameters are configurable (refer to figures 4-50, 4-51, 4-52, 4-53 for details). It requires the startup procedure to be completed before the test is started. The non-configurable test parameters are:

- Test duration (55 minutes)
- One (1) temperature profile created
- Heater tube thermocouple positions used to determine hot spot: A-4, A, A+4, A+8, A+12, A+16, A+20, A+24, A+28

Note: A hot spot determination should be done any time the heater tube thermocouple has been replaced, the heater tube holder has been replaced or whenever a heater tube of a different material is used. There will be a different hot spot for each heater tube material type.

Once the temperature profile has been completed, the temperature profile will be displayed showing what the determined hot spot is.

Once the test is complete, the heater tube temperature is cooled, the system pressure is released, the pump is stopped and reservoir heating is stopped. The heater tube temperature thermocouple will go to the home position when the outlet temperature is <40 °C. Once the heater tube thermocouple is in the home position, a hot spot complete pop-up display will appear notifying the operator that the test is complete. The machine can now be broken down for cleaning.

Hot Spot Validation

This test validates where the hottest position (A) in the heater tube was found. The hot spot position was previously found running a hot spot determination test for the particular tube material type. The test starts using the current hot spot position (for the given tube material type) as its base position and utilizes the latest hot spot determination test parameters (for the given tube material type) to determine the hot spot temperature profile. It requires the startup procedure to be completed before the test is started. Since the purpose of the test is to validate the hot spot position for the particular tube material type, the test parameters cannot be modified from the hot spot determination configuration parameters for the particular tube material type. The test duration and tube thermocouple positions used are the same as the hot spot determination test

Note: A hot spot validation should be done after a hot spot determination has been completed or any time when the hot spot location is suspect for the particular tube material type.

When the test is complete, it will compare the hot spot found during the hot spot validation test with the hot spot found during the hot spot determination test. If the hot spot found during the validation is within 2mm of the hot spot found during the determination, a hot spot 'validated' pop-up display will appear notifying the operator of validation (figure 4-48). Otherwise, a hot spot 'not validated' pop-up display will appear (figure 4-49). If the hot spot is not validated, it is recommended that the hot spot determination test and hot spot validation test be run again.

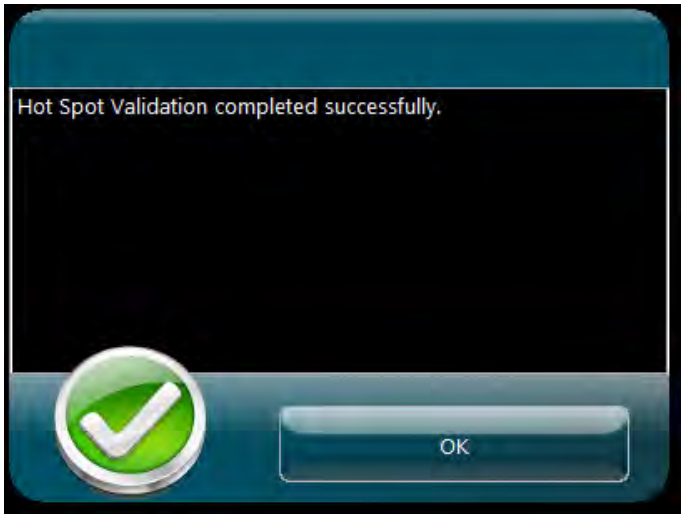


Figure 4-48 – Hot spot validated pop-up display

Figure 4-49 – Hot spot not validated pop-up display

Once the test is complete, the heater tube temperature is cooled, the system pressure is released, the pump is stopped and reservoir heating is stopped. The heater tube temperature thermocouple will go to the home position when the outlet temperature is <40 °C. Once the heater tube thermocouple is in the home position, a hot spot complete pop-up display will appear notifying the operator that the test is complete. The machine can now be broken down for cleaning.

Once the tube type and hot spot test type has been selected and any necessary information has been entered on the 'Test Configuration' display, one can navigate to the additional configuration displays available for the hot spot tests.

Note: The hot spot configuration displays are configurable for a hot spot determination test only. For a hot spot validation test, they only show the latest hot spot determination configuration for the particular tube type material.

Selecting the 'Configure' button will advance to the refinery process hot spot test configuration series of four (4) displays, where the test options and parameters can be defined (figures 4-50, 4-51, 4-52, 4-53). Each of the configuration displays has an 'Options' area (where the required options for the test are enabled/disabled) and an 'Overall Parameters section' (where the specific parameter settings can be defined). Selecting the button or button (located on either side of the Overall Parameters section) advances backward or forward through the configuration displays to allow the refinery process hot spot test options and parameters to be defined. Anytime an option is checked, the associated configuration display will appear so parameters related to the option can be configured.

The various options and parameter settings are discussed after the configuration display depictions.

Figure 4-50 – Refinery Process hot spot determination test configuration (standard parameters)

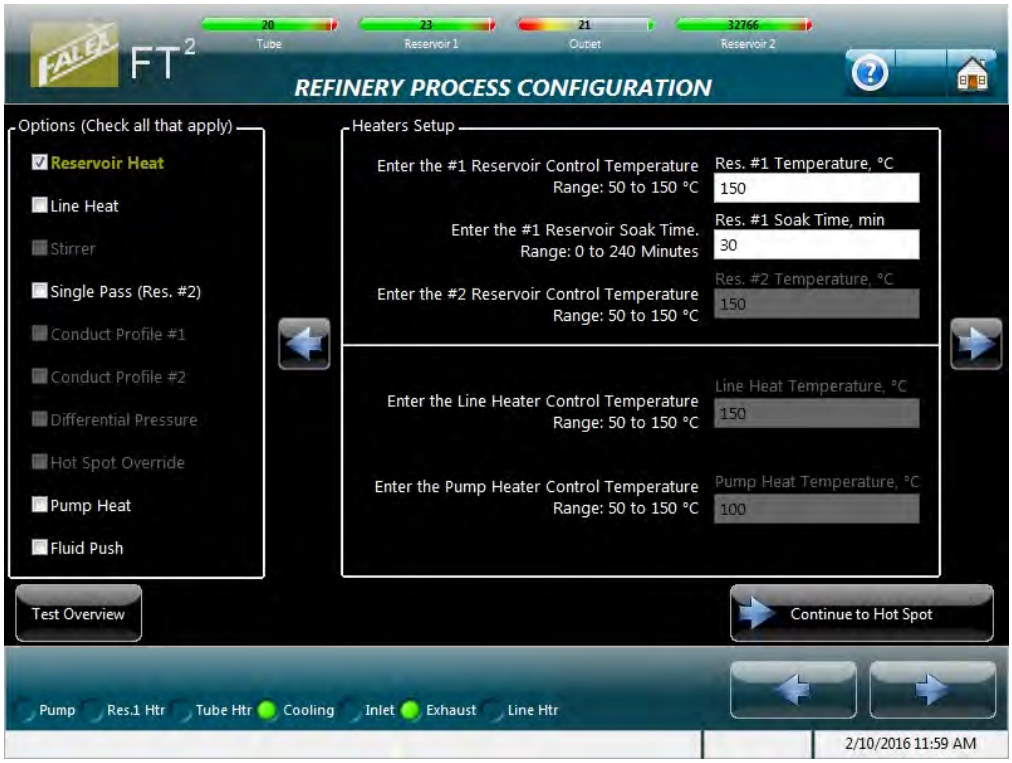


Figure 4-51 – Refinery Process hot spot determination test configuration (optional parameters)

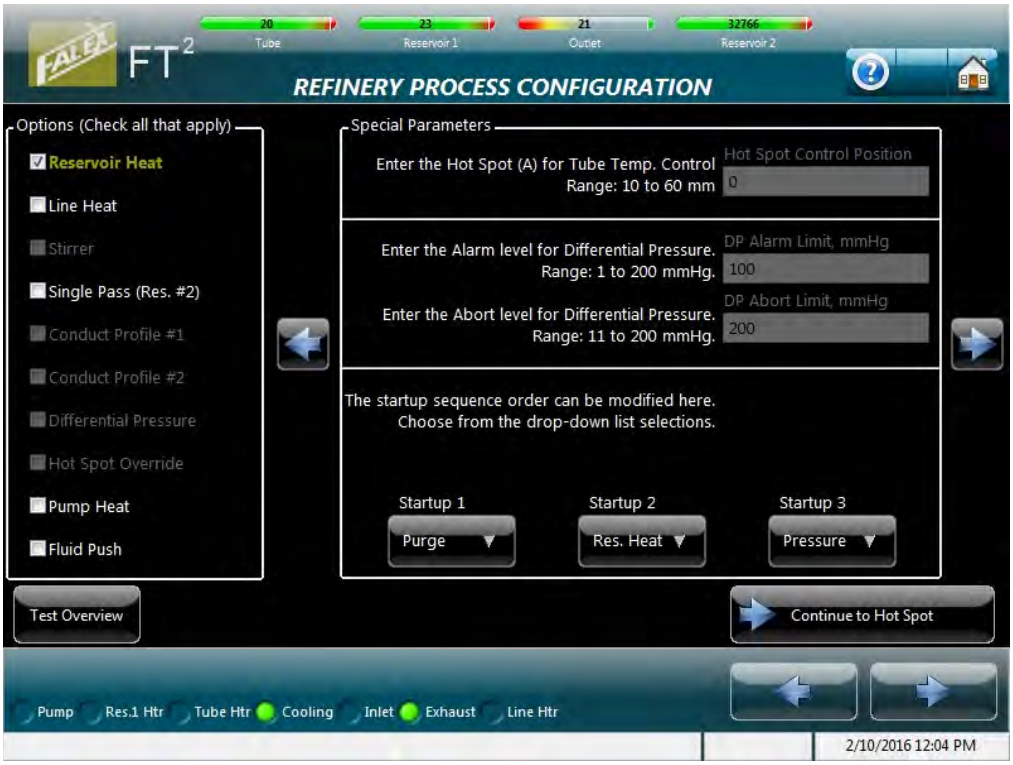


Figure 4-52 – Refinery Process hot spot determination test configuration (special parameter/sequence order)

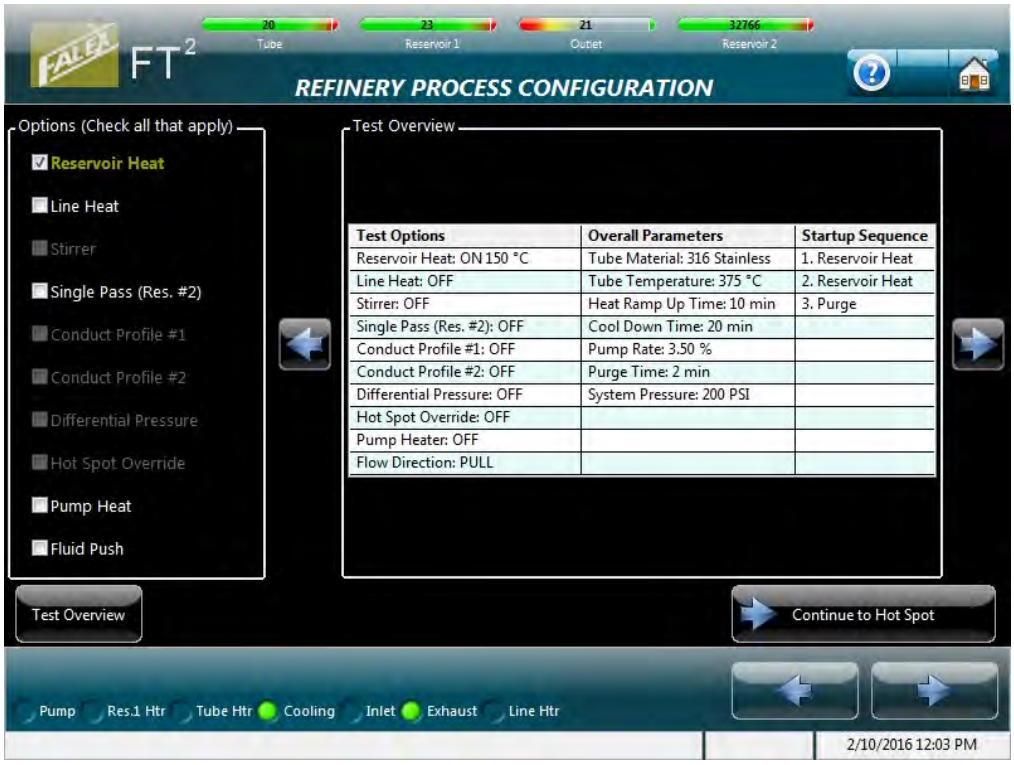


Figure 4-53 – Refinery Process hot spot determination test configuration (summary)

Note: The hot spot test requires the startup procedure to be completed before test duration is started.

Test options that can be selected for a hot spot test are as follows (figures 4-50, 4-51):

- Reservoir heat
- Line heat
- Single pass (requires reservoir #2)
- Pump heat
- Fluid Push

Options that are grayed out are not applicable to a hot spot test.

Note: Line heat, Single Pass, Pump heat and Fluid push are options to the standard FT^2 Refinery Process Analyzer machine and are to be ordered separately. Many of these options will need to be 'activated' within the software in order for their associated functionality to be enabled.

<u>Reservoir Heat</u>

Process that heats the primary reservoir to a determined temperature so that the test fluid's viscosity decreases and it can be pumped through the system. Requires temperature setpoint and soak time entered values.

Line Heat (must be activated)

Process that heats the tubing lines to eliminate any test fluid heat loss as it flows through the system and keeps the test fluid's viscosity constant so that it can be pumped through the system. This option is to be used with high viscosity fluids and requires that the standard tubing lines be removed and the optional heated lines be installed. Requires a temperature setpoint entered value. Refer to Addendum F for details regarding setup and configuration of this option.

Single Pass (must be activated)

System where the test fluid is pumped through the system only once and is deposited into a 2nd reservoir. This requires standard tubing to be removed and the optional 2nd reservoir tubing lines and 2nd reservoir assembly to be installed. The standard reservoir heat option must be selected in order for the single pass option to be enabled (single pass option must be activated). Requires a temperature setpoint entered value. Refer to Addendum H for details regarding setup and configuration of this option.

Note: Single pass option (2nd reservoir) cannot be configured without the standard reservoir heat option also being configured.

Pump Heat (must be activated)

Process that heats the pump to eliminate any test fluid heat loss as it flows through the pump and keeps the test fluid's viscosity constant so that it can be pumped through the system. This option is to be used with high viscosity fluids and requires that the pump heater and thermocouple be installed. Requires a temperature setpoint entered value. Refer to Addendum I for details regarding setup and configuration of this option.

Fluid Push

Fluid flow through the heater tube assembly can be configured depending on the tubing line assemblies that were supplied. The standard tubing line assemblies allow the fluid to be 'pulled' through the heater tube assembly (figure 4-54). With optional 'push' line assemblies, the fluid will be 'pushed' through the heater tube assembly (figure 4-55). When the 'Fluid Push' configuration box is checked, the flow direction is shown in the test summary of the data file as 'Push'. When left unchecked, the flow direction is shown in the test summary of the data file as 'Pull'.

***Note:** Reservoir and inlet tubing lines shown in figures 4-54 and 4-55 may not be representative of the reservoir type used in your system (reservoir type shown is the bolted flange). The diagrams purpose is to show the fluid flow differences through the system.*

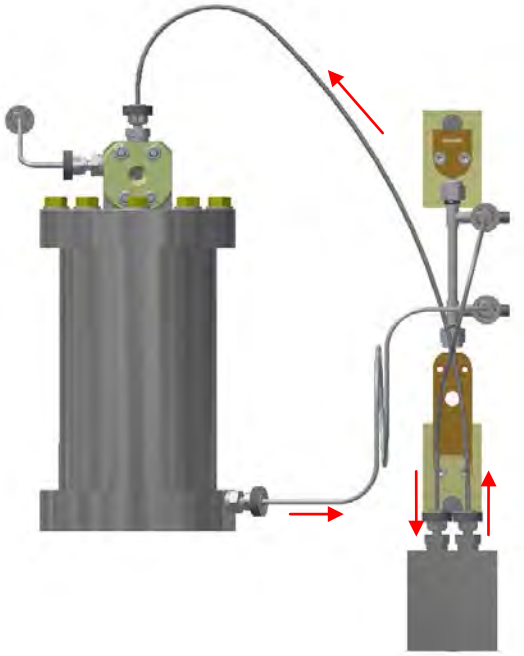


Figure 4-54 – Pull configuration

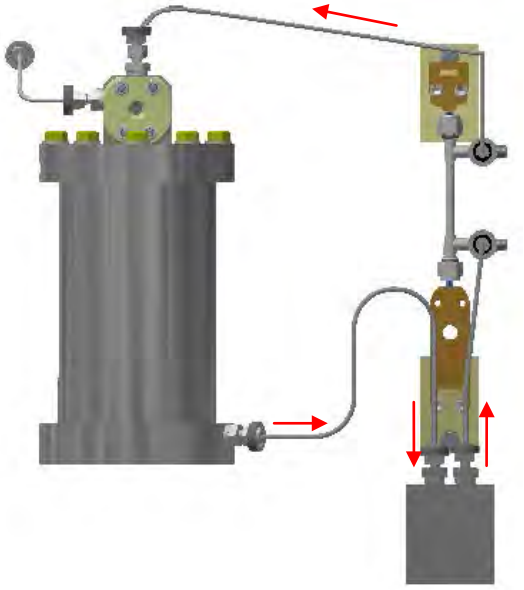


Figure 4-55 – Push configuration

Standard test parameters can be modified as follows (figure 4-50):

- Heater tube control temp. setpoint (150 – 650 °C)
- Heater tube control temp. ramp up time (2 – 120 min)
- Heater tube control temp. ramp down time (2 – 120 min)
- Pump rate (0 – 100%)
- Purge time (2 – 30 min)
- Pressure setpoint (0 - 1000 psi / 0 – 6895 kPa)

Optional test parameters can be modified as follows (figure 4-51):

- Reservoir #1 temperature setpoint (50 – 150 °C)
- Reservoir #1 temperature soak time (0 – 240 min)
- Reservoir #2 temperature setpoint (50 – 150 °C)
- Heated line temperature setpoint (50 – 150 °C)
- Pump heater temperature setpoint (50 – 150 °C)

Special parameters are not applicable to a hot spot test, but the sequence order configuration can be modified as follows (figure 4-52):

- Startup sequence order (based on selected options). Available options are selectable from a drop down list for each step.

WARNING: ***It is the operator's responsibility to determine the correct temperature/pressure combination for the particular fluid being tested to prevent the fluid from vaporizing. Failure to do so could cause the fluid to combust, causing serious injury to the operator.***

WARNING: ***For your own safety and protection from injury, running high temperature and/or high pressure tests while unattended is not recommended.***

It is the responsibility of the operator of this equipment to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

Note: Prior to running a hot spot test, verify the graph scales and redundant safety abort limits are set correctly for the desired test parameters. Graph scales can be modified by selecting the 'User Preferences' button on the Main Menu. See section 4.4.5 for more details. Redundant safety abort limits can be modified by selecting the 'Redundant Safety' button on the Main Menu. See section 4.4.4 for more details.

Selecting the 'Test Overview' button will call up a test summary of configured test (figure 4-53).

Once all test information has been entered and the test configuration has been completed, selecting the 'Continue to Hot Spot' button will advance to the 'Test Startup' sequence series of displays.

4.4.3.2 Purge System

One of the first three (3) displays in the startup process (depending on configuration) is the Purge System display (figure 4-56). The purpose of this process is to pump test fluid through the system to displace any air being held within the tubing lines and to achieve a constant stream of drops visible in the sight glass window.

The ability exists for the operator to initiate the line heater heating (if enabled) and reservoir #2 heating (if single pass option enabled) from this display (section 4.4.2.4 figure 4-33). It is up to the operator to determine when these heating sequences are to be initiated. If the line heater option is enabled (configured for the test) but never initiated, the startup process will not complete. When enabled, reservoir #2 heating does not affect the startup sequence criteria. If the heating for these options has already been initiated, their associated start button will be gold but not selectable.

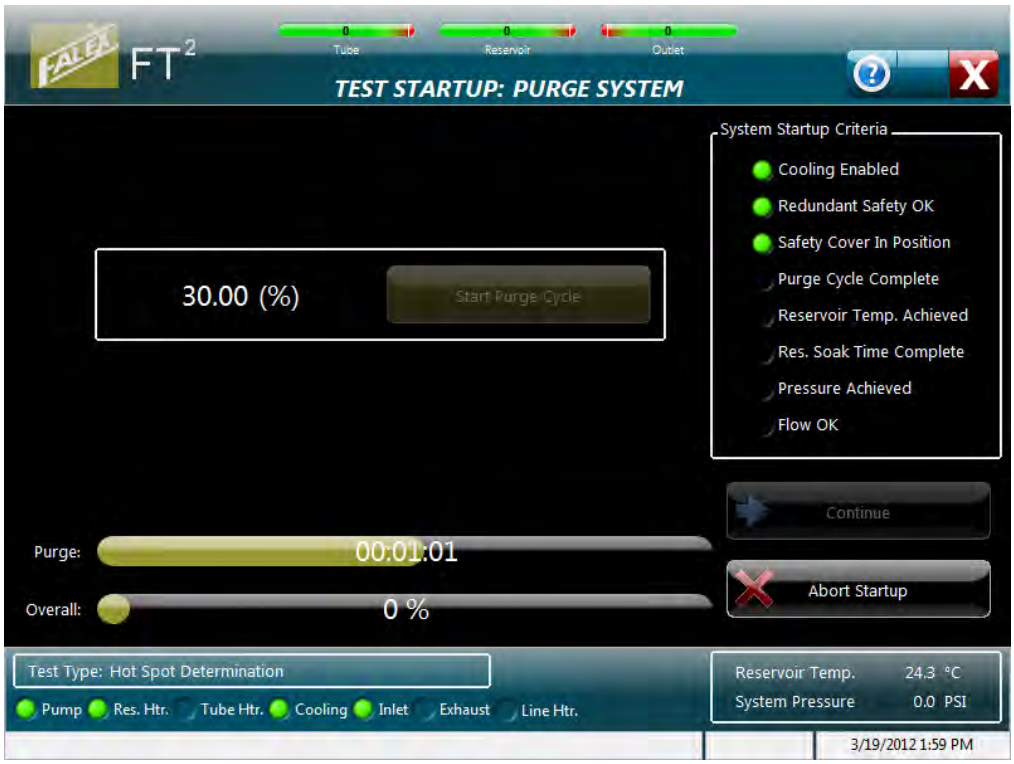


Figure 4-56 – Purge System display

This process is initiated by selecting the 'Start Purge Cycle' button.

The sample pump will start at a higher than normal speed and will run at this speed for 2 minutes (the duration of this sequence). The pump speed is shown as a percentage and cannot be changed.

When the sequence is complete, the following will occur:

- Pump speed is automatically changed to the changed to the value defined in the test configuration.
- An audible 'beep' is sounded notifying the operator that the sequence is complete.
- In the 'System Verification' section of the display, the indicator next to the 'Purge Cycle Complete' will turn green.
- The 'Continue' button will become enabled.

Two (2) progress bars are displayed to keep the operator informed on the startup process status. They are:

- *Purge* - purge sequence progress (entire progress bar represents the configured time in minutes)
- *Overall* - overall startup process progress

Selecting the 'Abort Startup' button will abort the startup process and stop any devices that may be running.

The 'Continue' button is not enabled until the condition has been satisfied. Once enabled, selecting the 'Continue' button will advance the startup process to the next configured step. If this is the last step, a 'Startup Completed Successfully' pop-up display will appear (refer to section 4.4.3.5).

4.4.3.3 Heat Reservoir

One of the first three (3) displays in the startup process (depending on configuration) is the Heat Reservoir display (figure 4-57). The purpose of this process is twofold, heating the reservoir to a desired temperature and allowing the reservoir to heat soak for 30 minutes to allow the temperature to equalize.

The ability exists for the operator to initiate the line heater heating (if enabled) and reservoir #2 heating (if single pass option enabled) from this display (section 4.4.2.2 figure 4-28). It is up to the operator to determine when these heating sequences are to be initiated. If the line heater option is enabled (configured for the test) but never initiated, the startup process will not complete. When enabled, reservoir #2 heating does not affect the startup sequence criteria. If the heating for these options has already been initiated, their associated start button will be gold but not selectable.

Figure 4-57 – Heat Reservoir display

This process is initiated by selecting the 'Start Reservoir Heater' button. It could take approximately 1 – 3 hours to attain the maximum reservoir temperature of 150 °C. The temperature that is to be attained is defined in the test configuration process. The reservoir temperature setpoint is shown on the display and cannot be changed.

Note: Reservoir temperature must be 6° C below the temperature setpoint before the reservoir will start heating. This is important should an abort occur during the startup process and the process is restarted. The reservoir heating sequence must see a 4 °C temperature rise in 10 minutes to confirm heating is occurring.

When the heating to temperature sequence is complete, the following will occur:

- An audible 'beep' is sounded notifying the operator that the reservoir temperature is within 3% of the configured setpoint and the configured temperature soak period has started.
- In the 'System Verification' section of the display, the indicator next to the 'Reservoir Temp. Achieved' will turn green.
- The heat soak sequence will start.

When the heat soak sequence is complete, the following will occur:

- An audible 'beep' is sounded notifying the operator that the sequence is complete.
- In the 'System Verification' section of the display, the indicator next to the 'Res. Soak Time Complete' will turn green.
- The 'Continue' button will become enabled.

Three (3) progress bars are displayed to keep the operator informed on the startup process status. They are:

- *Temp* – current reservoir jacket temperature (entire progress bar represents reservoir jacket temperature setpoint)
- *Soak* - elapsed soak time (entire progress bar represents the configured time in minutes)
- *Overall* - overall startup process progress

Selecting the 'Abort Startup' button will abort the startup process and stop any devices that may be running.

The 'Continue' button is not enabled until the primary reservoir temperature soak condition has been satisfied. Once enabled, selecting the 'Continue' button will advance the startup process to the next configured step. If this is the last step, a 'Startup Completed Successfully' pop-up display will appear (refer to section 4.4.3.5).

4.4.3.4 Pressurize System

One of the first three (3) displays in the startup process (depending on configuration) is the Pressurize System display (figure 4-58). The purpose of this process is to slowly pressurize the system with a compressed gas (dry grade oxygen/nitrogen mixture or nitrogen) to the desired pressure. System pressure will reduce the ability of the fluid to vaporize. Once pressurized, check for leaks (carefully tighten connection if a leak is found).

Warning: ***Always wear safety glasses/goggles and protective gloves when tightening any connection when the system is under pressure. Use caution and always tighten in the clockwise direction. Turning the tightening nut in the wrong direction will cause the system to depressurize rapidly, spraying test fluid.***

Note: It is up to the operator to determine what the correct pressure is to be set to for the given test fluid to prevent vaporization from occurring.

The ability exists for the operator to initiate the line heater heating (if enabled) and reservoir #2 heating (if single pass option enabled) from this display (section 4.4.2.3 figure 4-30). It is up to the operator to

determine when these heating sequences are to be initiated. If the line heater option is enabled (configured for the test) but never initiated, the startup process will not complete. When enabled, reservoir #2 heating does not affect the startup sequence criteria. If the heating for these options has already been initiated, their associated start button will be gold but not selectable.

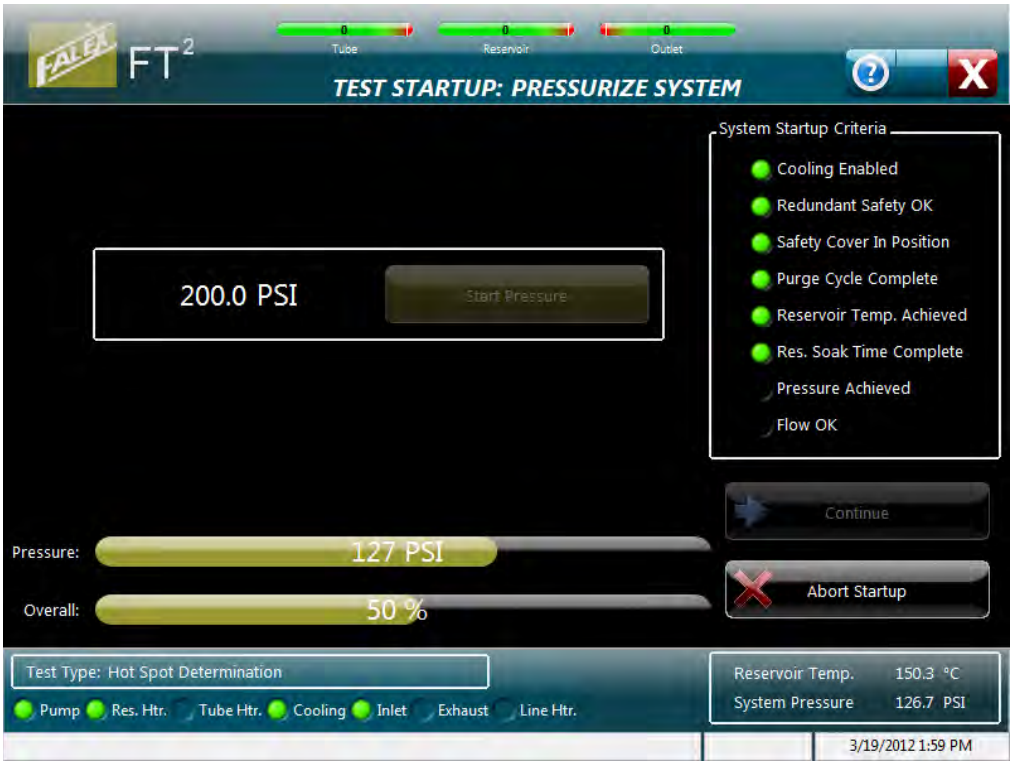


Figure 4-58 – Pressurize System display

This process is initiated by selecting the 'Start Pressure' button. The vent valve will close, the inlet valve will open and a pop-up display will appear reminding the operator to set the air tank regulator to the desired pressure (figure 4-59). Once the air tank valve is opened, the system will begin to pressurize. The pressure setpoint is shown and cannot be changed.

Note: Make sure that the manual inlet valve is opened and the manual vent valve is closed. These are located on the front of the machine, under the reservoir.

Note: Do not over-tighten the manual inlet valve or manual vent valve. Over-tightening these valves will damage the valve seat resulting in pressure leaks. Only tighten valves until tension is determined.

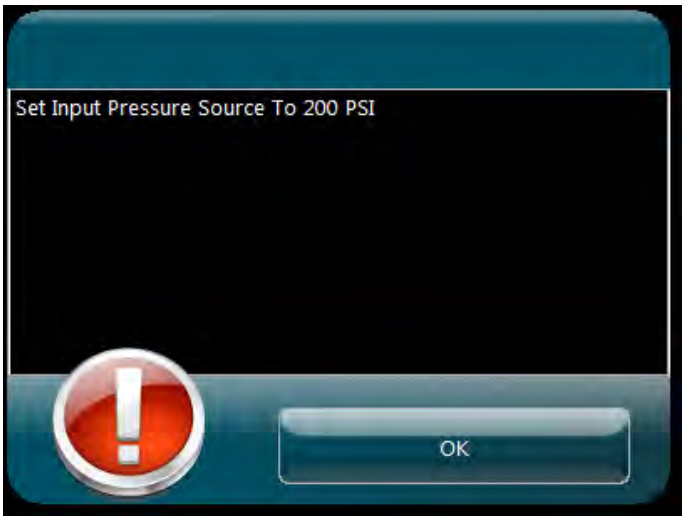


Figure 4-59 – Pressurization pop-up

When the sequence is complete, the following will occur:

- An audible 'beep' is sounded notifying the operator that pressure is within 3% of the configured setpoint and the sequence is complete.
- In the 'System Verification' section of the display, the indicator next to the 'Pressure Achieved' will turn green.
- The 'Continue' button will become enabled.

Note: Once the system has been pressurized, close the manual inlet valve to prevent possible pressure leakage through the solenoid valve.

Two (2) progress bars are displayed to keep the operator informed on the startup process status. They are:

- Pressure value as system is pressurizing (entire progress bar represents system pressure setpoint).
- Overall startup process progress.

Oil drops will become inconsistent until newly introduced air is displaced from tubing lines.

Selecting the 'Abort Startup' button will abort the startup process and stop any devices that may be running.

The 'Continue' button is not enabled until the condition has been satisfied. Once enabled, selecting the 'Continue' button will advance the startup process to the next configured step. If this is the last step, a 'Startup Completed Successfully' pop-up display will appear (refer to section 4.4.3.5).

4.4.3.5 Startup Completed

Once the startup sequence has been satisfied (all criteria have been met), selecting the 'Continue' button will cause the 'Startup Completed Successfully' pop-up display to appear (figure 4-60).

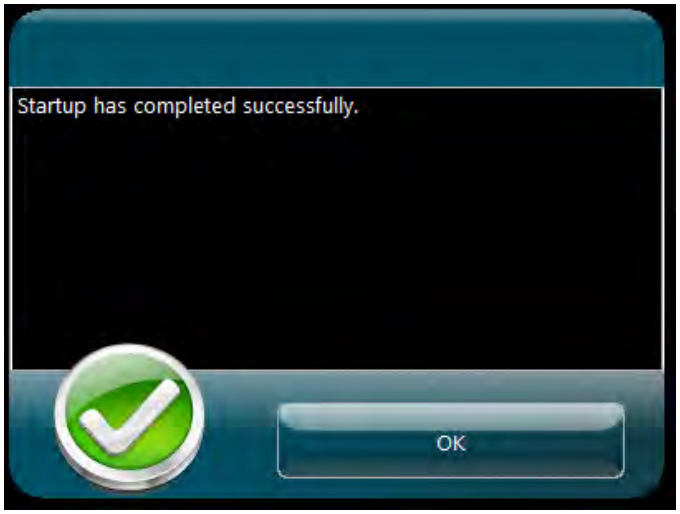


Figure 4-60 – Startup Completed Successfully pop-up

Selecting the 'OK' button will cause a 'Continue' display to appear (figure 4-61).

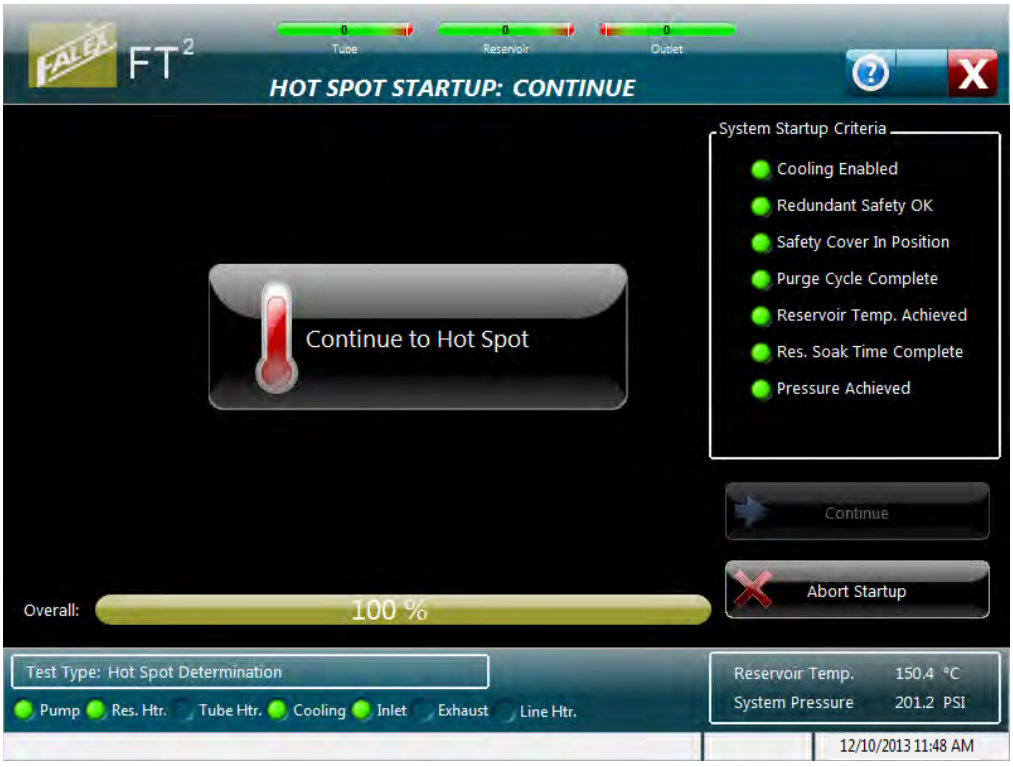


Figure 4-61 – Continue to Hot Spot display

- Selecting the 'Continue to Hot Spot' button will advance the operator to the Hot Spot Test display, where the test can be started.

4.4.3.6 Hot Spot Test

The Hot Spot Test display is the display that will be active for the duration of the hot spot test (figure 4-62) and has the following functionality:

- Test can be started by selecting the 'Start' button
- Pump flow can be adjusted (only during temperature ramp and heat soak equalization periods)
- Test data can be viewed both graphically and numerically
- Trend pens can be enabled/disabled
- Trend can be manipulated using trend tools
- Test can be aborted by selecting the 'Abort' button
- Access other displays associated with test

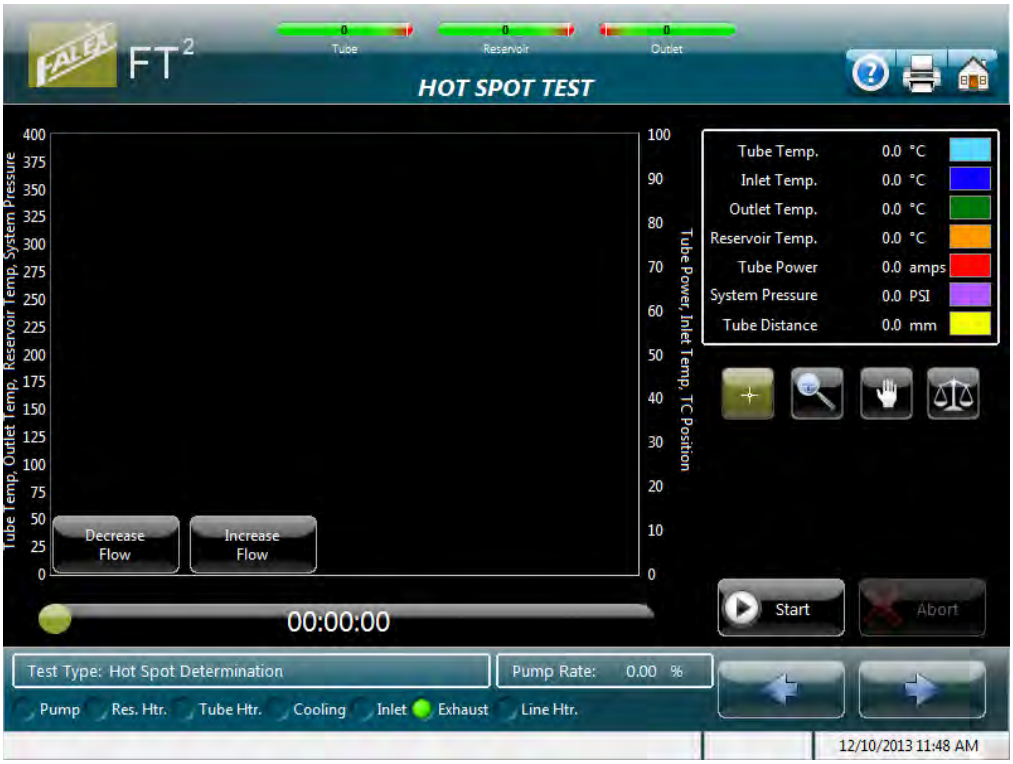


Figure 4-62 – Hot Spot Test display

Because the fluid viscosity will change as the heater tube heats up, the flow rate may no longer be equivalent to the desired rate (1 ml/min is the standard) per the pump rate configured for the test. Therefore, increase/decrease buttons can be utilized to adjust the flow rate to the desired flow rate (standard 1ml/min flow rate is equivalent to 20 drops in 30 seconds) during the heating sequence. Selecting the increase/decrease button will change the pump flow rate percentage by 0.01%. These buttons are only available during the temperature ramp and the 30 minute heat soak equalization period. Refer to section 4.4.7.6 for manually determining pump speed for various flow rates.

Note: If a custom flow rate is required, it is not known what the equivalent drip count should be.

Trend pens can be enabled/disabled by selecting the color box next to the particular parameter.
The graph window represents approximately 30 minutes of data.

The following trend tools are available to manipulate the graph:

Selecting this button is the 'No tool selected' button. This is the default trend tool. When this tool is selected, selecting anywhere on the graph will not do anything.

Selecting this button will open up a collection of 'zoom' tools to allow one to zoom in on the trend.

This is the 'Grab' tool. It allows the operator to grab the trend and move it around.

Selecting this button will return the trend to its original appearance.

Note: For aluminum tubes the power trace may go off of the display depending on the tube temperature setpoint. To rescale the chart so that the power trace is visible, select the 'zoom' tool button  ***and then select the 'auto scale'***  ***tool.***

The progress bar displays elapsed hot spot test duration time and represents the total hot spot test duration.

Navigation buttons at the bottom of the display allow access to other displays while the test is active. The available displays are:

- Test information
- Instrument Status
- Alarm Log
- Test Data

4.4.3.7 Test Information

The Test Information display shows the current test information associated for the running hot spot test (figure 4-63). This information is for reference only (nothing can be changed).

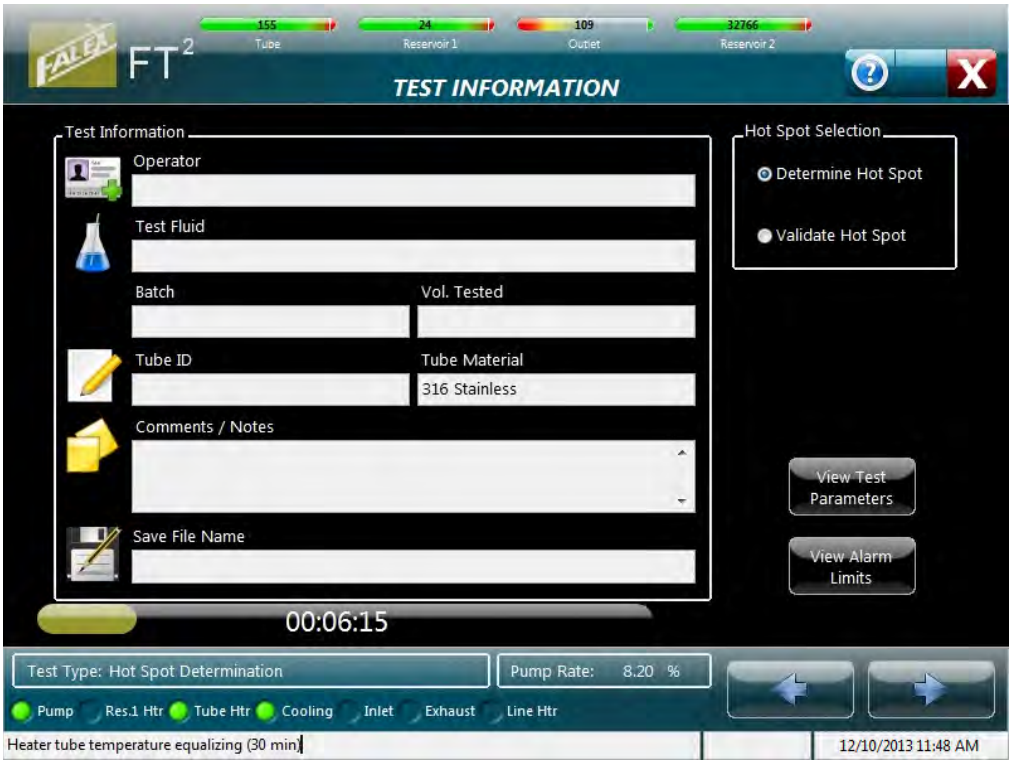


Figure 4-63 – Hot Spot test Information display

The progress bar displays elapsed hot spot test duration time and represents the total hot spot test duration.

Use the navigation buttons to view additional displays or return to the Run Test display.

4.4.3.8 Instrument Status

Same display and associated functionality that is utilized for a timed test. Refer to section 4.4.2.8 for full details.

Note: The repressurization functionality (as discussed in the timed test details) is not enabled during a hot spot test.

4.4.3.9 Alarm Log

Same display and associated functionality that is utilized for a timed test. Refer to section 4.4.2.10 for full details.

4.4.3.10 Test Data

The Test Data display shows the current test data profile in tabular form associated with the most current hot spot test (figure 4-64). The type of hot spot test is displayed within the data (hot spot determination data profile or hot spot validation data profile).

Note: Depending on the state of the current hot spot test, the data may be blank or show the previous hot spot data. When a hot spot test becomes active, the data will be cleared until the existing test is complete.

Figure 4-64 – Hot Spot test data display

The progress bar displays elapsed hot spot test duration time and represents the total hot spot test duration.

Use the navigation buttons to view additional displays or return to the Run Test display.

4.4.4 Redundant Safety

The 'Redundant Safety' selection shows parameters associated with the safety controller and allows abort limits to be changed (figure 4-65). If the

single pass option is enabled, the abort limit for the 2nd reservoir is shown (figure 4-66).

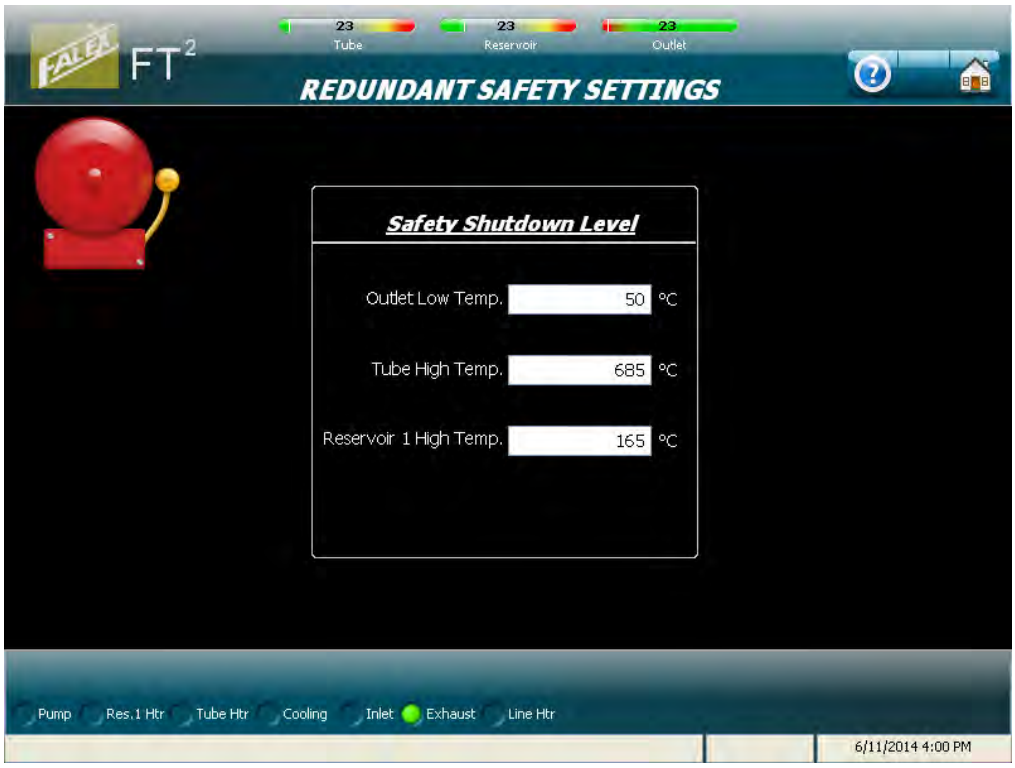


Figure 4-65 – Redundant Safety display (standard)

Figure 4-66 – Redundant Safety display (with single pass option enabled)

The safety controller is used as a safety backup. It will abort the test and stop all devices at certain temperature limits to protect the machine should the main controller fail.

There are four (4) temperature values that are monitored by the safety controller. They are:

- Outlet temperature (low temperature conditions)
- Heater tube temperature (high temperature conditions)
- Reservoir #1 temperature (high temperature conditions)
- Reservoir #2 temperature (high temperature conditions)

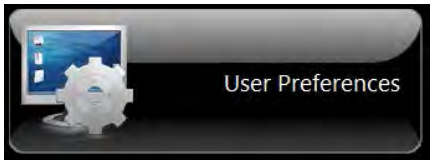
Note: Reservoir #2 is shown only when this option is enabled. It is used for single pass testing.

Each temperature has a hardcoded abort limit and an adjustable abort limit associated with them. The hardcoded limit is just that, a limit that cannot be changed and is the final limit that the particular temperature cannot exceed. The adjustable limit shown on the display is an operator selectable limit that can be set inside the hardcoded limit (if so desired). Initially, the adjustable limits are set to their default limits, which are equal to the hardcoded limits. Once the adjustable limits are changed, the values are retained. The operator adjustable limits can be changed by selecting the white box for the particular temperature to be changed.

Note: The adjustable limit cannot be set outside of the hardcoded limit. If the entered value exceeds the hardcoded limit, the value will default to the hardcoded limit.

Refer to Addendum A to review all alarm/abort conditions associated with the safety controller.

4.4.5 User Preferences



The ‘User Preferences’ selection allows the operator to change various items to better meet their specific requirements (figure 4-67).

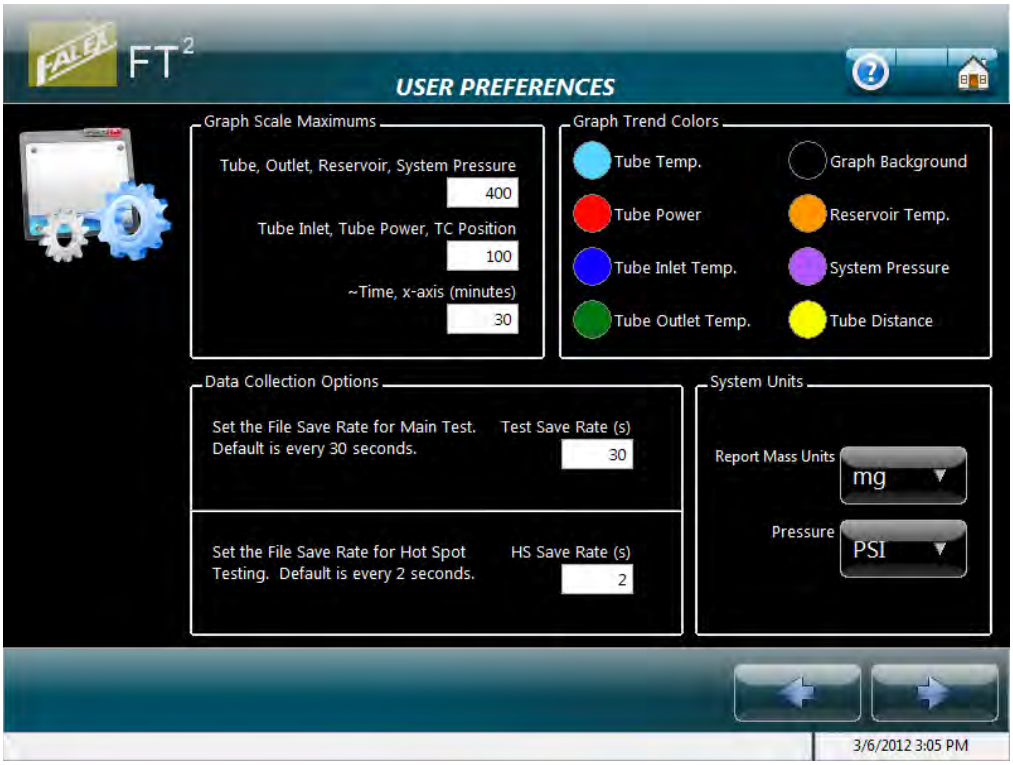


Figure 4-67 – User Preferences display

In the 'Graph Scales Maximums' section, graph scales can be changed from their default values. A graph scale is representative of multiple parameters on the graph. The new values will be saved by selecting 'OK' on the confirmation pop-up display that appears upon exiting the 'User Preferences' display. The new value will be retained. These graph scales are located on the Run Test, Hot Spot Test and Maintenance Graph displays. They can be changed by selecting the white box for the particular scale to be changed.

Trend pen colors for a particular parameter can be changed in the 'Graph Trend Colors' Section of the display. Selecting the color circle next to the particular parameter will call up a color pallet, where a new color can be selected. The new color will be saved by selecting 'OK' on the confirmation pop-up display that appears upon exiting the 'User Preferences' display. The new color will be retained.

In the 'Data Collection Options' section, the data file save rate can be changed for each type of test. The data save rate range for a timed test is 1 – 120 seconds (default 30 seconds). The data save rate range for a hot spot test is 2 – 10 seconds (default 2 seconds). They can be changed by selecting the white box for the particular save rate to be changed. The new value will be saved by selecting 'OK' on the confirmation pop-up display that appears upon exiting the 'User Preferences' display. The change will be retained. Data is always saved for a 'timed' test and for a 'hot spot' test.

Note: The faster the data rate, the larger the data file will be. Adjust the data rate accordingly for long duration tests.

In the ‘System Units’ section, the units for the heater tube weight (mass) and system pressure can be changed. For mass, the available selections are ‘mg’ or ‘g’. The default is ‘mg’. For pressure, the available selections are ‘PSI’ or ‘kPa’. The default is ‘PSI’. To change the units, select the box of the units that are to be changed and select the desired units. The changes will be saved by selecting ‘OK’ on the confirmation pop-up display that appears upon exiting the ‘User Preferences’ display. The change will be retained.

Navigation buttons at the bottom of the display allow access to other displays. The available displays are:

- User Tables
- Printer Setup
- Network Setup
- Change Password

Note: Due to the amount of data that must be accessed when the User Preferences button is selected, there will be a slight delay if operator immediately trys to access other displays using the navigation buttons.

4.4.5.1 User Tables

When test information is entered for the particular test on the ‘Test Configuration’ display, frequently used information is stored in user tables so that it can be easily recalled. The operator, fluid type, tube ID and tube type are stored in user tables. The User Tables display allows items to be added or deleted from the particular user table (figure 4-68).

Note: Tube types contained in the tube type user tables are read only. The associated add/delete buttons are grayed out. Tube types cannot be deleted or additional tube types be added.

Figure 4-68 – User Tables display

Selecting the 'Operators ↓' button will allow the operator to select the particular user table to be modified (operators, test fluids, tube IDs, tube types). Once the particular user table is opened, the various stored entries are shown. Selecting the 'Add Item' button will pop-up the keyboard and allow a new item to be added to the particular user table. Selecting the particular item within the user table and then the 'Delete Item' button will delete the item from the particular user table. Once a deletion is made to the particular user table, the operator will be prompted if the changes are to be saved when exiting the User Tables display.

If a directory has more items that can be displayed, the 'Scroll Up' and 'Scroll Down' buttons will allow the additional items to be displayed.

Use the navigation buttons to view additional displays or return to the User Preferences display.

4.4.5.2 Printer Setup

The Printer Setup display shows any installed printers and allows a new printer to be configured (figure 4-69).

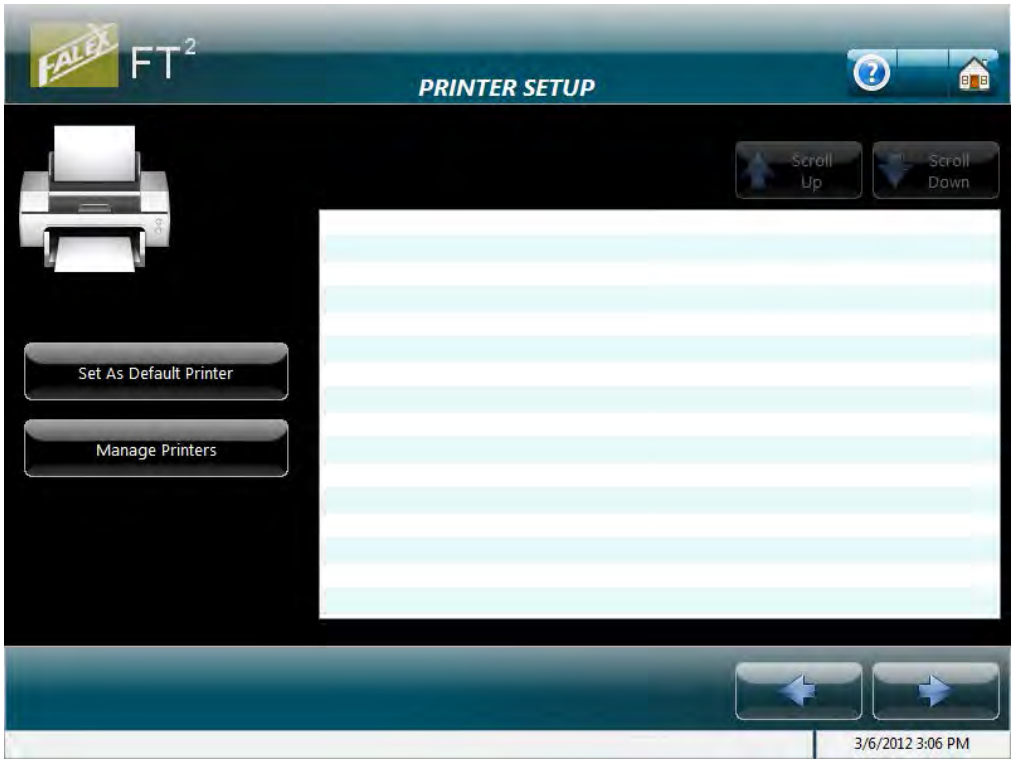


Figure 4-69 – Printer Setup display

Selecting the 'Manage Printers' button will open the Windows® Printers and Faxes window, where a printer can be added.

Selecting the 'Set As Default Printer' button will set the selected printer as the default printer.

Use the navigation buttons to view additional displays or return to the User Preferences display.

4.4.5.3 Network Setup

The Network Setup display allows the operator to configure the unit to connect to the local network (figure 4-70). It is recommended that an IT person be consulted prior to making configuration settings.

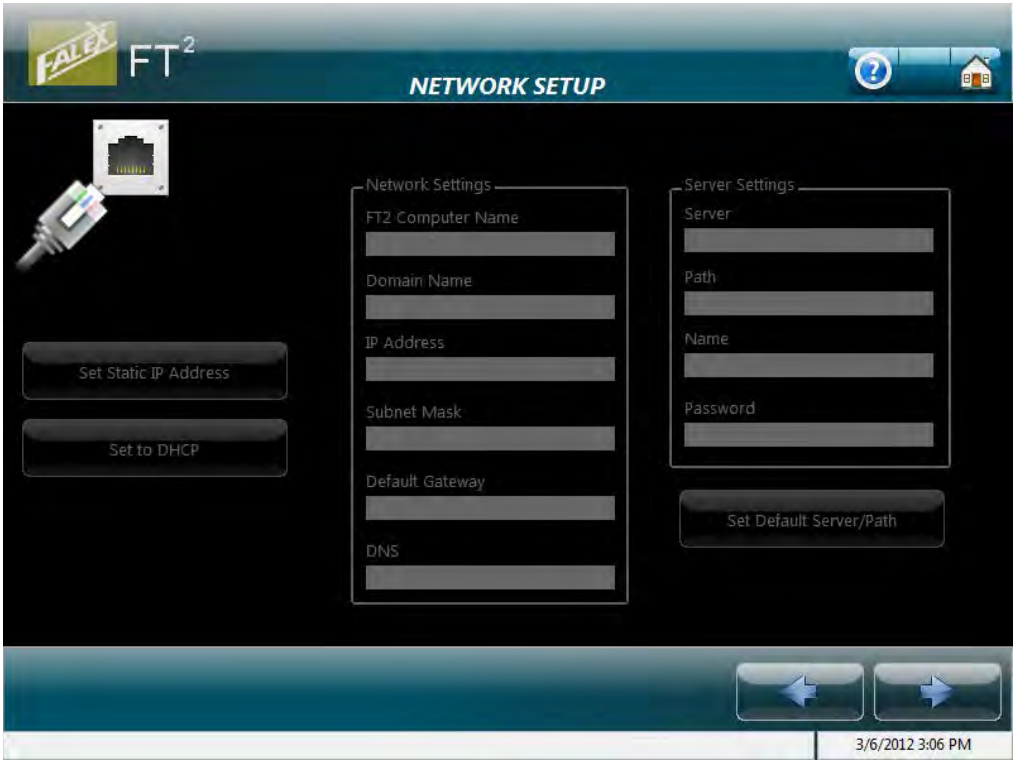


Figure 4-70 – Network Setup display

The external RJ-45 network connection port is located on the back of the unit, upper port (the lower RJ-45 port is for factory use only). This configuration requires a level 1 password. Select the Falex icon in the upper left hand corner, enter the level 1 password using the pop-up keyboard and select the 'Enter' key. Once the correct password has been entered, the various configuration fields will become enabled.

Selecting the 'Set Static IP Address' button will set the local area connection of the user interface to the configuration parameters entered in the 'Network Settings' area of the display.

Selecting the 'Set to DHCP' button will reset the local area connection of the user interface to dynamic properties.

Selecting the 'Set Default Server/Path' button will set the server path of the user interface to the configuration parameters entered in the 'Server Settings' area of the display. This is where selected data files are copied/moved to when using File Manager functionality (section 4.4.6).

Under the 'Network Settings' section of the display, enter the configuration settings by selecting the white box for the particular parameter to be modified.

Under the ‘Server Settings’ section of the display, enter the configuration settings by selecting the white box for the particular parameter to be modified.

Use the navigation buttons to view additional displays or return to the User Preferences display.

4.4.5.4 Change Password

The Change Password display allows the operator to change the level 1 password (figure 4-71). The machine is delivered with the default level 1 password of ‘123456’. Periodically, it should be changed for security purposes (the department supervisor is the intended facilitator of this functionality).

Note: Should the level 1 password be forgotten, it can be determined by contacting your local Falex representative.

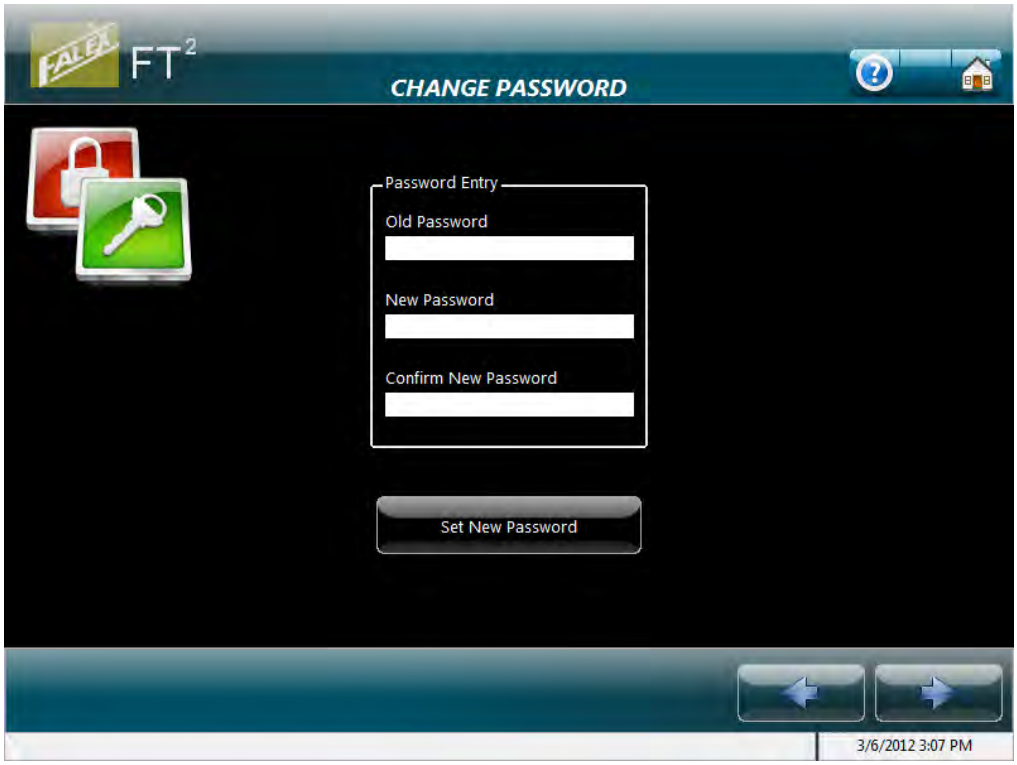


Figure 4-71 – Change Password display

In the ‘Password Entry’ section, the level 1 password can be changed. It can be changed by doing the following:

- Select the white box under ‘Old Password’ and enter the existing password that is to be changed.
- Select the white box under ‘New Password’ and enter the new password.

- Select the white box under ‘Confirm New Password’ and enter the new password again.
- Select the ‘Set New Password’ button to finalize the password change.

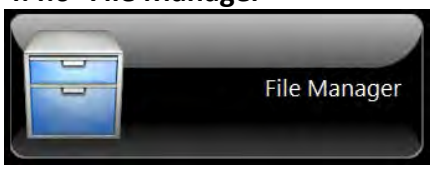
Pop-up displays will notify the operator should a parameter be entered incorrectly.

A pop-up display will confirm that the password was successfully changed.

Note: There are no restrictions on the length of the password or the format of the password.

Use the navigation buttons to view additional displays or return to the User Preferences display.

4.4.6 File Manager



The ‘File Manager’ selection allows the operator to copy various data files to an external device or delete them from the system (figure 4-72).

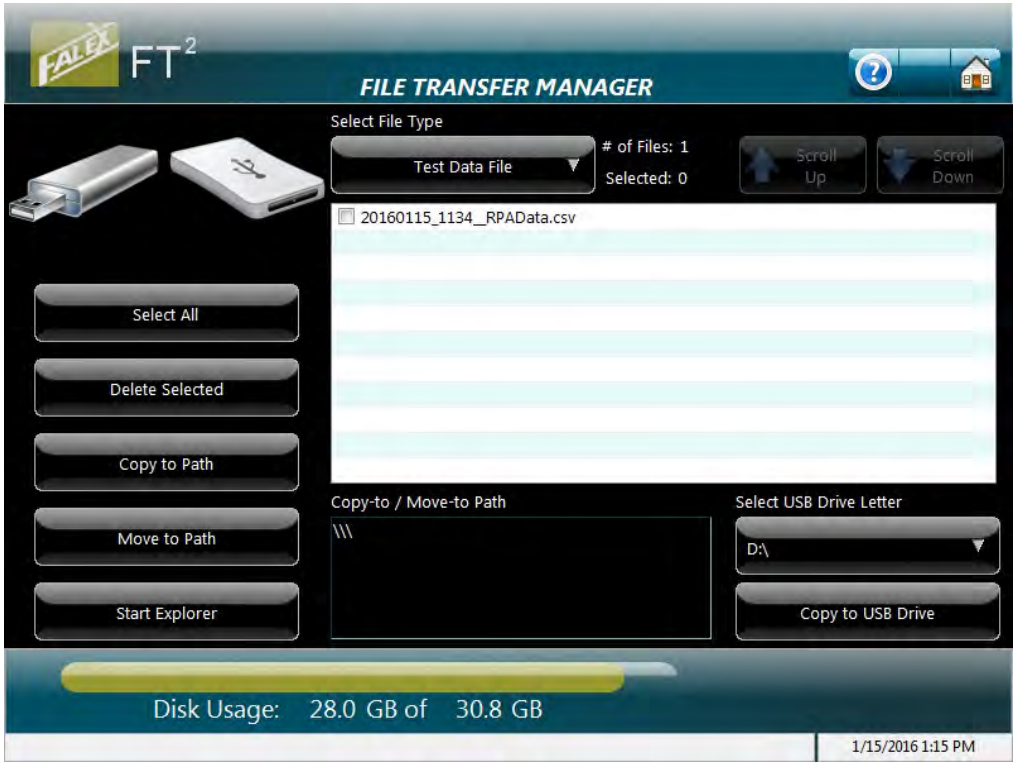


Figure 4-72 – File Transfer Manager display

There are five (5) types of data files that can be selected: Test Data File, Test Profiles, Hot Spot Data File, Hot Spot Profiles and Test Configuration File.

Note: The Report File is not available.

Select the 'Select File Type' ↓ button and select the type of file that is to be transferred or deleted. Within the file type directory, select the file(s) to transfer or delete. A check mark will indicate that the file has been selected. If a file has been selected by mistake, selecting it again will deselect it.

Once the desired file type has been selected, there are a number of options available. They are:

- 'Select All' button will automatically select all files contained within the specific file type directory.
- 'Delete Selected' button will delete the selected file from the system freeing up disk space.
- 'Copy to Path' button will copy the selected file(s) to the path designated in the 'Copy to / Move to Path' location, which was configured in Network Settings of the User Preferences display.
- 'Move to Path' button will move the selected file(s) to the path designated in the 'Copy to / Move to Path' location which was configured in Network Settings of the User Preferences display.
- 'Copy to USB Drive' button will copy the selected file(s) to the USB drive designated in the 'Select USB Drive Letter' button. The USB drive can be a flash drive, external hard drive or portable cd burner (if properly configured). A specific directory will be created on the external USB device for the particular file type and that is where the data file will be located (FT2 Test Data Files, FT2 Test Profiles, FT2 Hot Spot Data Files, FT2 Hot Spot Profiles).

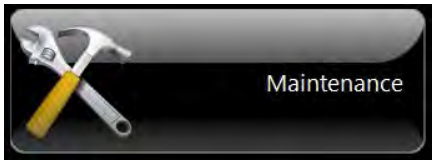
Note: The correct USB drive letter must be selected before the copy button is selected for the copy function to be successful.

The 'Start Explorer' button will open up a Windows® Explorer window. A level 1 password is required. Upon selecting the 'Start Explorer' button, the pop-up keyboard will appear where the level 1 password can be entered. This is to allow the operator to get into Windows® (with supervisor permission), should it be required.

If a directory has more files that can be displayed, the 'Scroll Up' and 'Scroll Down' buttons will allow the additional files to be displayed.

A 'Disk Usage' bar is displayed at the bottom of the display showing how much of the hard disk space is used.

4.4.7 Maintenance



The ‘Maintenance’ selection allows the operator to view various displays, manually operate certain devices and execute functionality that is not routinely done. The initial display that is shown is the Maintenance Graph display (figure 4-73).

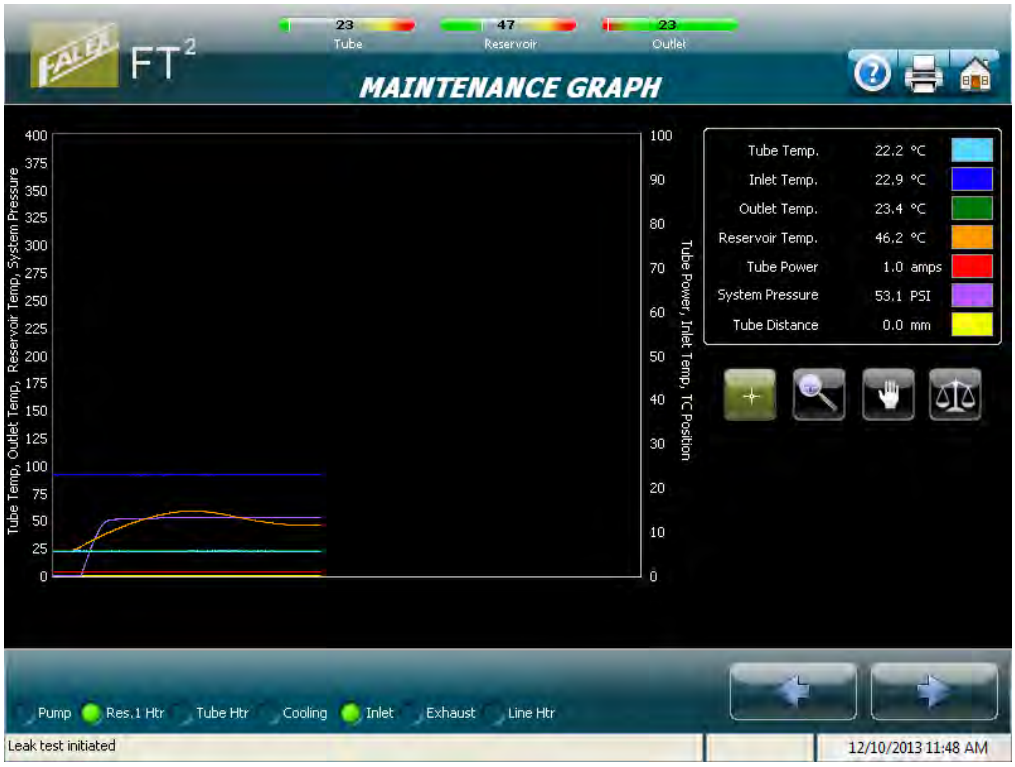


Figure 4-73 – Maintenance Graph display

The Maintenance Graph display can be used for troubleshooting purposes and has the following functionality:

- Current data can be viewed both graphically and numerically
- Trend pens can be enabled/disabled
- Trend can be manipulated using trend tools
- Access miscellaneous displays

Trend pens can be enabled/disabled by selecting the color box next to the particular parameter.

The graph window represents approximately 30 minutes of data.

The following trend tools are available to manipulate the graph:

Selecting this button is the 'No tool selected' button. This is the default trend tool. When this tool is selected, selecting anywhere on the graph will not do anything.

Selecting this button will open up a collection of 'zoom' tools to allow one to zoom in on the trend.

This is the 'Grab' tool. It allows the operator to grab the trend and move it around.

Selecting this button will return the trend to its original appearance.

Navigation buttons at the bottom of the display allow access to other displays. The available displays are:

- Instrument Status
- System Alarm Log
- System Info
- Time Settings
- System Calibration
- Manual Controls

4.4.7.1 Instrument Status

Same display and associated functionality that is utilized for a timed test (figure 4-74). Refer to section 4.4.2.8 for full details.

Note: The repressurization functionality (as discussed in the timed test details) is not available in Maintenance.

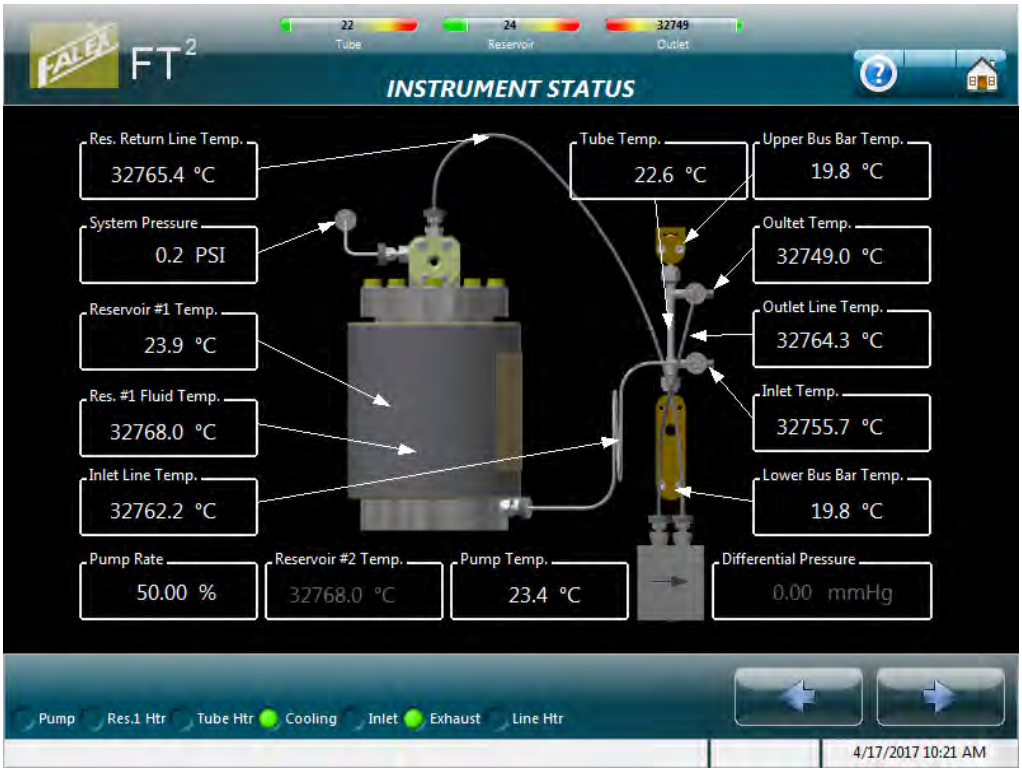


Figure 4-74 – Instrument Status

4.4.7.2 System Alarm Log

The System Alarm Log display shows the last fifty (50) alarms/aborts that have occurred (figure 4-75). They are shown with the most recent alarm/abort at the top and the oldest at the bottom. A date and time stamp of when the alarm/abort happened and a short description are shown. Refer to Addendum A to see all available alarm/abort conditions and associated messages.

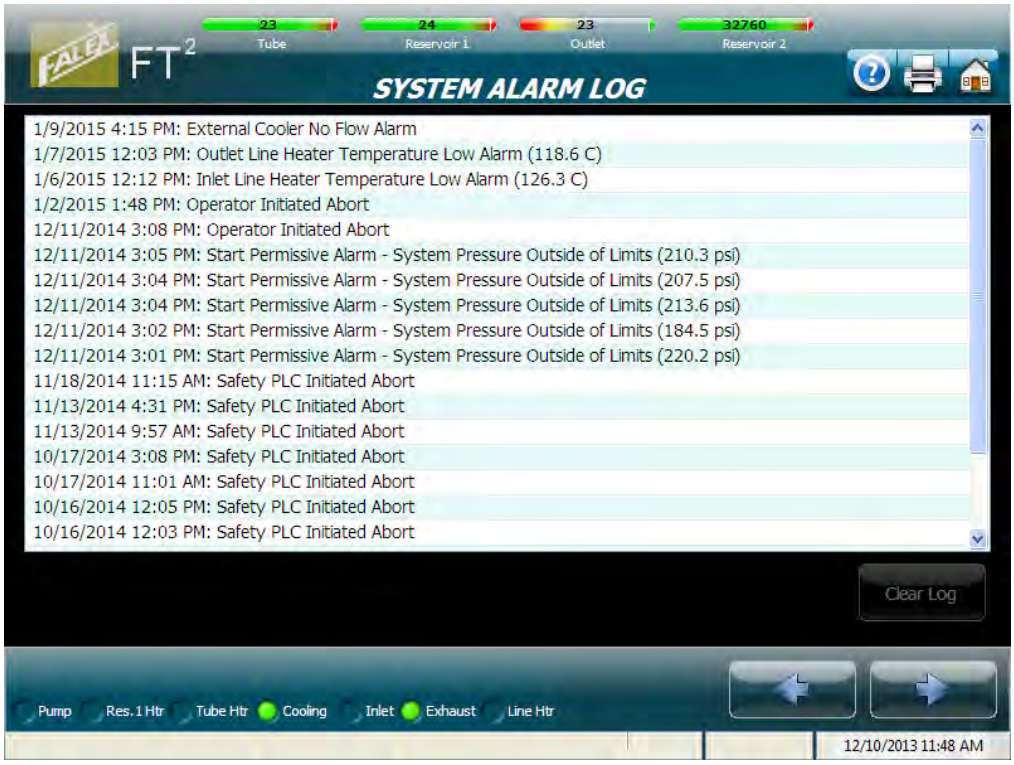


Figure 4-75 – System Alarm Log display

When more alarms/aborts exist than are shown on the display, selecting the slider bar on the right of the display and sliding it down will show the older alarms/aborts.

Note: Only the last fifty (50) alarms are viewable.

When the alarm log is called up, it will automatically refresh with current alarm/abort information prior to being displayed.

The log can be printed if a printer is configured, connected and the 'Print Log' button is selected.

The 'Clear Log' button can only be enabled by Falex authorized personnel (this is a factory function). Selecting this button will permanently clear all alarms/aborts from the log.

Use the navigation buttons to view additional displays or return to the Maintenance Graph display.

4.4.7.3 System Info

The System Info display shows current test statistics for the unit since last reset and various information regarding the particular unit (figure 4-76).

Figure 4-76 – System Info display

Statistics shown in the 'System Stats Log' section are:

- Tests started
- Tests completed
- Tests manually aborted
- Tests automatically aborted
- Hot Spots started
- Hot Spots completed
- Hot Spots manually aborted
- Hot Spots automatically aborted
- Startups manually aborted
- Startups automatically aborted
- System hours

'Tests' refers to a Refinery Process test.

'Startups' refers to the startup process prior to starting a timed test or hot spot test.

'Manually aborted' refers to a test or hot spot that was aborted by the operator.

'Automatically aborted' refers to a test or hot spot that was aborted due to a condition relative to the machine (refer to Addendum A for abort conditions).

‘System Hours’ is the amount of runtime the machine has accumulated since last reset. The time is accumulated only during the timed duration part of the test or hot spot (time not accumulated during startup process).

The ‘Reset Log’ button can only be enabled by Falex authorized personnel (this is a factory function).

The ‘Instrument Serial No.’ and ‘Instrument Owner’ information is entered at the factory prior to shipment.

‘Select USB Drive Letter’ allows selection of an available USB drive to copy the system information file to.

‘Send System Data to USB’ button copies system information to an external device (i.e. flash drive). It will be stored in a .zip file called FT2SystemData. This will be useful should an issue occur and system information be requested by the Falex customer service representative.

Use the navigation buttons to view additional displays or return to the Maintenance Graph display.

4.4.7.4 Time Settings

The Time Settings display allows the operator to change the user interface date/time and also manually synchronize the controller with the same date/time (figure 4-77).

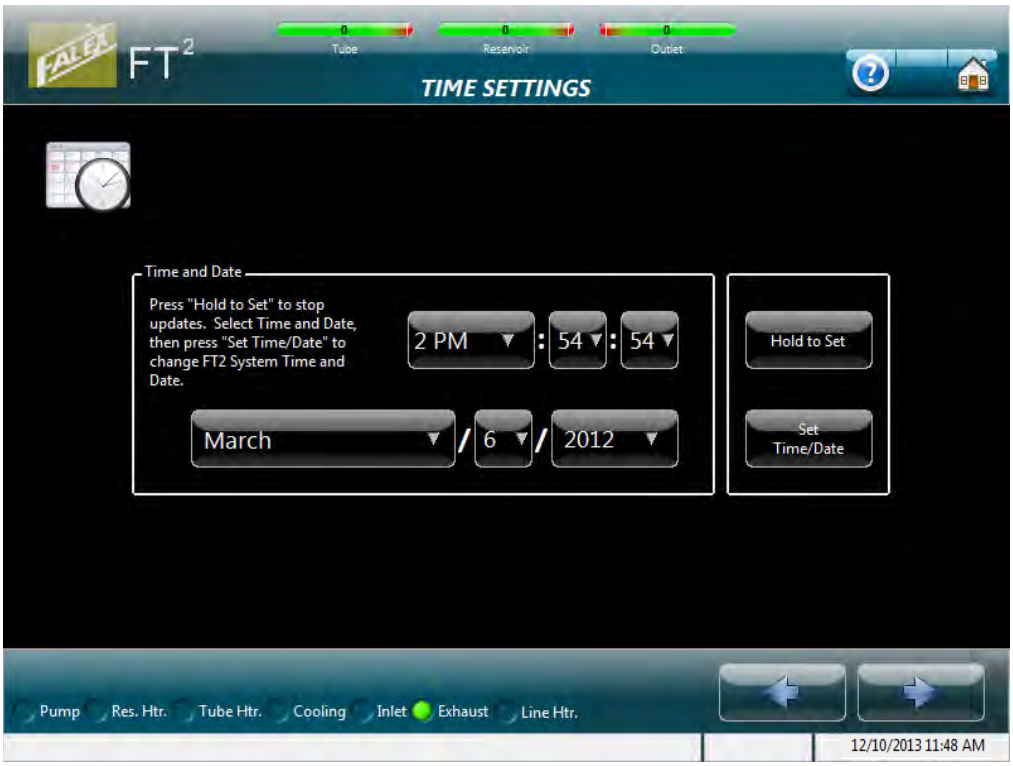


Figure 4-77 – Time Settings display

Note: The main controller will be automatically synchronized with the current user interface date/time stamp whenever a test (timed duration or hot spot) is initiated.

Select the 'Hold to Set' button to stop the time from incrementing so that the operator can change the time hours/minutes/seconds. The button will turn gold and display 'Time Held'. Selecting the hour, minute, or seconds area on the display will open up a drop down screen where the desired time element can be selected. The month, date, or year can be selected at any time. Selecting the month, date, or year area on the display will open up a drop down screen where the desired date element can be selected.

Once the desired time and/or date has been configured, selecting the 'Set Time/Date' button will change the user interface time and/or date and will also synchronize the main controller time/date with the user interface time/date. The 'Time Held' designation on the hold to set button will return to its default state (Hold to Set and black).

Note: If setting the time and/or date back, the machine must be power cycled.

Use the navigation buttons to view additional displays or return to the Maintenance Graph display.

4.4.7.5 System Calibration

The System Calibration display allows the operator to calibrate the particular device, view calibration data and to calibrate the user interface touchscreen (figure 4-78).

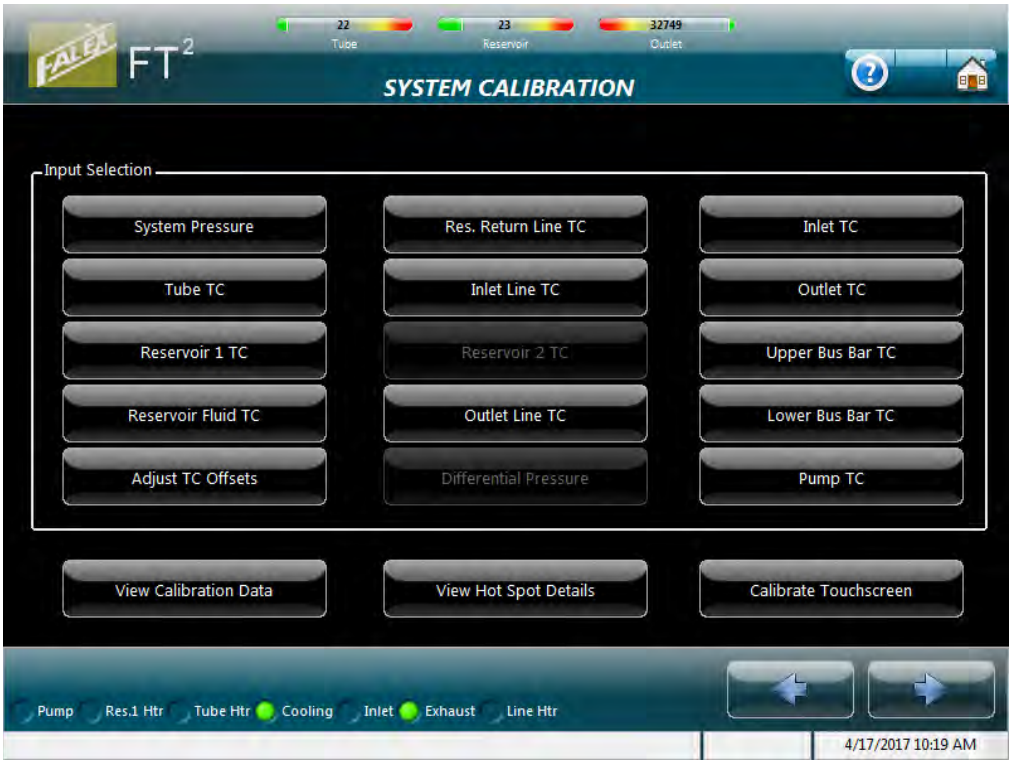


Figure 4-78 – System Calibration display (after password entered)

A level 1 password is required to access the various device calibration buttons shown in the 'Input Selection' area of the display. Selecting the Falex logo in the upper left corner will allow the ability to type in the password.

The following devices can be calibrated:

- System pressure
- Tube thermocouple
- Reservoir #1 thermocouple
- Inlet thermocouple
- Outlet thermocouple
- Upper bus bar thermocouple
- Lower bus bar thermocouple
- Return line heater thermocouple*
- Inlet line heater thermocouple*
- Outlet line heater thermocouple*
- Reservoir #2 thermocouple*
- Pump heater thermocouple*
- Differential Pressure*
- Reservoir fluid thermocouple*

Note: * designates optional equipment.

Each thermocouple can be calibrated electronically. The heater tube thermocouple also has the ability to be calibrated by capturing its lead eutectic point. The system pressure can be calibrated electronically. Refer to Section 5 for calibration details.

Selecting the ‘Adjust TC Offsets’ button will pop-up the ‘System Calibration - Offset Factors’ display (figure 4-79) allowing a thermocouple offset factor to be entered for the particular thermocouple. The allowable range is ± 10 with two (2) decimal places. They can be entered by selecting the white box for the particular thermocouple factor to be entered. The new value will be saved by selecting ‘OK’ on the confirmation pop-up display that appears after selecting the ‘Done’ button. The value will be retained.

Note: The thermocouple offset factor is to be determined by a certified calibration service.

Note: If thermocouple offset factors are used, the value must be changed whenever a thermocouple is replaced.

Note: Since only one (1) thermocouple exists for the reservoir temperature and only one (1) thermocouple exists for the heater tube temperature and each are wired to the main controller and the safety controller, the calibration factor must be entered twice (once for each controller).

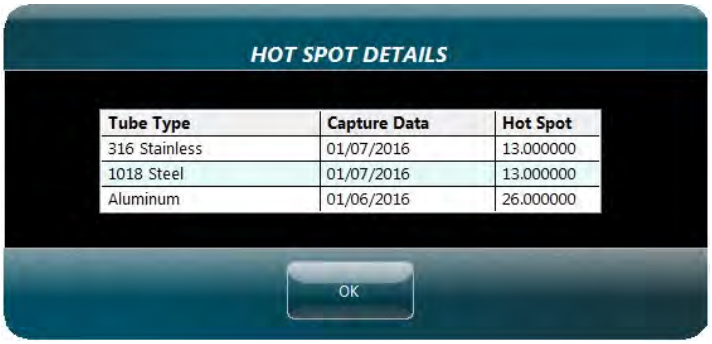
Figure 4-79 – Thermocouple Offset Factor display

Selecting the ‘View Calibration Data’ button will pop-up the ‘Calibration Information’ display (figure 4-80) showing the current calibration values and calibration date for the various devices. Selecting the ‘Print Info’ button will print the calibration information page, if a printer is connected and configured.

Calibration Type	Calibration Date	Zero	Span	Cal Factor
Tube TC Eutectic	00/00/00	-0.626484	0.999680	0.000000
Tube TC Electronic	04/10/2017	-0.626484	0.999680	0.000000
Reservoir 1 TC	04/10/2017	-1.176405	0.999793	0.000000
Inlet TC	04/10/2017	0.189480	0.999631	0.000000
Outlet TC	04/10/2017	-0.959284	0.999390	0.000000
Upper Bus Bar TC	04/10/2017	-0.882535	0.999800	0.000000
Lower Bus Bar TC	04/10/2017	-0.448071	0.999731	0.000000
Res. Return Line TC	04/10/2017	-1.189671	0.999885	0.000000
Inlet Line TC	04/10/2017	-0.856958	0.999796	0.000000
Outlet Line TC	04/10/2017	-1.061652	0.999854	0.000000
Reservoir 2 TC	00/00/00	0.000000	1.000000	0.000000
System Pressure	04/10/2017	0.283423	1.202198	n/a
Safety Reservoir 1 TC	04/10/2017	-1.176405	0.999793	0.000000
Safety Reservoir 2 TC	00/00/00	0.000000	1.000000	0.000000
Safety Tube TC	04/10/2017	-0.626484	0.999680	0.000000
Differential Pressure	00/00/00	0.000000	n/a	n/a
Pump Heater TC	04/10/2017	-0.626877	0.999837	0.000000
Reservoir Fluid TC	00/00/00	0.000000	1.000000	0.000000

Figure 4-80 – Calibration Information display

Selecting the 'View Hot Spot Details' button will pop-up the 'Hot Spot Details' display (figure 4-81) showing the current hot spot position and capture date for each tube material type (if a hot spot test has been ran for the particular tube type).



Tube Type	Capture Data	Hot Spot
316 Stainless	01/07/2016	13.000000
1018 Steel	01/07/2016	13.000000
Aluminum	01/06/2016	26.000000

Figure 4-81 – View Hot Spot Details display

Selecting the 'Calibrate Touchscreen' button will initiate touchscreen calibration process. This is a series of screens that direct the operator to touch designated positions on the display.

Use the navigation buttons to view additional displays or return to the Maintenance Graph display.

4.4.7.6 Manual Controls

The Manual Controls display allows the operator to manually control various devices and set the heater tube thermocouple position offset (figure 4-82). Manual control functionality can only be done when the machine is at idle (timed test or a hot spot test is not active).

Figure 4-82 – Manual Controls display

Within the 'Pump Control' area of the display, the operator can:

- Manually turn the sample pump on/off by selecting the 'Pump ON' or 'Pump OFF' button.
- Change the sample pump flow rate by selecting the white pump rate box and entering the desired percentage.
- Set the default pump rate for pump speed during a duration test or hot spot test (initially set at factory) by selecting the 'Save Default' button. This speed is typically set to achieve a flow rate of approximately 1ml/min.

Note: Device button on/off or open/close text will change accordingly depending upon the state of the device.

Manual pump control functionality is useful when purging the system during the cleaning process or determining the pump flow rate for a specific fluid. See section 3.3 for more details on the cleaning process.

To determine the pump speed range for various flow rates for a particular fluid, it is recommended to use a 100ml graduated cylinder to manually time fluid collection for a set time period. Fluid viscosity changes with heat, so it

is also recommended to manually heat the reservoir when this process is being done. Remove the reservoir lid with the sight glass and allow the fluid to drip into the graduated cylinder.

WARNING: ***Be careful not to touch the reservoir, it will be hot.***

Within the 'Machine Controls' area of the display, the operator can:

- Manually start/stop the reservoir #1 heater by selecting the 'Reservoir #1 Heater ON' or 'Reservoir #1 Heater OFF' button. The reservoir temperature is displayed so that it can be observed increasing when the reservoir heater is manually turned on.
- When enabled, manually start/stop the reservoir #2 heater by selecting the 'Reservoir #2 Heater ON' or 'Reservoir #2 Heater OFF' button. The reservoir temperature is displayed so that it can be observed increasing when the reservoir heater is manually turned on.

Note: Heating of the reservoirs during the startup sequence of a timed test can take 1- 3 hours depending on the desired setpoint. Also, some fluids need to heat to become fluid. If possible, it is recommended to start the reservoir(s) preheating manually prior to starting a test. This will save time allowing the startup sequence to complete and start a test in a shorter time frame.

- Manually open/close the inlet valve by selecting the 'Inlet Valve Open' or 'Inlet Valve Close' button.
- Manually open/close the exhaust valve by selecting the 'Exhaust Valve Open' or 'Exhaust Valve Close' button.

Note: The system can be manually pressured by closing the exhaust valve and opening the inlet valve. The manual inlet valve (located under the reservoir) must be open and the manual exhaust valve (located under the reservoir) must be closed.

- When enabled, manually start/stop each line heater individually by selecting the associated 'xxxx Line Heater ON' or 'xxxx Line Heater OFF' button. Each line heater temperature is displayed so that it can be observed increasing when the associated line heater is turned on.
- When enabled, manually open/close the DP bypass valve by selecting the 'DP Bypass Valve Open' or 'DP Bypass Valve Close' button.
- Initiate a pressure leak test by selecting the 'Run Pressure / Leak Test' button (button will turn gold). This will turn the sample pump on at the default flow rate, close the exhaust valve, open the inlet valve and pressurize the system. After 2 minutes, the inlet valve will close. Check for leaks. The system pressure is displayed to see if the value decreases. Once it has been determined that no leaks exist, the pressure leak test is to be stopped by selecting the 'Run Pressure /

Leak Test' button a second time (button will turn black). The sample pump will stop and the exhaust valve will open, releasing pressure. It is recommended that a leak test be conducted prior to starting a timed test or hot spot test.

- When enabled, manually start/stop the pump heater by selecting the 'xxxx ON' or 'xxxx OFF' button. The pump heater temperature is displayed so that it can be observed increasing when the pump heater is turned on.

Note: In order for the manual leak test to function correctly and the system to pressurize, the manual inlet valve must be open and the manual exhaust valve must be closed. Once the system has been pressurized to the desired pressure, close the manual inlet valve.

Buttons will change to gold when a device change has been initiated that is different from the default state. Default states are shown with black buttons.

Note: Exiting the Manual Controls display will automatically place all devices back to their default state and the actuator will be returned to its home position.

Within the 'Thermocouple Controls' area of the display, the operator can:

- Manually 'jog' the heater tube thermocouple up/down by selecting the ↑ or ↓ buttons.
- Manually force the heater tube thermocouple to its 'Home' position by selecting the 'Go Home' button
- Manually check the heater tube thermocouple position offset by selecting the 'Check Offset' button. The offset is the space between the tip of the heater tube thermocouple when in the home position and the top of the heater tube (when heater tube properly positioned within the bus bars). When properly determined, the heater tube thermocouple should move the 'offset' so that the tip of the heater tube thermocouple should come in contact with the top of the heater tube.
- Manually set the heater tube thermocouple position offset by:
  a. Verify that the heater tube thermocouple is in its home position. If not, select the 'Go Home' button on the display.
  b. If installed, remove heater tube holder assembly
  c. Remove thermocouple guide
  d. Install a used heater tube between the bus bars making sure that the top of the heater tube is flush with the top of the upper bus bar
  e. From the display, select the 'distance' white box and enter a distance in mm (increments of .25mm are allowed). This is typically between 1 – 4mm.

f. From the display, select the 'Move Now' button to initiate the actuator to move the distance entered (button will become enabled after a valid distance is entered). Be sure to help guide the thermocouple into the heater tube, should the entered distance be too long. Otherwise, the thermocouple could bend. Proper distance is when the thermocouple just touches the top of the heater tube.
g. If distance is not correct, select 'Go Home' button. Follow steps e - g until a satisfactory distance is achieved
h. Select the 'Set New Offset' button to store the new distance as the desired offset
i. Select the 'Check Offset' button to verify the offset was correctly stored
j. Remove used heater tube

Note: It is very important that the heater tube thermocouple position offset be set correctly so that the heater tube thermocouple starts out at the correct position. Otherwise, the captured hot spot will not be determined at the correct position and all subsequent temperature profiles will be inaccurate.

Note: The heater tube thermocouple position offset needs to be verified any time the heater tube thermocouple is removed from the actuator arm. If the heater tube thermocouple position offset has changed, a new offset is to be determined.

Use the navigation buttons to view additional displays or return to the Maintenance Graph display.

5. Calibration

Calibration of the thermocouples, system pressure and differential pressure (if enabled) is done from the System Calibration display (figure 5-1). The display can be accessed by selecting Maintenance from the Main Menu and using the navigation buttons.

Figure 5-1 – System Calibration display

A level 1 password is required to access the various device calibration buttons shown in the 'Input Selection' area of the display. Selecting the Falex logo in the upper left corner will allow the ability to type in the password.

The following devices can be calibrated:

- System pressure
- Tube thermocouple
- Reservoir #1 thermocouple
- Inlet thermocouple
- Outlet thermocouple
- Upper bus bar thermocouple
- Lower but bar thermocouple
- Return line heater thermocouple*
- Inlet line heater thermocouple*
- Outlet line heater thermocouple*
- Reservoir #2 thermocouple*
- Pump heater thermocouple*
- Differential pressure*
- Reservoir fluid thermocouple*

Note: * designates optional equipment.

Each thermocouple can be calibrated electronically. However, the heater tube thermocouple also has the ability to be calibrated by capturing its lead eutectic point (calibration by the electronic method is the recommended calibration method). The system pressure can also be calibrated electronically. Instructions

are displayed throughout the calibration process to assist the operator. The calibration procedure can be aborted anytime by selecting the 'Abort Calibration' button or the X on the header portion of the active display. Anytime the calibration process is aborted, the previous calibration factors for the particular device being calibrated are restored.

The calibration procedures are outlined below for each device type.

Note: Each device has been calibrated at the factory using the electronic method prior to shipment. If a device calibration is needed and the required calibration equipment is not available, please contact your local Falex representative to schedule a service visit.

Note: At any time, the calibration process can be aborted by selecting the 'Abort Calibration' button. This will abort the process and reinstate the previous calibration parameters.

Note: Calibration factors for the reservoir temperature and the heater tube temperature are automatically applied to the safety controller inputs.

Note: The thermocouple calibration offset factors are factory set to 0. If the end user has the thermocouples certified, they can be entered into the system (refer to section 4.4.7.5).

<u>Electronic Calibration of Thermocouples</u>

This method requires the use of an electronic calibrator, figure 5-2 shows the calibrator type used at the factory.

Figure 5-2 – Thermocouple Electronic Calibrator

The following is the procedure for calibrating any of the thermocouples electronically:

Note: All thermocouples desired span will be 500 °C except for the heater tube thermocouple which will be 1000 °C.

1. From the display, select the desired thermocouple button to be calibrated. If the tube thermocouple is to be calibrated, select the 'Electronic' button when asked for the method to be performed (two (2) methods of calibration exist for the tube thermocouple).
2. Select the 'Begin Calibration' button on the Calibration Wizard display to start the process (figure 5-3).

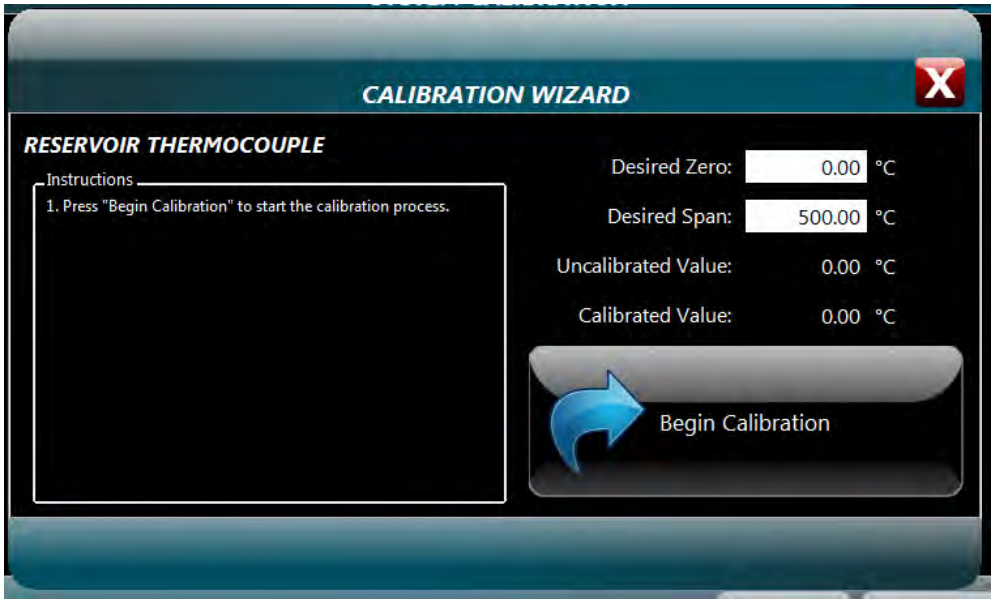


Figure 5-3 – Thermocouple Electronic Calibration Wizard display with Begin button

3. Connect the thermocouple calibrator to the correct input jack and adjust the output to 0 °C.
4. Verify 'Desired Zero' value is set to match that of the calibrator and correct if necessary (figure 5-4).

Figure 5-4 – Thermocouple Calibration Wizard display

5. Once the 'Uncalibrated Value' has stabilized, press the 'Continue' button.
6. Adjust the thermocouple calibrator to an output of 500 °C.
7. Once the 'Uncalibrated Value' has stabilized, press the 'Continue' button.
8. Press the 'Continue' button to store the new calibration factors.

Eutectic Calibration of the Heater Tube Thermocouple

Note: Heater tube eutectic calibration is selected from the System Calibration display after selecting the 'Tube T/C button'.

The following is the procedure for calibrating the heater tube thermocouple using the lead eutectic method:

1. Select the 'Begin Calibration' button on the Calibration Wizard display to start the process (figure 5-5).

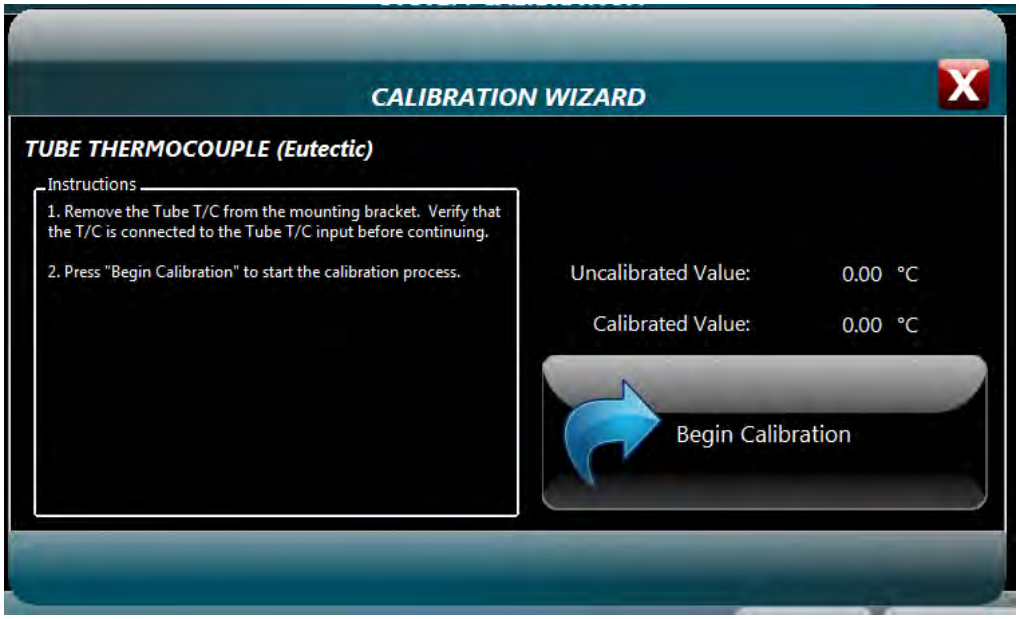


Figure 5-5 – Eutectic Calibration Wizard display with Begin button

2. Locate the lead calibration assembly and install it into the upper/lower bus bars. Verify that the lead calibration assembly has been pre-loaded with melted lead. Make sure the top of the lead calibration assembly is flush with the top of the upper bus bar and that the bus bar screws are tight.
3. Prepare a low temperature standard, which is an ice bath of distilled water and distilled ice. It is recommended that this be prepared in an insulated cup.
4. Leaving the heater tube thermocouple connected to the machine, carefully remove the heater tube thermocouple from the actuator arm (do not bend the thermocouple). Loosen set screws located on front and side (.050" Allen wrench). If thermocouple does not easily pull out of the actuator arm, use the Allen wrench to push up from the underside of the actuator arm.
5. Insert the heater tube thermocouple into the ice bath.
6. Stir the thermocouple in the ice bath for a few minutes. The 'Uncalibrated Value' will decrease.
7. Once the 'Uncalibrated Value' has stabilized (no longer dropping), press the 'Save Ice Point' button to store the low temperature value. The temperature must be 0 °C (±2 °C) to be accepted. Otherwise, the low calibration process is aborted.
8. Remove the heater tube thermocouple from the ice bath and wipe it dry.
9. Insert the thermocouple through the top shoulder of the lead calibration assembly until the tip touches the lead.

Note: For accurate calibration functionality, the heater tube thermocouple must stay in contact with the lead.

10. Press the 'Start Heating' button when ready to initiate the heating process. The lead calibration assembly will heat to 350 °C.

Note: Severe burns could occur from skin contact with the lead calibration assembly during the heating process. Be very careful when handling the heater tube thermocouple during the heating process.

11. Once the lead temperature is >330 °C, it will become molten.
12. Carefully press the heater tube thermocouple into the center of the molten lead using caution to prevent contact with the sides or bottom of the lead cup.
13. Once the lead temperature has equalized (45 seconds), the cooling sequence will be initiated so that the eutectic temperature can be detected. Wait for the system to complete the process and display the pass or fail message.
14. Pressing the 'OK' button on the pass/fail pop-up display will initiate the heating process so the heater tube thermocouple can be removed from the lead. The system will apply heat, causing the lead to change to its molten state.
15. Wait for the 'Uncalibrated Value' to be >330 °C and then carefully remove the thermocouple and wipe off any molten lead from the thermocouple tip.

Note: Heater tube temperature will only be >330 °C for one (1) minute to allow thermocouple removal.

Note: Wear appropriate gloves when handling the hot thermocouple to prevent skin contact.

16. A seven (7) minute cooling timer will start to cool the lead calibration assembly. When timer has timed out, cooling will stop and a pop-up notification (figure 5-6) will appear notifying the operator that the calibration sequence has completed.

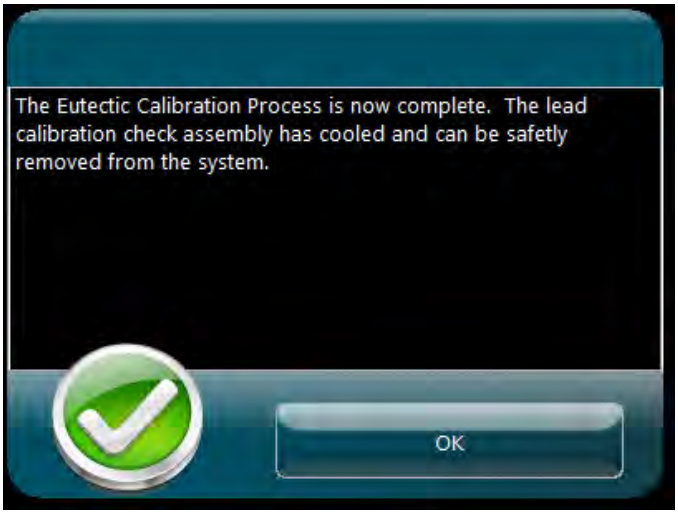


Figure 5-6 – Eutectic calibration complete pop-up

Note: To be sure that the lead calibration assembly is at a safe handling temperature (<40 °C), insert the heater tube thermocouple back into the lead calibration assembly so that the thermocouple tip is in contact with the hardened lead and verify the temperature on the Calibration Wizard display.

17. Press the ‘Continue’ button to view the calibration information.

Note: Should the eutectic temperature capture fail, it is recommended that the test be repeated to confirm that the thermocouple is defective. If the thermocouple fails eutectic capture again, it should be replaced.

18. Remove the lead calibration assembly and install the heater tube thermocouple back into the actuator arm. Slide the heater tube thermocouple into the hole within the actuator arm until the thermocouple tip is 2 – 4mm above the bus bar when the actuator is at its home position. Secure the thermocouple into the actuator arm by tightening the front and side set screws (.050 Allen wrench).
19. Verify the heater tube thermocouple position offset and change it if necessary. Refer to section 4.4.7.6 for more details.

<u>Electronic Calibration of the System Pressure</u>

Note: Pressure is to be calibrated using psi units. Conversion takes place within the software to convert psi to kPa.

This method requires the use of a calibrated pressure gauge calibrator and is to be done by Falex personnel or a properly trained Falex representative.

The following is the procedure for calibrating the system pressure electronically:

1. Press the ‘Begin Calibration’ to start the calibration process (figure 5-7).

Figure 5-7 – Pressure Calibration Wizard display with Begin button

2. Connect the calibrated pressure gauge calibrator to the system pressure fitting on the front of the cabinet (above reservoir). Press 'Continue' after installation (figure 5-8).

Figure 5-8 – Pressure Calibration Wizard display

3. Power up the calibrated pressure gauge and enter the displayed value into the 'Desired Zero' field on the Calibration Wizard display.
4. Once the 'Uncalibrated Value' has stabilized, press the 'Continue' button.
5. Set the pressure regulator on the air source to a value between 1000 – 1050 psi (6895 – 7239 kPa).
6. Verify the manual inlet air valve on the front of the machine is open (left valve below reservoir).
7. Observe the displayed value on the calibrated pressure gauge and enter this number in the 'Desired Span' field.
8. Once the 'Uncalibrated Value' has stabilized, press the 'Continue' button.
9. After the 'Calibrated Value' displays 0 psi, press the 'Continue' button.
10. Press the 'Continue' button to store the new calibration factors.

Electronic Calibration of the Differential Pressure (DP)

Refer to Addendum G for information regarding the setup and calibration of the optional differential pressure (DP) system.

6. Maintenance

Maintenance is to be routinely performed to keep the machine operating at its peak performance and to provide consistent and accurate results. The following is a recommended maintenance schedule:

- Hot spot determination test should be done any time the heater tube thermocouple has been replaced, the heater tube holder has been replaced, whenever a heater tube of a different material is used or whenever changing to a different test fluid.
- Hot spot validation test should be done after a hot spot determination has been completed or any time when the hot spot location is suspect.
- If a thermocouple has been replaced, the new thermocouple is to be calibrated prior to running any tests.
- Calibration of all thermocouples should be completed every 6 months.
- Calibration of the system pressure should be completed every 6 months.
- If thermocouple offset factors are used, the particular thermocouple's value is to be updated whenever a new thermocouple is installed.
- Heater tube thermocouple position offset should be verified any time the heater tube thermocouple is removed from the actuator arm. Change accordingly (refer to section 4.4.7.6).
- Heater tube O-rings are to be changed on every hot spot test or timed test.
- Heater tube specimen is to be changed on every hot spot test or timed test.
- Wipe clean any oil residue that may collect within the upper/lower bus bar clamp area (where heater tube is held into place). This will maintain clean contact between the bus bars and the heater tube.
- Outlet temperature thermocouple O-ring is to be changed on every test (hot spot or timed test).
- Inlet temperature thermocouple O-ring is to be changed on every test (hot spot or timed test).
- All tubing O-rings should be changed every test (hot spot or timed test). This includes the sample input line, sample output line, sample return line and the air inlet line.
- Sample pump inlet and outlet O-rings should be changed once leaks are observed.
- Sight glass O-rings (3) should be changed every 6 months or if showing signs of wear.
- Reservoir O-ring should be inspected after every test (hot spot or timed test) and replaced when deterioration is detected.
- Reservoir outlet fitting O-ring should be changed once leaks are observed.
- Keep all test fluid leaks or spills cleaned up so that they do not seep into the electronic cabinet.
- Keep the touchscreen free of test fluid or dust that could damage the surface and its functionality.

- Do not let the user interface hard drive fill to capacity with data files. Failure to do so could crash the system. Develop a system where data files are routinely saved to an external source and deleted from the user interface. Refer to section 4.4.6 to determine disk usage and to delete data files.
- Maintain the external cooler reservoir fluid level.
- Coalescing Gas Filter:
  - Filter Element: Visually inspect the filter element once per month (depending on machine use) or if the system pressure does not vent to <1 psi (7 kPa) after completion of a test.
    - ✓ *Drain fluid buildup*
    - ✓ *Replace filter if showing signs of wear or excessive buildup*

  - O-Ring: Replace O-Ring every 6 months or if showing signs of wear.

WARNING: *Make sure the system pressure is <1 psi (7 kPa) before opening the coalescing gas filter.*

WARNING: *When re-assembling the coalescing gas filter assembly, make sure the housing is tight. Otherwise, pressure leaks will occur.*

Note: Anytime an O-ring shows signs of deterioration, it is to be replaced.

7. Data Files

As mentioned throughout this manual, temperature profiles and data files are created and stored on the user interface. Temperature profiles are a table of captured heater tube thermocouple temperatures at specific positions within the heater tube. Data files are a table of captured parameters that are captured at a predetermined collection rate for the duration of the test.

The file naming format was discussed in detail in sections 4.4.2.1 for timed tests and in 4.4.3.1 for hot spot tests. Data collection rates can be changed within the User Preferences portion of the user interface, as discussed in section 4.4.5. Temperature profiles and data files can be copied from the machine to an external device within the File Manager portion of the user interface, as discussed in section 4.4.6. The temperature profiles and data files are saved in a format that can be opened within a standard spreadsheet or document application, once transferred to an external PC. The temperature profiles and data files are saved as a .csv formatted file.

The makeup of the various data files is discussed below.

Temperature Profile

Up to two (2) temperature profiles could be included within the temperature profile data file, depending upon the test configuration. The temperature profile data file consists of header information and stored data records. A data record is captured and stored for each heater tube thermocouple position. Refer to Addendum B to see a typical temperature profile example.

The header portion contains information that was entered from the Test Information display for the particular test. The type of test the profile represents is also shown.

Each stored data record has five (5) components. They are:

- Date when the data record was captured
- Test time (seconds) when the data record was captured
- Heater tube thermocouple captured temperature (°C)
- Actual heater tube thermocouple position (mm) when the temperature was captured
- Heater tube thermocouple reference to the ‘A’ position when the temperature was captured

Data File

The data file consists of header information and stored data records. A data record is captured and stored at a predetermined collection rate for the duration of the test. Refer to Addendum C to see a typical data file example (due to length of the file, entire file not shown).

The header portion contains information that was entered from the Test Information display for the particular test, some miscellaneous information and the test configuration summary.

Each stored data record has eleven (14) components as standard. They are:

- Time stamp when the data record was captured
- Test time (seconds) when the data record was captured
- Heater tube thermocouple captured temperature (°C)
- Power captured reading (amps)
- Inlet thermocouple captured temperature (°C)
- Outlet thermocouple captured temperature (°C)
- Upper bus bar thermocouple captured temperature (°C)
- Lower bus bar thermocouple captured temperature (°C)
- Reservoir #1 thermocouple captured temperature (°C)
- Captured system pressure (psi or kPa, depending on user preference configuration)
- Actual heater tube thermocouple position (mm)
- Tube Voltage (VAC)
- Tube Power (watts)
- Differential Pressure value (mmHg) *(only displayed when option enabled)*

8. Specimens

Each timed test or hot spot test requires one (1) heater tube. The heater tube can only be used for a single timed test or hot spot test. It cannot be used for multiple tests or multiple hot spot tests. This machine is designed and has been tested to work with three (3) types of heater tubes: 316 stainless steel, 1018 steel and Aluminum. The typical heater tube to be used for this machine is made out of 316 stainless steel.

- Aluminum, box of 12 (400-560-001)
- 316 stainless steel, box of 12 (400-560-003)
- 1018 steel (contact your local Falex representative)

WARNING: ***Machine functionality using heater tubes made from materials other than those listed above cannot be guaranteed. Using heater tubes made from materials other than those listed above could cause damage to the machine and put the operator at risk for injury.***

Note: Each Aluminum tube comes with a DP kit (DP filter and three O-rings). If the aluminum tube will not be used for a DP test, the DP kit will not be used.

Note: Always wear lint free gloves when handling a heater tube to prevent introducing finger prints or other foreign substances to the heater tube. Always handle the heater tube by the shoulders, do not touch the test area (middle area).

The 316 stainless steel heater tubes meet all of the SAE ARP5996 requirements for dimensions, surface finish and material. The aluminum heater tubes meet all ASTM D3241 requirements for dimensions, surface finish and material.

Each tube must be properly prepared prior to being used for a test. Refer to section 3.4 for the tube preparation procedure.

9. Parts Listing

PART #	DESCRIPTION
100-200-052	External cooler
400-018-003	Insulation bushing (2 pairs/pack)
400-108-004	Lead calibration holder with melted lead
400-560-003	Heater tubes (316SS) (12 tubes/box)
450-014-001	Thermocouple guide
450-041-002	Tube holder (for oven and balance)
450-041-005	Dual tube holder (for oven and balance)
450-097-003	O-Ring kit, Standard (20 tests)
450-097-012	Pump gasket kit (package of 2)
450-097-013	Replacement Pump kit
450-099-001	Heater tube holder assembly
450-105-010	Bypass cleaning line assembly
450-105-064	Reservoir return line cleaning extension
450-106-002	Pump heater kit
450-109-004	Thermocouple assembly- inlet/outlet
450-109-006	Remote emergency stop
620-006-004	O-Ring, tubing (package of 100)
620-008-006	O-Ring, heater tube (package of 25)
620-011-010	O-Ring, SAE fitting (package of 10)
648-400-007	Hex Socket wrench
648-400-009	Ceramic insulator removal tool
648-450-001	Heater tube cleaning brush
650-009-061	Thermocouple - heater tube
650-030-150	Power Cord (220V)
669-450-003	Disposable filter for coalescing gas filter
669-450-004	O-ring for coalescing gas filter
***** For use with bolted flange reservoirs only *****	
450-097-004	Heated line set – pull configuration
450-097-006	O-ring kit, bolted flange reservoir
450-097-010	Heated line set – push configuration
450-097-011	Unheated line set – push configuration
450-106-006	Reservoir heater jacket (bolted flange)
450-200-003	Differential pressure assembly
450-200-004	Single pass flow assembly

PART #	DESCRIPTION
***** For use with split ring clamping collar reservoirs only *****	
450-097-014	O-ring kit – split ring clamping collar reservoir
450-097-017	Heated line set – pull configuration
450-097-018	Heated line set – push configuration
450-097-020	Unheated line set – push configuration
450-106-008	Reservoir heater jacket (split ring clamping collar)
450-200-007	Mechanical stirrer assembly
450-200-008	Single pass flow assembly

Addendum 'A' – Alarm Matrix

Main Controller

The following details the alarm/abort conditions that exist in the main controller. The alarm/abort value will be captured and included at the end of the alarm/abort message, where applicable.

Note: When a lead eutectic calibration is active, the heater tube temperature high alarm is set to 400°C and the heater tube temperature high abort is set to 420°C.

Description	Alarm	Abort	Condition	Lo Limit	Hi Limit	Alarm Message (HMI)	Comments
Heater Tube Temperature Heating Failure		x	5 ºC in xx sec (based on ramp time)			Heater Tube Failed to Heat	Checked at beginning of Test. ***Possible Cause: T/C not installed properly, T/C not in heater tube, invalid calibration factors.***
Heater Tube Failed to Reach Temperature		x	xx mins after test start (based on ramp time)	< SP - 0.75 ºC	> SP + 0.75 ºC	Heater Tube Failed to Reach Temperature	Checked at beginning of Test. Temp must be within range within alotted time. ***Possible Cause: T/C not installed properly, heater failure.***
Reservoir #1 Heating Failure		x	4 ºC in 10 min			Reservoir #1 Failed to Heat	Checked at start of heating sequence. ***Possible Cause: Heater jacket not installed correctly, Heater jacket not plugged in, heater failure.***
Operator Abort		x				Operator Initiated Abort	Initiated from touchscreen to stop any running devices or active test. ***Possible Cause: Operator hit abort button on display, Operator hit 'X' icon during an active test.***
HMI Communication Failure		x	Test active			Communication Failure With User Interface	Abort after 65 seconds. For PLC purposes only! (HMI detects failure & generates its own messge). ***Possible Cause: Network cable disconnected, Network HUB failure, Touchscreen failure.***
Start Permissive Pressure Alarm	X		Start Permissive active	< SP - 3%	> SP + 3%	Start Permissive Alarm - System Pressure Outside of Limits	Active only during start permissive sequence. Alarm after 5 seconds once within press range and then fall out of range before start permissive is achieved. ***Possible Cause: Pressure regulator not set correctly at tank, pressure leak.***
Heater Tube 'High' Temp	X		Test active		SP + 30	Heater Tube Temperature High Alarm	Alarm after 5 seconds. ***Possible Cause: Excessive deposit on heater tube, Heater tube T/C failure.***
Heater Tube 'High' Temp		x	Test active		SP + 45	Heater Tube Termperature High Abort	Abort after 5 seconds. ***Possible Cause: Excessive deposit on heater tube, Heater tube T/C failure.***
Upper Bus Bar 'High' Temp		x	Test active		50 ºC	Upper Bus Bar Temperature High Abort	Abort after 5 seconds. ***Possible Cause: Cooling system failure, T/C not installed properly.***
Lower Bus Bar 'High' Temp		x	Test active		60 ºC	Lower Bus Bar Temperature High Abort	Abort after 5 seconds. ***Possible Cause: Cooling system failure, T/C not installed properly.***
Reservoir #1 'Low' Temp	X		Test active & Res Heat enabled	SP - 10		Reservoir #1 Heater Temperature Low Alarm	Alarm after 5 seconds. ***Possible Cause: Heater jacket not installed correctly, Heater jacket not plugged in, heater failure.***
Reservoir #1 'Low' Temp		x	Test active & Res Heat enabled	SP - 15		Reservoir #1 Heater Temperature Low Abort	Abort after 5 seconds. ***Possible Cause: Heater jacket not installed correctly, Heater jacket not plugged in, heater failure.***

Description	Alarm	Abort	Condition	Lo Limit	Hi Limit	Alarm Message (HMI)	Comments
Reservoir #1 'High' Temp	X		Heater active		SP + 10	Reservoir #1 Heater Temperature High Alarm	Alarm after 5 seconds. ***Possible Cause: Heater jacket not installed correctly, heater failure.***
Reservoir #1 'High' Temp		x	Heater active		SP + 15	Reservoir #1 Heater Temperature High Abort	Abort after 5 seconds. ***Possible Cause: Heater jacket not installed correctly, heater failure.***
System 'Low' Pressure	X		Test active	If SP<=500 SP – 30 else SP-(10% of SP-20)		System Pressure Low Alarm	Alarm after 5 seconds. ***Possible Cause: Pressure leak, inlet valve failure.***
System 'Low' Pressure		x	Test active	If SP<=500 SP – 50 else SP-(10% of SP)		System Pressure Low Abort	Abort after 5 seconds. ***Possible Cause: Pressure leak, inlet valve failure.***
System 'High' Pressure	X		Test active		If SP<=500 SP + 30 else SP+(10% of SP-20)	System Pressure High Alarm	Alarm after 5 seconds. ***Possible Cause: Air supply not adjusted to desired pressure.***
System 'High' Pressure		x	Test active or Startup active		If SP<=500 SP + 50 else SP+(10% of SP)	System Pressure High Abort	Abort after 5 seconds. ***Possible Cause: Air supply not adjusted to desired pressure.***
Heater Tube Temp T/C Failure		x	Test active or Lead Eutectic Calibration active	+32000 ºC		Heater Tube Temperature Thermocouple Failure	Abort after 5 seconds. ***Possible Cause: TC failure, TC not connected.***
Inlet Temp T/C Failure		x	Test active	+32000 ºC		Inlet Temperature Thermocouple Failure	Abort after 5 seconds. ***Possible Cause: TC failure, TC not connected.***
Reservoir #1 Heater Jacket T/C Failure		x	Heater active	+32000 ºC		Reservoir #1 Heater Jacket Temperature Thermocouple Failure	Abort after 5 seconds. ***Possible Cause: TC failure, TC not connected.***
Upper Bus Bar Temp T/C Failure		x	Test active	+32000 ºC		Upper Bus Bar Temperature Thermocouple Failure	Abort after 5 seconds. ***Possible Cause: TC failure, TC not connected.***
Lower Bus Bar Temp T/C Failure		x	Test active	+32000 ºC		Lower Bus Bar Temperature Thermocouple Failure	Abort after 5 seconds. ***Possible Cause: TC failure, TC not connected.***
SCR Heater Breaker Trip		x	Digital Output 'On'			Tube Heater Breaker Trip	Device called to start, but after 3 sec delay, status does not confirm action. ***Possible Cause: Opto point failure, blown fuse.***
Sample Pump Breaker Trip		x	Digital Output 'On'			Sample Pump Breaker Trip	Device called to start, but after 3 sec delay, status does not confirm action. ***Possible Cause: Opto point failure, blown fuse.***
Reservoir #1 Heater Breaker Trip		x	Digital Output 'On'			Reservoir #1 Heater Breaker Trip	Device called to start, but after 3 sec delay, status does not confirm action. ***Possible Cause: Opto point failure, blown fuse.***
24V Primary Breaker Trip		x	Digital Output 'On'			Primary 24VAC Power Breaker Trip	Device called to start, but after 3 sec delay, status does not confirm action. ***Possible Cause: Opto point failure, blown fuse.***
Heater Tube Temperature Eutectic Low Calibration Abort		x	Lead Eutectic Calibration active	-2 ºC	2 ºC	Heater Tube Temperature Eutectic Low Calibration Aborted (Not Within Limits)	Captured low eutectic temperature not within allowable limits. Previous calibration factors are restored. ***Possible Cause: Operator hit 'save ice point' button prematurely, ice bath not cold enough.***
Heater Tube Temperature Eutectic Low Calibration Operator Abort		x	Lead Eutectic Calibration active			Heater Tube Temperature Eutectic Low Calibration Manually Aborted	Initiated from touchscreen to stop any running devices or active calibration. Previous calibration factors are restored. ***Possible Cause: Operator hit abort button on display, Operator hit 'X' button on display.***
Heater Tube Temperature Eutectic High Calibration Operator Abort		x	Lead Eutectic Calibration active			Heater Tube Temperature Eutectic High Calibration Manually Aborted	Initiated from touchscreen to stop any running devices or active calibration. Previous calibration factors are restored. ***Possible Cause: Operator hit abort button on display, Operator hit 'X' button on display.***
Heater Tube Temperature Electronic Calibration Operator Abort		x	Heater Tube Temp Electronic Calibration active			Heater Tube Temperature Electronic Calibration Manually Aborted	Initiated from touchscreen to stop any running devices or active calibration. Previous calibration factors are restored. ***Possible Cause: Operator hit abort button on display, Operator hit 'X' button on display.***

Description	Alarm	Abort	Condition	Lo Limit	Hi Limit	Alarm Message (HMI)	Comments
Inlet Temperature Electronic Calibration Operator Abort		x	Inlet Temp Electronic Calibration active			Inlet Temperature Calibration Manually Aborted	Initiated from touchscreen to stop any running devices or active calibration. Previous calibration factors are restored. ***Possible Cause: Operator hit abort button on display, Operator hit 'X' button on display.***
Outlet Temperature Electronic Calibration Operator Abort		x	Outlet Temp Electronic Calibration active			Outlet Temperature Calibration Manually Aborted	Initiated from touchscreen to stop any running devices or active calibration. Previous calibration factors are restored. ***Possible Cause: Operator hit abort button on display, Operator hit 'X' button on display.***
Reservoir #1 Temperature Electronic Calibration Operator Abort		x	Reservoir Temp Electronic Calibration active			Reservoir #1 Temperature Calibration Manually Aborted	Initiated from touchscreen to stop any running devices or active calibration. Previous calibration factors are restored. ***Possible Cause: Operator hit abort button on display, Operator hit 'X' button on display.***
Upper Bus Bar Temperature Electronic Calibration Operator Abort		x	Upper Bus Bar Temp Electronic Calibration active			Upper Bus Bar Temperature Calibration Manually Aborted	Initiated from touchscreen to stop any running devices or active calibration. Previous calibration factors are restored. ***Possible Cause: Operator hit abort button on display, Operator hit 'X' button on display.***
Lower Bus Bar Temperature Electronic Calibration Operator Abort		x	Lower Bus Bar Temp Electronic Calibration active			Lower Bus Bar Temperature Calibration Manually Aborted	Initiated from touchscreen to stop any running devices or active calibration. Previous calibration factors are restored. ***Possible Cause: Operator hit abort button on display, Operator hit 'X' button on display.***
System Pressure Electronic Calibration Operator Abort		x	System Pressure Electronic Calibration active			System Pressure Calibration Manually Aborted	Initiated from touchscreen to stop any running devices or active calibration. Previous calibration factors are restored. ***Possible Cause: Operator hit abort button on display, Operator hit 'X' button on display.***
Lead Eutectic Assembly Temperature Fail To Rise		x	5 ºC in 30 sec			Lead Eutectic Assembly Failed to Heat - Verify Thermocouple In Contact With Lead	Checked at beginning of high temperature calibration. ***Possible Cause: T/C not installed properly, T/C not in contact with the lead.***
Sample Pump Fault		x	Pump starting or running			Pump Fault	Active only when pump being started or is running. ***Possible Cause: Pump blockage, pump over-temperature, pump failure.***
Safety Cover Missing	X		Test active			Safety Cover Missing Alarm	Warning only. ***Possible Cause: Cover removed during test, photo eye failure.***
Safety PLC Abort		x				Safety PLC Initiated Abort	Any of Safety abort limits exceeded. ***Possible Cause: see safety alarm matrix.***
External Cooler No Flow	X		Test active			External Cooler No Flow Alarm	Alarm after 5 seconds. ***Possible Cause: External cooler not enabled, external cooler failure, Opto point failure.***
Differential Pressure High	X		Test active & DP enabled		Operator set (default 100 mmHg)	DP High Alarm	Alarm after 5 seconds. ***Possible Cause: Filters plugged.***
Differential Pressure High		x	Test active & DP enabled		Operator set (default 250 mmHg)	DP High Abort	Abort after 5 seconds. ***Possible Cause: Filters plugged.***
Differential Pressure Electronic Calibration Operator Abort		x	Differential Pressure Electronic Calibration active			DP Calibration Manually Aborted	Initiated from touchscreen to stop any running devices or active calibration. Previous calibration factors are restored. ***Possible Cause: Operator hit abort button on display, Operator hit 'X' button on display.***
DP Bypass Valve Failed to Close		x	Test active & DP enabled			DP Bypass Valve Failed to Close	Abort after 15 seconds. ***Possible Cause: DP assembly not connected, bypass valve failure, opto point failure.***
DP Bypass Valve Failed to Open		x	Test active & DP enabled			DP Bypass Valve Failed to Open	Abort after 15 seconds. ***Possible Cause: DP assembly not connected, bypass valve failure, opto point failure.***
Inlet Line Heater Temperature T/C Failure		x	Line Heat enabled & Test active	+32000 ºC		Inlet Line Heater Temperature Thermocouple Failure	Abort after 5 seconds. ***Possible Cause: TC failure, TC not connected.***
Inlet Line Heater 'Low' Temp	X		Line Heat enabled & Test active	SP - 10		Inlet Line Heater Temperature Low Alarm	Abort after 5 seconds. ***Possible Cause: TC failure, TC not connected.***
Inlet Line Heater 'High' Temp	X		Line Heat enabled & Test active		SP + 10	Inlet Line Heater Temperature High Alarm	Abort after 5 seconds. ***Possible Cause: TC failure, TC not connected.***

Description	Alarm	Abort	Condition	Lo Limit	Hi Limit	Alarm Message (HMI)	Comments
Inlet Line Heater Breaker Trip		x	Digital Output 'On'			Inlet Line Heater Breaker Trip	Device called to start, but after 3 sec delay, status does not confirm action. ***Possible Cause: Opto point failure, blown fuse.***
Inlet Line Heater Heating Failure		x	5 ºC in 1 min			Inlet Line Heater Failed to Heat	Checked at start of heating sequence. ***Possible Cause: Heater not connected, heater failure.***
Inlet Line Heater Temperature Electronic Calibration Operator Abort		x	Inlet Line Heater Temp Electronic Calibration Active			Inlet Line Heater Temperature Calibration Manually Aborted	Initiated from touchscreen to stop any running devices or active calibration. Previous calibration factors are restored. ***Possible Cause: Operator hit abort button on display, Operator hit 'X' button on display.***
Outlet Line Heater Temperature T/C Failure		x	Line Heat enabled & Test active	+32000 ºC		Outlet Line Heater Temperature Thermocouple Failure	Abort after 5 seconds. ***Possible Cause: TC failure, TC not connected.***
Outlet Line Heater 'Low' Temp	X		Line Heat enabled & Test active	SP - 10		Outlet Line Heater Temperature Low Alarm	Abort after 5 seconds. ***Possible Cause: TC failure, TC not connected.***
Outlet Line Heater 'High' Temp	X		Line Heat enabled & Test active		SP + 10	Outlet Line Heater Temperature High Alarm	Abort after 5 seconds. ***Possible Cause: TC failure, TC not connected.***
Outlet Line Heater Breaker Trip		x	Digital Output 'On'			Outlet Line Heater Breaker Trip	Device called to start, but after 3 sec delay, status does not confirm action. ***Possible Cause: Opto point failure, blown fuse.***
Outlet Line Heater Heating Failure		x	5 ºC in 1 min			Outlet Line Heater Failed to Heat	Checked at start of heating sequence. ***Possible Cause: Heater not connected, heater failure.***
Outlet Line Heater Temperature Electronic Calibration Operator Abort		x	Outlet Line Heater Temp Electronic Calibration Active			Outlet Line Heater Temperature Calibration Manually Aborted	Initiated from touchscreen to stop any running devices or active calibration. Previous calibration factors are restored. ***Possible Cause: Operator hit abort button on display, Operator hit 'X' button on display.***
Reservoir Return Line Heater Temperature T/C Failure		x	Line Heat enabled & Test active	+32000 ºC		Reservoir Return Line Heater Temperature Thermocouple Failure	Abort after 5 seconds. ***Possible Cause: TC failure, TC not connected.***
Reservoir Return Line Heater 'Low' Temp	X		Line Heat enabled & Test active	SP - 10		Reservoir Return Line Heater Temperature Low Alarm	Abort after 5 seconds. ***Possible Cause: TC failure, TC not connected.***
Reservoir Return Line Heater 'High' Temp	X		Line Heat enabled & Test active		SP + 10	Reservoir Return Line Heater Temperature High Alarm	Abort after 5 seconds. ***Possible Cause: TC failure, TC not connected.***
Reservoir Return Line Heater Breaker Trip		x	Digital Output 'On'			Reservoir Return Line Heater Breaker Trip	Device called to start, but after 3 sec delay, status does not confirm action. ***Possible Cause: Opto point failure, blown fuse.***
Reservoir Return Line Heater Heating Failure		x	5 ºC in 1 min			Reservoir Return Line Heater Failed to Heat	Checked at start of heating sequence. ***Possible Cause: Heater not connected, heater failure.***
Reservoir Return Line Heater Temperature Electronic Calibration Operator Abort		x	ResReturn Line Heater Temp Electronic Calibration Active			Reservoir Return Line Heater Temperature Calibration Manually Aborted	Initiated from touchscreen to stop any running devices or active calibration. Previous calibration factors are restored. ***Possible Cause: Operator hit abort button on display, Operator hit 'X' button on display.***
Pump Heater Temperature T/C Failure		x	Pump Heat enabled & Test active	+32000 ºC		Pump Heater Temperature Thermocouple Failure	Abort after 5 seconds. ***Possible Cause: TC failure, TC not connected.***
Pump Heater 'Low' Temp	X		Pump Heat enabled & Test active	SP - 10		Pump Heater Temperature Low Alarm	Abort after 5 seconds. ***Possible Cause: TC failure, TC not connected.***
Pump Heater 'High' Temp	X		Pump Heat enabled & Test active		SP + 10	Pump Heater Temperature High Alarm	Abort after 5 seconds. ***Possible Cause: TC failure, TC not connected.***
Pump Heater Breaker Trip		x	Digital Output 'On'			Pump Heater Breaker Trip	Device called to start, but after 3 sec delay, status does not confirm action. ***Possible Cause: Opto point failure, blown fuse.***

Description	Alarm	Abort	Condition	Lo Limit	Hi Limit	Alarm Message (HMI)	Comments
Pump Heater Heating Failure		x	5 ºC in 1 min			Pump Heater Failed to Heat	Checked at start of heating sequence. ***Possible Cause: Heater not connected, heater failure.***
Pump Heater Temperature Electronic Calibration Operator Abort		x	Pump Heater Temp Electronic Calibration Active			Pump Heater Temperature Calibration Manually Aborted	Initiated from touchscreen to stop any running devices or active calibration. Previous calibration factors are restored. ***Possible Cause: Operator hit abort button on display, Operator hit 'X' button on display.***
Reservoir #2 Heater Jacket T/C Failure		x	Test active	+32000 ºC		Reservoir #2 Heater Jacket Temperature Thermocouple Failure	Abort after 5 seconds. ***Possible Cause: TC failure, TC not connected.***
Reservoir #2 'High' Temp	X				SP + 10	Reservoir #2 Heater Temperature High Alarm	Abort after 5 seconds. ***Possible Cause: Heater jacket not installed correctly, heater failure.***
Reservoir #2 'High' Temp		x			SP + 15	Reservoir #2 Heater Temperature High Abort	Abort after 5 seconds. ***Possible Cause: Heater jacket not installed correctly, heater failure.***
Reservoir #2 Heater Breaker Trip		x	Digital Output 'On'			Reservoir #2 Heater Breaker Trip	Device called to start, but after 3 sec delay, status does not confirm action. ***Possible Cause: Opto point failure, blown fuse.***
Reservoir #2 Heating Failure		x	4 ºC in 10 min			Reservoir #2 Failed to Heat	Checked at start of heating sequence. ***Possible Cause: Heater jacket not installed correctly, Heater jacket not plugged in, heater failure.***
Reservoir #2 Temperature Electronic Calibration Operator Abort	X		Reservoir Temp Electronic Calibration Active			Reservoir #2 Temperature Calibration Manually Aborted	Initiated from touchscreen to stop any running devices or active calibration. Previous calibration factors are restored. ***Possible Cause: Operator hit abort button on display, Operator hit 'X' button on display.***
Stirrer Motor Breaker Trip		x	Digital Output 'On'			Stirrer Motor Breaker Trip	Device called to start, but after 3 sec delay, status does not confirm action. ***Possible Cause: Opto point failure, blown fuse.***

Safety Controller

The following details the abort conditions that exist in the safety controller.
Any of these aborts will trigger the 'Safety PLC abort' in the main controller.

Description	Alarm	Abort	Condition	Lo Limit	Hi Limit	Alarm Message (HMI)	Comments
Outlet 'Low' Temp (hardcoded limit)		x	Alarm enabled	50 ºC		Safety PLC Shutdown - Outlet Temperature Low	Alarm is enabled when test is running and heater tube temp in range (setpoint ± 3 ºC) for 5 minutes. Hardcoded limit. Abort after 5 seconds. ***Possible Cause: cooling system failure, pump failure.***
Outlet 'Low' Temp (user selectable limit)		x	Alarm enabled	default 50 ºC (range 50 - 500 ºC)		Safety PLC Shutdown - Outlet Temperature Low	Alarm is enabled when test is running and heater tube temp in range (setpoint ± 3 ºC) for 5 minutes. User selectable limit. Abort after 5 seconds. ***Possible Cause: cooling system failure, pump failure.***
Heater Tube 'High' Temp (hardcoded limit)		x			685 ºC	Safety PLC Shutdown - Heater Tube Temperature High	Hardcoded limit. Abort after 5 seconds. ***Possible Cause: Excessive deposit on heater tube, Heater tube T/C failure.***
Heater Tube 'High' Temp (user selectable limit)		x			default 685 ºC (range 200 - 685 ºC)	Safety PLC Shutdown - Heater Tube Temperature High	User selectable limit. Abort after 5 seconds. ***Possible Cause: Excessive deposit on heater tube, Heater tube T/C failure.***
Reservoir #1 'High' Temp (hardcoded limit)		x			165 ºC	Safety PLC Shutdown - Reservoir #1 Heater Temperature High	Hardcoded limit. Abort after 5 seconds. ***Possible Cause: Heater jacket not installed correctly, heater failure.***
Reservoir #1 'High' Temp (user selectable limit)		x			default 165 ºC (range 0 - 165 ºC)	Safety PLC Shutdown - Reservoir #1 Heater Temperature High	User selectable limit. Abort after 5 seconds. ***Possible Cause: Heater jacket not installed correctly, heater failure.***
Reservoir #2 'High' Temp (hardcoded limit)		x			165 ºC	Safety PLC Shutdown - Reservoir #2 Heater Temperature High	Hardcoded limit. Abort after 5 seconds. ***Possible Cause: Heater jacket not installed correctly, heater failure.***
Reservoir #2 'High' Temp (user selectable limit)		x			default 165 ºC (range 0 - 165 ºC)	Safety PLC Shutdown - Reservoir #2 Heater Temperature High	User selectable limit. Abort after 5 seconds. ***Possible Cause: Heater jacket not installed correctly, heater failure.***
Reservoir #1 Heater Jacket T/C Failure		x	Heater Active	+32000 ºC		Safety PLC Shutdown - Reservoir #1 Heater Temperature Thermocouple Failure	Abort after 5 seconds. ***Possible Cause: TC failure, TC not connected.***
Reservoir #2 Heater Jacket T/C Failure		x	Heater Active	+32000 ºC		Safety PLC Shutdown - Reservoir #2 Heater Temperature Thermocouple Failure	Abort after 5 seconds. ***Possible Cause: TC failure, TC not connected.***
Heater Tube Temp T/C Failure		x	Test active	+32000 ºC		Safety PLC Shutdown - Heater Tube Temperature Thermocouple Failure	Abort after 5 seconds. ***Possible Cause: TC failure, TC not connected.***
Outlet Temp T/C Failure		x	Test active	+32000 ºC		Safety PLC Shutdown - Outlet Temperature Thermocouple Failure	Abort after 5 seconds. ***Possible Cause: TC failure, TC not connected.***

Addendum 'B' – Temperature Profile Example

Note: Data file shown is for test that had both profiles selected in test configuration.

Date: 09/03/2015
Time: 12:34:43

Machine #: 123456
Tube ID: 222222
Sample ID: Fluid A
Test Name:
Operator: Lab Tech
Hot Spot Offset: 18.0 mm

Temperature Data Profile #1 (RP)

Date	Time (sec)	Temp (DegC)	TC Position (mm)	
9/03/2015	1981	271.4	16	A-12
9/03/2015	2100	281.8	20	A-8
9/03/2015	2220	289.4	24	A-4
9/03/2015	2340	291.2	28	A
9/03/2015	2460	288.8	32	A+4
9/03/2015	2580	282.8	36	A+8
9/03/2015	2700	270.4	40	A+12

Temperature Data Profile #2 (RP)

Date	Time (sec)	Temp (DegC)	TC Position (mm)	
9/03/2015	10980	278.3	16	A-12
9/03/2015	11100	289.6	20	A-8
9/03/2015	11220	299.2	24	A-4
9/03/2015	11340	298.1	28	A
9/03/2015	11460	295.8	32	A+4
9/03/2015	11580	294	36	A+8
9/03/2015	11700	280.7	40	A+12

Addendum 'C' – Data File Example

Note: Due to length of file, entire data file is not shown.

Note: Data file below had the differential pressure option enabled.

Datafile Name: 20160129_1039__RPAData.csv
Test Type: RPA Test
Test Fluid: Fluid A
Batch #:
Volume Tested: 200 ml

Operator: Lab Tech
Tube ID: 1111111
Machine #: 123456

Test Started: 01/29/2016 10:39:06 AM
Data recorded every 30 s
Last Heater Tube TC Calibration Date: 09/08/2015
Last System Pressure Calibration Date: 09/08/2015

Hot Spot Measured Date: 08/23/15

Test Options:
Reservoir Heat: ON 150 °C
Line Heat: OFF
Stirrer: OFF
Single Pass (Res. #2): OFF
Conduct Profile #1: OFF
Conduct Profile #2: OFF
Differential Pressure: ON
Hot Spot Override: OFF
Pump Heater: OFF
Flow Direction: PULL

Overall Parameters:
Tube Material: Aluminum
Tube Temperature: 280 °C
Heat Ramp Up Time: 10 min
Cool Down Time: 20 min
Pump Rate: 8 %
Purge Time: 2 min
System Pressure: 550 PSI
Test Duration: 5.0 hr

Startup Order:
1. Purge
2. Reservoir Heat
3. Pressure

Comments:

Real Time-HH:MM:SS	Test Time-DD:HH:MM:SS	Tube Temp. (°C)	Tube Power (amps)	Inlet Temp. (°C)	Outlet Temp. (°C)	Upper Bus Bar Temp. (°C)	Lower Bus Bar Temp. (°C)	Reservoir Temp. (°C)	System Pressure (PSI)	Tube Distance (mm)	Tube Voltage (VAC)	Tube Power (watts)	Differential Pressure (mmHG)
10:39 AM	00:00:00:00	30.3	0.1	43.8	26.6	21.2	21.3	151	560.6	0	0.002	0	0
10:39 AM	00:00:00:00	27.6	0.1	43.5	26.5	21.3	21.3	151	559	20	0.002	0	0
10:40 AM	00:00:00:00	51.3	95.1	43.3	29.6	21.5	21.3	150	558.5	26	0.074	7	0
10:40 AM	00:00:00:00	62.2	105.8	43.6	35.3	21.8	21.5	150	557.3	26	0.082	8.7	0
10:41 AM	00:00:00:00	73.5	116.2	44.1	40.5	22.1	21.6	150	556.5	26	0.092	10.6	0
10:41 AM	00:00:00:00	84.9	126	44.5	45.6	22.5	21.6	149	555.8	26	0.101	12.7	0
10:42 AM	00:00:00:00	96.6	134.8	45	50.9	23	21.9	149	554.6	26	0.109	14.7	0
10:42 AM	00:00:00:00	108	142.8	45.5	56.2	23.3	22	148	554.1	26	0.117	16.7	0
10:43 AM	00:00:00:00	119.6	150.3	46.1	61.6	23.7	22.2	148	553.6	26	0.125	18.8	0
10:43 AM	00:00:00:00	131.2	157.1	46.7	66.9	24.2	22.4	148	553.3	26	0.133	20.9	0
10:44 AM	00:00:00:00	142.6	164.1	47.3	72.4	24.6	22.5	148	552.9	26	0.141	23.1	0
10:44 AM	00:00:00:00	154.3	169.2	48	78	25	22.7	148	552.9	26	0.148	25	0
10:45 AM	00:00:00:00	165.8	176	48.8	83.7	25.5	22.9	148	552.6	26	0.156	27.4	0
10:45 AM	00:00:00:00	177.4	181	49.5	89.3	25.9	23.1	148	553	26	0.162	29.3	0
10:46 AM	00:00:00:00	188.8	184.7	50.4	94.9	26.4	23.3	148	553.4	26	0.17	31.4	0
10:46 AM	00:00:00:00	200.1	191.6	51.3	101.1	26.8	23.6	148	553.8	26	0.176	33.8	0
10:47 AM	00:00:00:00	211.2	196.6	52.4	107.4	27.3	23.7	149	554.2	26	0.182	35.9	0
10:47 AM	00:00:00:00	222.4	202.1	53.5	113.9	27.8	23.9	149	554.9	26	0.192	38.7	0
10:48 AM	00:00:00:00	233.8	206	54.7	120.8	28.3	24.2	149	555.4	26	0.199	40.9	0
10:48 AM	00:00:00:00	245.1	210.9	56	128	28.8	24.3	150	556.1	26	0.204	43.1	0
10:49 AM	00:00:00:00	256.6	215.7	57.4	135.3	29.3	24.5	150	556.4	26	0.213	45.9	0
10:49 AM	00:00:00:00	268.2	216.8	58.9	142.8	29.9	24.8	151	557.3	26	0.219	47.5	0
10:50 AM	00:00:00:00	279.2	220.2	60.3	150.4	30.3	24.9	151	557.7	26	0.223	49.1	0
10:50 AM	00:00:00:00	279.9	219.6	61.7	155.5	30.8	25.1	151	558.4	26	0.222	48.8	0
10:51 AM	00:00:00:23	280.1	218.4	62.8	158.7	31.1	25.4	152	558.7	26	0.22	48	0
10:51 AM	00:00:00:53	280.1	220.8	63.5	160.6	31.1	25.5	152	558.9	26	0.219	48.4	0
10:52 AM	00:00:01:23	280.2	218.6	64.1	162.2	31.3	25.7	152	559.1	26	0.218	47.7	0
10:52 AM	00:00:01:53	280.1	217.8	64.6	163.5	31.4	25.7	152	559.2	26	0.218	47.5	0
10:53 AM	00:00:02:23	280	215.2	65.1	164.4	31.3	25.8	152	558.9	26	0.219	47	0
10:53 AM	00:00:02:53	280.1	216.3	65.5	165.2	31.4	25.9	152	559.1	26	0.217	47	0
10:54 AM	00:00:03:23	280	216.4	65.9	165.9	31.5	26	152	558.6	26	0.219	47.3	0
10:54 AM	00:00:03:53	280	217.6	66.3	166.5	31.5	26	151	558.3	26	0.217	47.3	0
10:55 AM	00:00:04:23	279.9	218.8	66.5	167	31.5	26	151	557.8	26	0.218	47.7	0
10:55 AM	00:00:04:54	279.9	219.2	66.8	167.5	31.5	26.1	151	557.2	26	0.218	47.8	0
10:56 AM	00:00:05:24	279.9	214.7	67.1	167.9	31.5	26.1	151	556.9	26	0.217	46.6	0
10:56 AM	00:00:05:54	279.9	217.4	67.1	168.2	31.5	26.1	150	556	26	0.217	47.2	0
10:57 AM	00:00:06:24	279.9	215.5	67.4	168.5	31.5	26.2	150	555.3	26	0.217	46.7	0
10:57 AM	00:00:06:54	280	216.7	67.7	168.8	31.5	26.1	149	554.9	26	0.217	47.1	0

10:58 AM	00:00:07:24	280	215.7	67.8	169	31.4	26.2	149	554.3	26	0.218	47	0
10:58 AM	00:00:07:54	280.1	216.5	67.9	169.2	31.4	26.2	149	553.7	26	0.218	47.2	0
10:59 AM	00:00:08:24	280	216.2	68	169.4	31.4	26.1	149	553.4	26	0.219	47.3	0
10:59 AM	00:00:08:54	279.9	214.8	68.3	169.5	31.4	26.1	148	552.9	26	0.217	46.5	0
11:00 AM	00:00:09:24	280.1	216.4	68.4	169.6	31.5	26.1	148	552.8	26	0.217	46.9	0
11:00 AM	00:00:09:55	280	214.2	68.5	169.8	31.5	26.1	148	552.9	26	0.217	46.4	0
11:01 AM	00:00:10:25	280	214.2	68.6	169.9	31.4	26.2	148	552.6	26	0.217	46.5	0
11:01 AM	00:00:10:55	280	215.3	68.9	170.1	31.4	26.2	148	552.9	26	0.217	46.7	0
11:02 AM	00:00:11:25	280	218.2	69.1	170.3	31.5	26.2	148	553.3	26	0.218	47.5	0
11:02 AM	00:00:11:55	279.9	217.9	69.2	170.3	31.5	26.1	149	553.5	26	0.217	47.2	0
11:03 AM	00:00:12:25	279.9	215.9	69.5	170.4	31.4	26.3	149	553.9	26	0.217	46.8	0
11:03 AM	00:00:12:56	279.9	214.4	69.6	170.5	31.4	26.2	149	554.3	26	0.216	46.4	0
11:04 AM	00:00:13:26	280	215.8	69.8	170.5	31.4	26.2	150	554.8	26	0.217	46.8	0
11:04 AM	00:00:13:56	279.9	214.9	69.9	170.6	31.5	26.3	150	555.5	26	0.218	46.8	0
11:05 AM	00:00:14:26	279.9	213.8	70	170.7	31.5	26.3	150	556	26	0.217	46.4	0
11:05 AM	00:00:14:56	280	216.6	70.2	170.7	31.4	26.1	151	556.6	26	0.216	46.9	0
11:06 AM	00:00:15:26	280	215.6	70.4	170.8	31.5	26.3	151	557.1	26	0.216	46.6	0
11:06 AM	00:00:15:56	280	214.7	70.5	170.8	31.4	26.3	151	557.4	26	0.217	46.5	0
11:07 AM	00:00:16:26	280	212.2	70.6	170.9	31.4	26.2	152	557.7	26	0.216	45.9	0
11:07 AM	00:00:16:56	280	213.7	70.7	170.9	31.4	26.3	152	557.8	26	0.216	46.1	0
11:08 AM	00:00:17:26	280	215.5	70.8	170.9	31.4	26.4	152	558.1	26	0.216	46.6	0
11:08 AM	00:00:17:56	280	217.3	70.9	170.9	31.4	26.2	152	558	26	0.216	46.9	0
11:09 AM	00:00:18:26	279.9	215	71	170.8	31.4	26.4	152	557.8	26	0.217	46.7	0
11:09 AM	00:00:18:57	280	218.1	71.1	170.9	31.5	26.3	152	557.7	26	0.216	47	0
11:10 AM	00:00:19:27	279.9	213.8	71.2	170.9	31.5	26.3	152	557.3	26	0.216	46.3	0
11:10 AM	00:00:19:57	280	217.6	71.2	170.8	31.4	26.4	152	556.9	26	0.216	47.1	0
11:11 AM	00:00:20:27	280	212.9	71.3	170.9	31.4	26.2	151	556.5	26	0.217	46.1	0
11:11 AM	00:00:20:57	279.9	215	71.4	170.9	31.4	26.2	151	555.6	26	0.217	46.7	0
11:12 AM	00:00:21:27	280	216.1	71.5	170.9	31.4	26.2	151	555.1	26	0.218	47.1	0
11:12 AM	00:00:21:57	280	216.8	71.6	170.9	31.4	26.3	150	554.3	26	0.216	46.9	0
11:13 AM	00:00:22:27	280	214.3	71.6	170.9	31.4	26.1	150	553.6	26	0.217	46.4	0
11:13 AM	00:00:22:57	280	215	71.6	170.9	31.3	26.2	149	553	26	0.216	46.6	0
11:14 AM	00:00:23:28	280	216.9	71.7	170.9	31.4	26.2	149	552.2	26	0.217	47	0
11:14 AM	00:00:23:58	280	212	71.8	171	31.4	26.1	149	551.5	26	0.215	45.7	0
11:15 AM	00:00:24:28	280	217.9	71.8	171	31.4	26.2	148	551.3	26	0.216	47.2	0
11:15 AM	00:00:24:58	279.9	216.6	71.9	171	31.4	26.2	148	551.1	26	0.218	47.2	0
11:16 AM	00:00:25:28	280	215.3	72	170.9	31.4	26.2	148	550.8	26	0.217	46.7	0
11:16 AM	00:00:25:58	280	219	72	171	31.4	26.3	148	550.5	26	0.216	47.4	0
11:17 AM	00:00:26:28	280	217.5	72	171	31.4	26.3	148	550.7	26	0.215	46.7	0
11:17 AM	00:00:26:58	280	218.1	72.1	171	31.4	26.2	148	550.8	26	0.216	47.1	0
11:18 AM	00:00:27:29	280.1	211.6	72.2	171	31.4	26.2	148	551.1	26	0.216	45.7	0
11:18 AM	00:00:27:59	280.1	216.8	72.3	171	31.4	26.2	149	551.5	26	0.216	46.8	0.1
11:19 AM	00:00:28:29	280.1	217.3	72.4	170.9	31.4	26.3	149	551.8	26	0.216	47	0.1
11:19 AM	00:00:28:59	280.1	216.8	72.4	171	31.4	26.2	149	552.2	26	0.216	46.7	0.1
11:20 AM	00:00:29:29	280	215	72.4	171	31.4	26.3	150	552.9	26	0.216	46.4	0.1
11:20 AM	00:00:29:59	280	214.3	72.5	171	31.4	26.3	150	553.5	26	0.216	46.2	0.1

Addendum 'D' – External Cooler Overview

Note: The external cooling system has been configured at Falex for use with the Falex 450 (FT^2) machine and should not be modified.

The external cooling system consists of two (2) components, the circulator unit and the cooling unit. Figure D1 shows the location of both components and important areas associated with each component.

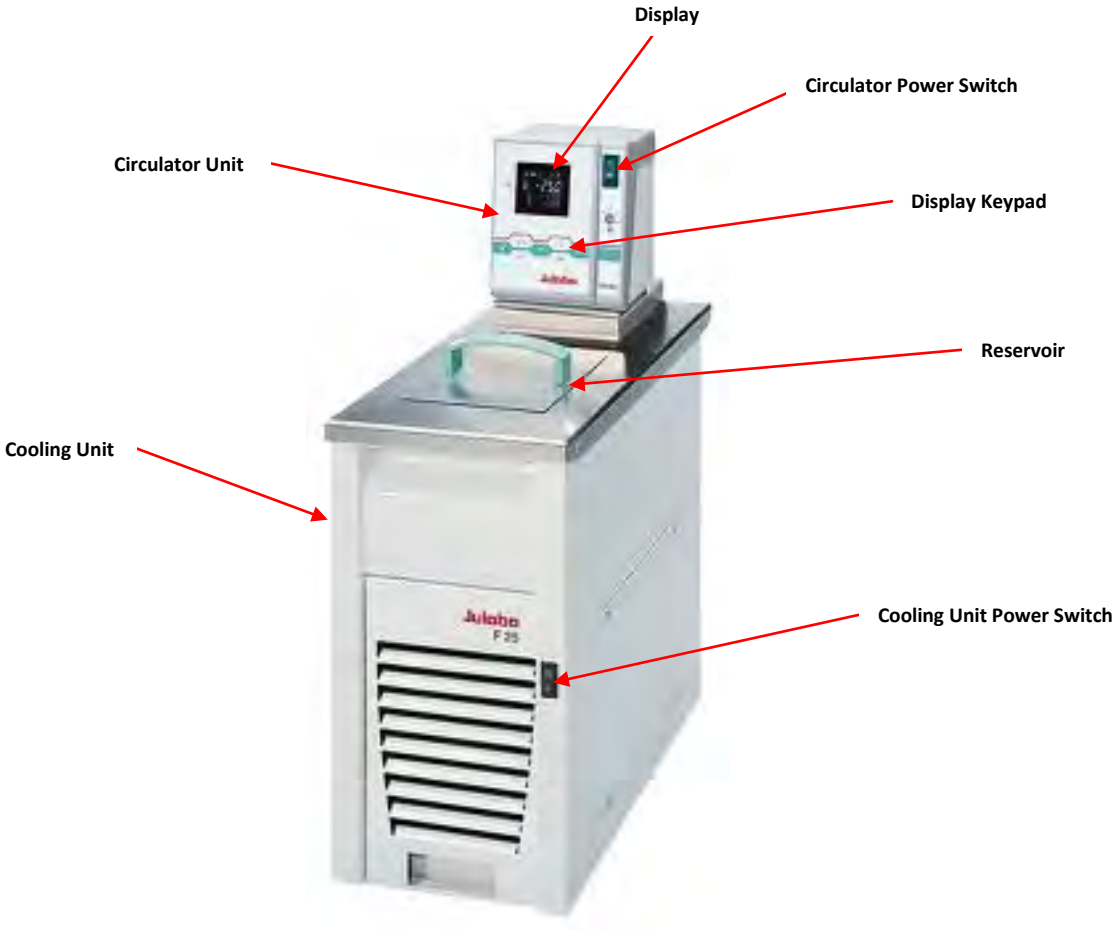


Figure D1 – External Cooler System (Front)

The back of the circulator unit is where the cooling flow external temperature sensor connection and the coolant flow connections are located that interface to the back of the Falex 450 (FT^2) machine (figure D2).

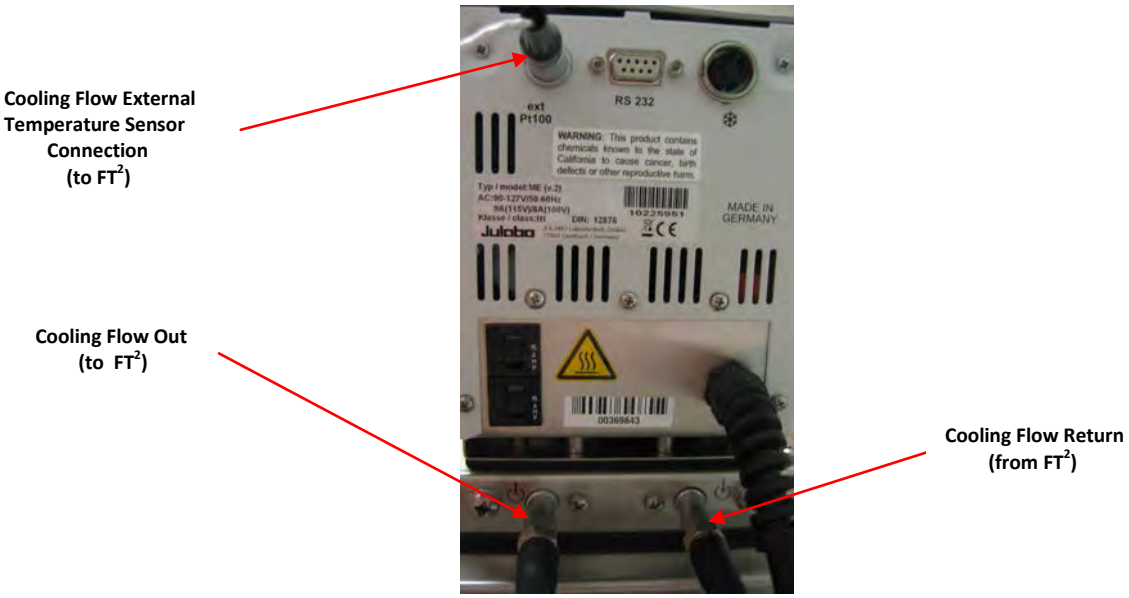


Figure D2 – Circulator Unit (Back)

Note: To ensure safe operation of the external cooler, it is recommended that its 'Operating Manual' be reviewed. It has been provided with the Falex 450 (FT²) machine and can be found in the component manual directory of the supplied Falex 450 (FT²) manual CD.

Typical operation for use with the Falex 450 (FT²)

1. Make sure the external cooler inlet/outlet ports and the temperature sensor are connected to the rear of the Falex 450 (FT²) machine. Make sure the inlet/outlet connections are tight.
2. Make sure the reservoir is filled with approximately 1.2 gal (4.5 l) of fluid.

Note: Recommended bath fluids are soft/decalcified water or a water/glycol mixture (1:1 ratio). For further details, refer to the manufacturers operating manual.

Note: Recommended maximum filling level: 30mm below the tank rim.

3. Power-up the external cooling system by toggling the power button on the circulator (top switch) and cooling unit (bottom switch) to the illuminated 'on' position.
4. Initiate cooling flow to the Falex 450 (FT²) unit by pressing the 'OK' button on the circulator display keypad (actual bath temperature will appear on the circulator display). Flow should be observed in the flow meter located on the front of the Falex 450 (FT²) machine above the reservoir (ball should be floating within the flow meter). If no flow is observed, adjust the flow control knob accordingly. If flow is still not observed, the inlet/outlet lines from the external cooler to the Falex 450 (FT²) are probably reversed.
5. When the test has completed and the heater tube section has cooled down (<40°C), the coolant flow to the Falex 450 (FT²) machine can be stopped by pressing the 'OK' button on the circulator display keypad (message on the circulator display will indicate 'OFF').

Note: ***It is ok that the coolant flow continues to the Falex 450 (FT^2) machine for long periods after cool down, as some tests may complete when lab personnel are not present. It is recommended to stop the coolant flow prior to disassembly and deposit determination.***

Note: ***It is recommended to turn on/off the circulator and cooling unit together. If the circulator is turned off while the cooling unit is on, the potential exists for the fluid in the reservoir to freeze.***

Note: ***It is recommended that the power to the circulator unit and cooling unit is turned off when the unit is idle for long durations.***

Addendum 'E' – Remote E-Stop Setup & Configuration (option)

(450-109-006)

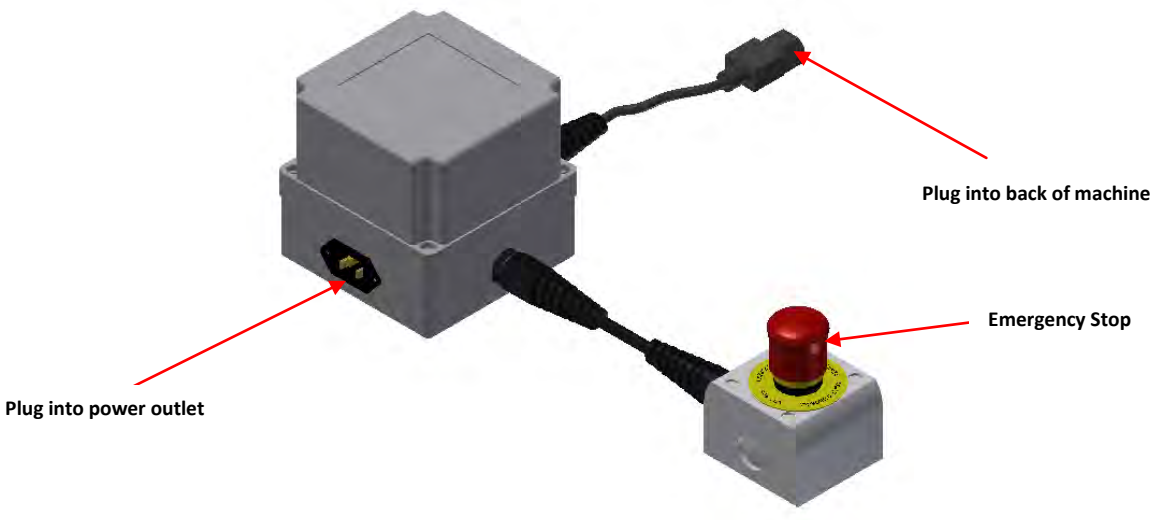


Figure E1 – Remote Emergency Stop (E-Stop) assembly

This option is to allow a 2nd emergency stop button to be placed in a convenient location for the operator remotely from the machine. It has a radius of approximately 12'.

Note: Consult local laboratory safety policies for proper placement of the remote emergency stop assembly.

Installation

1. Connect the remote Emergency E-Stop assembly into the power connector located on the back of the machine (figure E2).

Figure E2 – Remote E-Stop connection to back of machine

2. The power cord (supplied with the machine) is then to be connected to the remote Emergency E-Stop assembly (figure E3) and plugged into a 220 volt, single phase, 50/60Hz power source.

Figure E3 – Outlet power connection to Remote E-Stop assembly

3. Refer to figure E4 for a picture of an installed remote E-Stop assembly.

Figure E4 – Installed Remote E-Stop assembly

Addendum 'F' – Heated Lines Setup & Configuration (option)

*** For use with bolted flange reservoirs ***
(450-097-004) – Pull heated line option (set of 4)
(450-097-010) – Push heated line option (set of 4)

*** For use with split ring clamping collar reservoir mounted on attachable stand ***
(450-097-017) – Pull heated line option (set of 4)
(450-097-018) – Push heated line option (set of 4)

The use of heated lines eliminates any test fluid heat loss as it flows through the system and keeps the test fluid's viscosity constant so that it can be pumped through the system. This option is to be used with high viscosity fluids and requires that the standard tubing lines be removed and the optional heated lines be installed. There are two (2) heated line options available for each reservoir type, one that 'pulls' the fluid through the heater tube assembly (figures F1 & F3) and one that 'pushes' the fluid through the heater tube assembly (figures F2 & F4). Each option (sold separately) consists of four (4) tubing line assemblies. Only three (3) of the lines will be used depending on system configuration.

Note: All 3 heated lines are to be used together for the system to function correctly.

The 'push' heated lines were developed to be used with high viscosity fluids. Because of the need to be able to 'push' high viscosity fluids, they are designed with a larger inside diameter tubing. A 'push' non-heated option is also available that also utilizes the larger inside diameter tubing (400-097-011 for bolted flange reservoir systems and 400-097-020 for split ring clamping collar reservoir systems).

The heated line option must be activated within the software application (factory set) in order for it to be selectable within the test configuration. The heated lines will heat to the operator entered setpoint (50 - 150°C). This is set during the test configuration. All line heaters are controlled to the same setpoint.

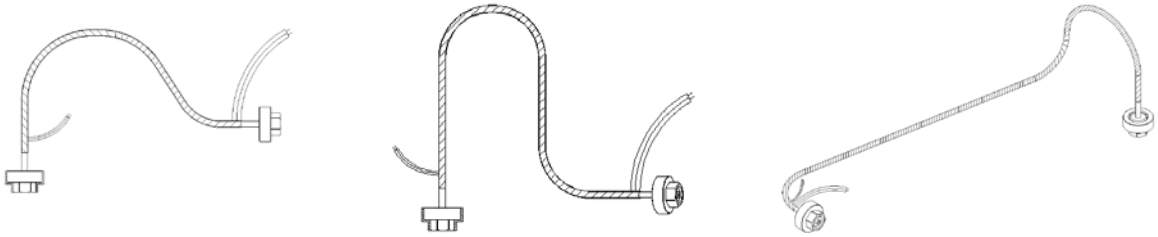
Use of this option does not change the dimensions of the machine.

Bolted Flange Reservoir System

Note: The 4th tubing line assembly is the reservoir return for the single pass option which uses the 2nd reservoir. It is not shown in the figures below, as it is a larger version of the reservoir return lines shown.

Outlet Line Inlet Line Reservoir Return Line

Figure F1 – Pull heated line set



Outlet Line Inlet Line Reservoir Return Line

Figure F2 – Push heated line set

Pull Heated Line set (450-097-004)

- 1 450-105-022 Inlet line assembly
- 1 450-105-023 Outlet line assembly
- 1 450-105-024 Reservoir return line assembly
- 1 450-105-056 Reservoir return line assembly (for single pass flow option)

Push Heated Line set (450-097-010)

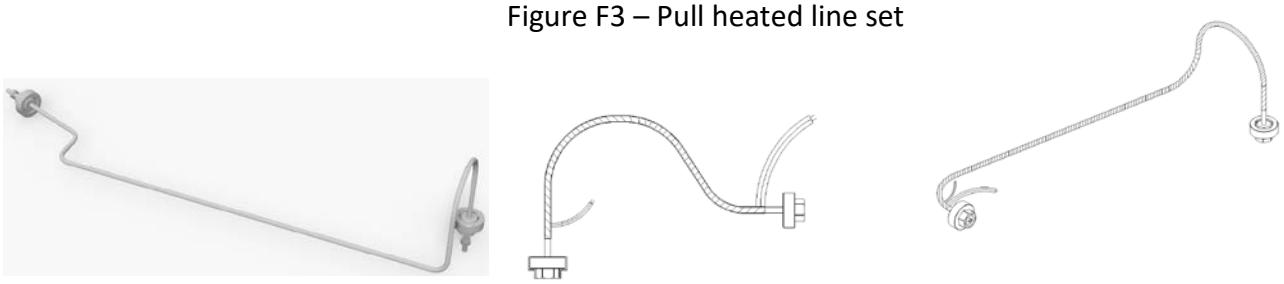
- 1 450-105-052 Outlet line assembly
- 1 450-105-053 Inlet line assembly
- 1 450-105-054 Reservoir return line assembly
- 1 450-105-055 Reservoir return line assembly (for single pass flow option)

Split Ring Clamping Collar Reservoir System (mounted on attachable stand)

Note: The 4th tubing line assembly is the reservoir return for the single pass option which uses the 2nd reservoir. It is not shown in the figures below, as it is a smaller version of the reservoir return lines shown.

Inlet Line Outlet Line Reservoir Return Line

Figure F3 – Pull heated line set



Inlet Line Outlet Line Reservoir Return Line

Figure F4 – Push heated line set

Note: The following heated line sets are for use with reservoir #1 located on the attached stirred reservoir stand. Reservoir #2 (for single pass flow option) is to be located on the machine.

Pull Heated Line set (450-097-017)

- 1 450-105-082 Inlet line assembly
- 1 450-105-023 Outlet line assembly
- 1 450-105-083 Reservoir return line assembly
- 1 450-105-024 Reservoir return line assembly (for single pass flow option)

Push Heated Line set (450-097-018)

- 1 450-105-084 Inlet line assembly
- 1 450-105-052 Outlet line assembly
- 1 450-105-055 Reservoir return line assembly
- 1 450-105-054 Reservoir return line assembly (for single pass flow option)

Installation

1. Place new O-rings (620-006-004) on all tubing ends. O-rings are not included with this option. The O-rings are the same ones used on the standard tubing lines.
2. Connect all tubing lines to their respective locations. Refer to figure F5 for 'Pull' configuration and figure F6 for 'Push' configuration.

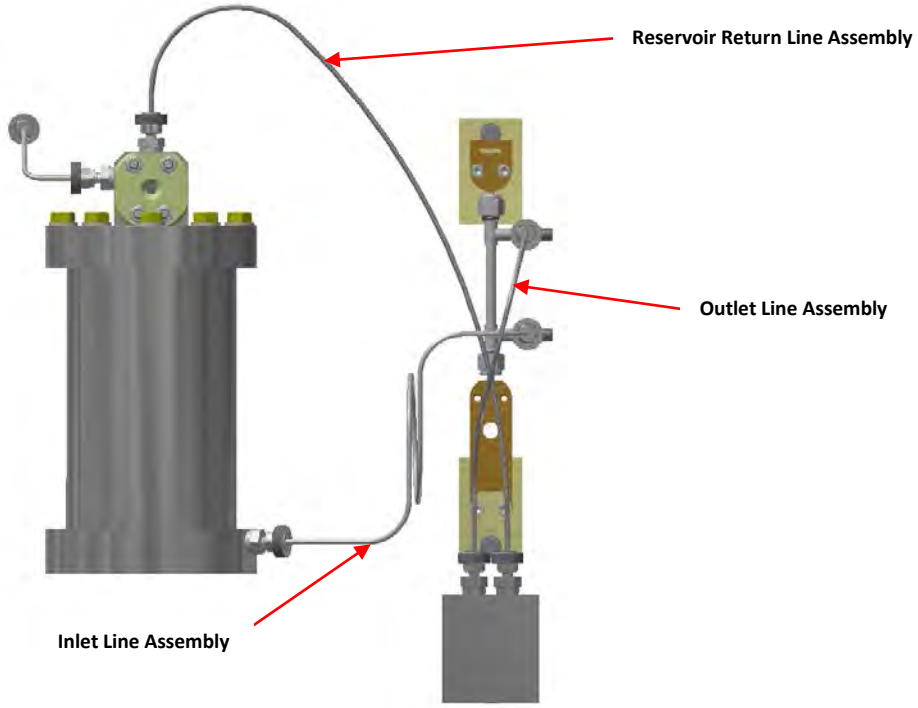


Figure F5 – Pull configuration

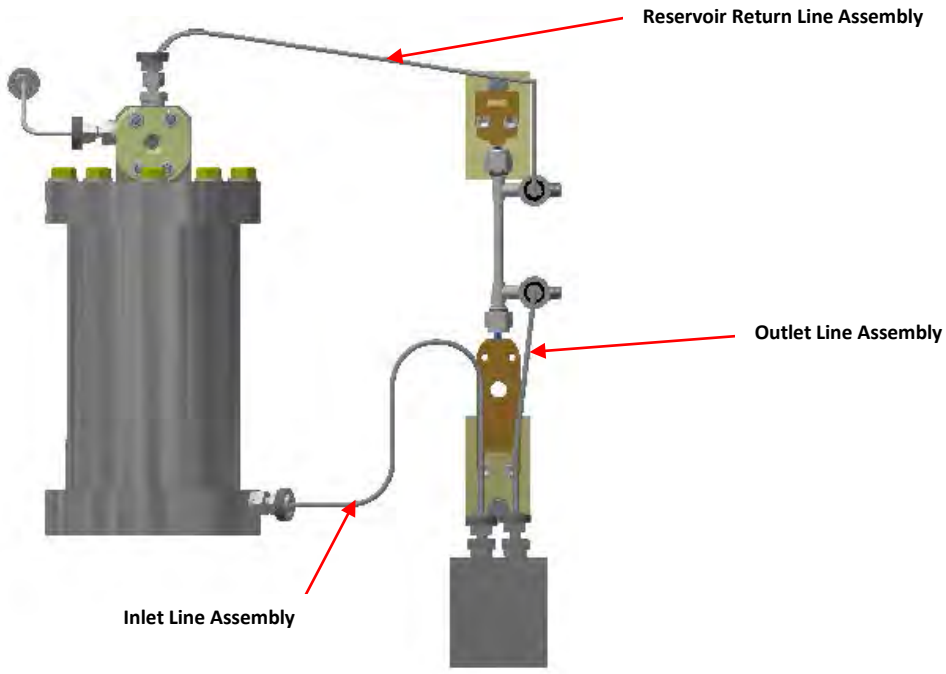


Figure F6 – Push configuration

Note: Reservoir assembly and inlet tubing lines shown in figures F5 and F6 depict the bolted flange reservoir configurations. For split ring clamping collar reservoir configurations, the reservoir is different and the inlet line is different.

3. Make sure all connections are hand tight.
4. Connect each heated line power cable to its associated power connector on the front of the machine.
5. Connect each heated line thermocouple to its associated connector on the front of the machine.

Calibration

Each heated line thermocouple is to be calibrated per the process detailed in section 5.

Cleaning

- Wipe clean any fluid residue or cleaning solvent that may have gotten on the heated line insulation.
- Flush the heated lines using the same procedure detailed in the 'Reservoir/Tubing Lines' area of Section 3.3 – Component Cleaning.

Spare Parts

- 620-006-004 O-ring, tubing (package of 100)

Addendum 'G' – Differential Pressure Setup & Configuration (option)

(450-200-003)

Note: This option is only available for use with bolted flange reservoir systems.

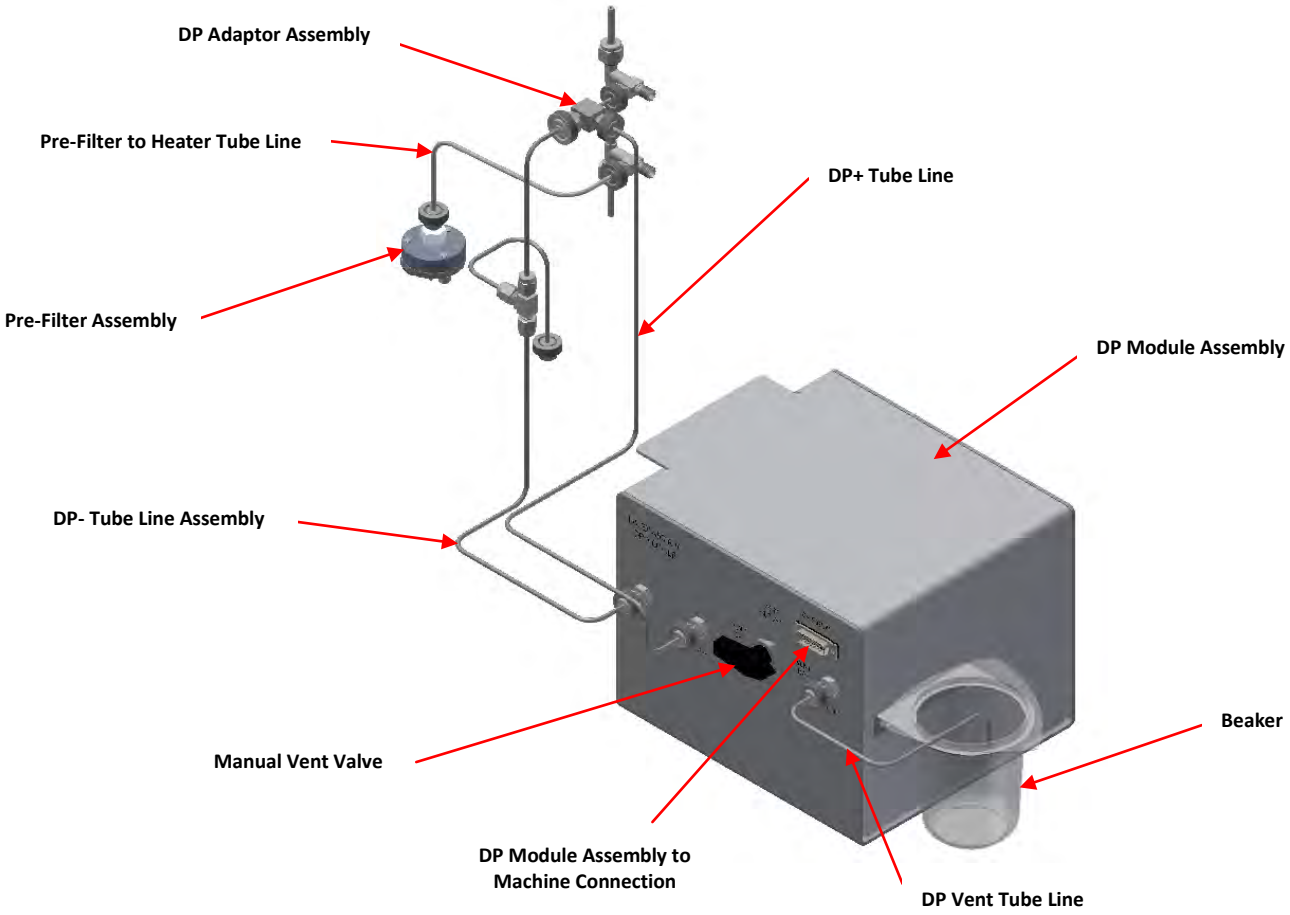


Figure G1 – Differential Pressure (DP) assembly

This option must be activated within the software application (factory set) in order for it to be selectable within the test configuration and is only to be used with **'low viscosity'** fluids.

Note: The DP system uses 0.45 micron filters. The use of high viscosity fluids will plug up these filters and provide high differential pressure due to the pressure drop across the filter, causing damage to the equipment and preventing the DP transducer from sensing the DP value correctly.

Use of this option increases the depth of the machine by 3". Therefore, the machine with this option requires bench space of approximately 36"W x 33"D to comfortably operate the test machine.

The following parts and accessories are included with the differential pressure (DP) option:

- 1 400-105-010 Pre-Filter Assembly (includes O-ring and screen)
- 1 400-200-005 DP Calibration Bottle
- 1 bag 450-097-008 DP filters (25 filters/bag)
- 1 450-105-025 Pre-filter to heater tube line
- 1 450-105-026 DP adaptor assembly
- 1 450-105-027 DP+ tube line
- 1 450-105-028 DP- tube line assembly
- 1 450-105-029 DP vent tube line
- 2 450-105-039 Line plug
- 1 648-019-001 Beaker
- 1 box 648-400-005 Pre-Filter Papers (25 filters/box)
- 1 650-030-176 DB15 communication cable
- 2 977-102-001 Cap nut

Installation

1. Remove storage tray from FT^2 machine.
2. Remove the safety cover base from the FT^2 machine.
3. Carefully place DP module assembly in location vacated by storage tray.
4. Connect the DB15 communication cable between the DP module assembly and the FT^2 machine and tighten down the connectors.
5. Assemble the pre-filter with screen and filter paper (figure G2).

Note: Make sure the white 'filter' paper is used and not the blue separator paper. A new paper filter is to be used for each test.

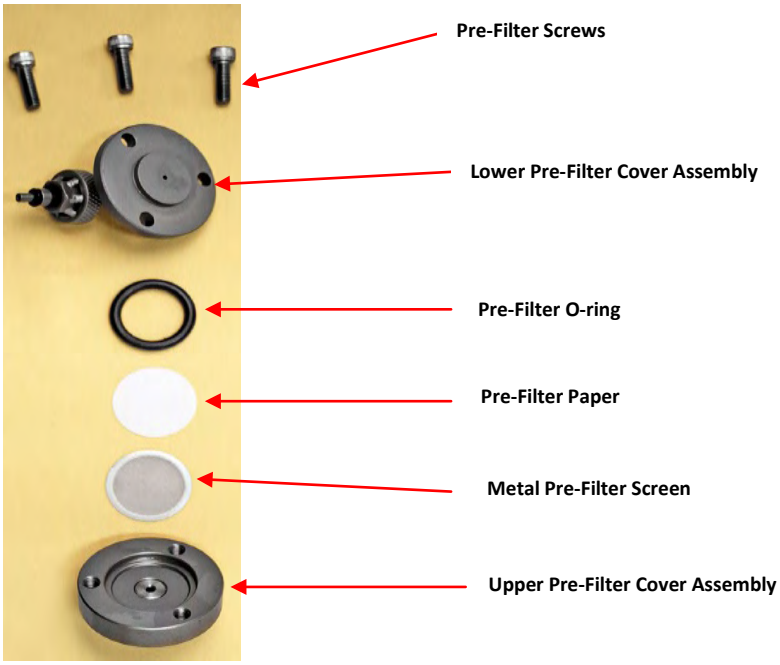


Figure G2 – Pre-Filter Assembly

6. With the reservoir empty, connect pre-filter assembly to the outlet of the reservoir.
7. Connect the tubing line assemblies and DP adaptor assembly to the fully assembled heater tube assembly and to the front of the DP module assembly (figure G3).

Note: Make sure new O-rings are placed on all of the tubing line ends to prevent leaks.

Figure G3 – Differential Pressure (DP) assembly

8. Locate a DP filter and associated O-ring that are to be installed in the DP adaptor (figure G4).

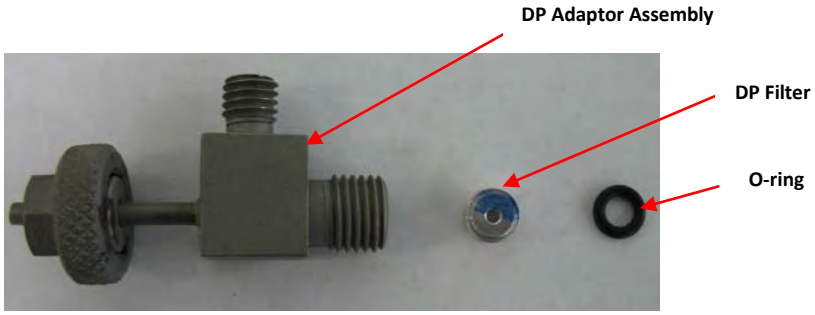


Figure G4 – DP adaptor accessories

9. Insert a DP filter into the DP adaptor discharge hole. Make sure the blue side is facing out (figure G5). Place a new O-ring on top and push into place (figure G6).

Figure G5 – DP filter installation

Figure G6 – O-ring installation

Note: A new DP filter and O-ring are to be used for each test.

10. Make sure all tubing line connections are tight.
11. Follow the procedure below to 'Charge' the DP assembly with fluid prior to each test.

'Charging' the DP System

The DP assembly must be 'charged' with test fluid for the DP transducer to work accurately and must be done prior to any test. Air will be introduced into the system each time the assembly is broken down for heater tube replacement. The charging process makes sure that the DP system is liquid full, displacing any trapped air from both sides of the DP transducer. The compressed air supply is to be connected to the machine to supply the required reservoir pressure.

Note: Make sure a sufficient amount of fluid is placed into the reservoir to satisfy the test requirements and the purging requirements. Approximately 80 – 100 ml of fluid will be purged during the 'charging' sequence.

1. Verify that all DP tube lines are connected and all connections are tight.
2. Verify that the manual inlet valve and the manual exhaust valve are closed (front of machine under the reservoir). If they are not closed, close them.

Note: Do not over-tighten the manual valves. Over-tightening will damage the valves causing them to leak.

3. Navigate to the Maintenance → Manual Controls display on the touchscreen.
4. In the 'Machine Controls' area of the display, verify that the DP bypass valve is open (button should be black and show open).
5. In the 'Machine Controls' area of the Manual Controls display, pressurize the system with light pressure (4 - 5 psi / 28 – 34 kPa) by pressing the Exhaust Valve button to close the exhaust solenoid valve (button will turn gold and show closed) and pressing the Inlet Valve button to open the inlet solenoid valve (button will

turn gold and show open). The pressure tank regulator will need to be adjusted accordingly.

6. While monitoring the pressure value on the Manual Controls display, ***slowly*** open the manual inlet valve. The system will start to pressurize quickly. Control the amount of pressure with the manual inlet valve. Once the pressure is in the 4 - 5 psi (28 – 34 kPa) range, close the manual inlet valve and press the Inlet Valve button to close the inlet solenoid valve (button will turn black and show closed).

Note: Failure to control the pressure during this process could damage the DP transducer. Open the manual exhaust valve to release pressure in case of over pressurization.

7. In the 'Pump Control' area of the Manual Controls display, manually start the pump by entering a 10% pump rate and pressing the Pump button (button will turn gold and show on).
8. Once test fluid is consistently dripping through the site glass (pump speed can be increased to achieve flow up to 20%), stop the pump by pressing the Pump button (button will turn black and show off) and release pressure (press the Exhaust Valve button on the display to open the exhaust solenoid valve and open the manual exhaust valve). You may need to continually open the manual exhaust valve to vent the pressure <1 psi (7 kPa).
9. Once the system has been depressurized (< 1 psi / 7 kPa), close the manual exhaust valve, disconnect the reservoir return line, plug the reservoir return line with a line plug and cap the reservoir sight glass assembly with a cap nut (figure G7). Make sure the line plug and cap nut are tight (they will be under pressure).

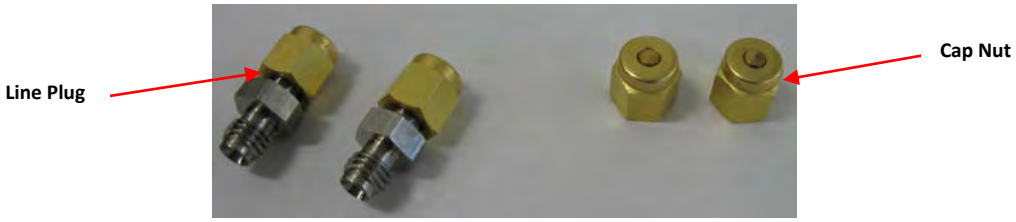


Figure G7 – Line plugs & cap nuts

10. Carefully pressurize the system again with light pressure (step 2 - 6).
11. Close the DP Bypass valve by pressing the DP Bypass Valve button in the 'Machine Controls' are of the Manual Controls display. You will hear the DP bypass valve close (button will turn gold and show closed).
12. With the vent line connected and positioned so that it drains into the waste beaker, carefully turn the manual vent valve on the DP assembly to the Vent DP- position and to the DP+ position purging the air out of each side of the system. Let each side (DP-/DP+) purge until no air bubbles/pockets are observed. Properly purging will take several minutes until the fluid is draining consistently and will drain approximately 40 – 50 ml of fluid per side.
13. Close the Manual DP vent valve on the DP assembly by turning the selector to the Vent Closed position.

Note: Air must be completely purged out of the system. Failure to purge all air will cause erroneous DP values.

14. Depressurize the system (press the Exhaust Valve button on the display to open the exhaust solenoid valve and open the manual exhaust valve). You may need to continually open the manual exhaust valve to vent the pressure <1 psi (7 kPa).
15. Open the DP Bypass valve by pressing the DP Bypass Valve button in the 'Machine Controls' area of the Manual Controls display (button will turn black and show open).
16. Once the system has depressurized, close the manual exhaust valve.
17. Re-connect the reservoir return line to the reservoir sight glass assembly.
18. The DP system is now charged and ready to run a test. Exit out of the 'Manual Controls' display and navigate to the 'Main Menu'.
19. Place the safety cover on the machine. The safety cover base is not used (figure G8). The safety cover will rest on the DP module assembly (figure G9).

Note: Prior to pressurization during the startup sequence, make sure the manual inlet valve is closed. During the pressurization sequence, once the inlet solenoid valve is opened (opened when the Start Pressure button is pressed on the 'Test Startup: Pressurize System' display), slowly open the manual inlet valve after the DP Bypass Valve is closed (will hear it close) to start pressurization during the initial 100 psi (689 kPa). Allowing rapid pressurization during the first 100 psi (689 kPa) could damage the DP transducer.

Note: When the test has started (test duration time accumulating), the ability exists to adjust the pump speed for the first 30 minutes. However, when running a DP test, do not change the pump speed after the first 10 minutes. Changing the pump speed after the first 10 minutes will affect the DP reading.

Figure G8 – Safety cover base removed

Figure G9 – Assembled differential pressure option (with safety cover)

Calibration

Calibration of the DP requires that the DP module assembly be properly connected to the Falex 450 (FT^2) with the DB15 communication cable. The DP- and DP+ line assemblies do not need to be connected and the DP-/DP+ ports on the DP module should be initially capped with the supplied cap nuts (figure G10). The calibration process will require the supplied calibration bottle (figure G11).

Figure G10 – Cap nuts

Figure G11 – DP calibration bottle

Recommended calibration fluids:

- Jet-A fuel
- Kerosene

Two calibration marks are to be made on the right side of the machine, a lower mark and an upper mark. The location of these marks is dependent on the DP module assembly that is installed, assembly 'A' or assembly 'B'. The DP module assembly used is labeled on the back of the assembly box. The location of the calibration marks for each assembly is as follows:

	Assembly 'A' (short)	Assembly 'B' (tall)
Lower mark	6.25" from bottom of tray	4" from bottom of tray
Upper mark	22" from bottom of tray	19.75" from bottom of tray
	(15.25" between the lower and upper mark)	

1. Falex 450 (FT2) must be on for at least 30 minutes before following this procedure.
2. Fill the calibration bottle ¾ full with test fluid.
3. Be sure the vent line is attached to the DP module assembly and empties into a waste beaker.
4. The heater tube and pre-filter assemblies are not used for this calibration. If they are assembled and connected, disconnect the tubing lines from the DP- and DP+ ports on the front of the DP module assembly. Place a cap nut over the DP-/DP+ ports on the DP assembly and plug both lines using the line plugs to prevent leaking (figure G12).

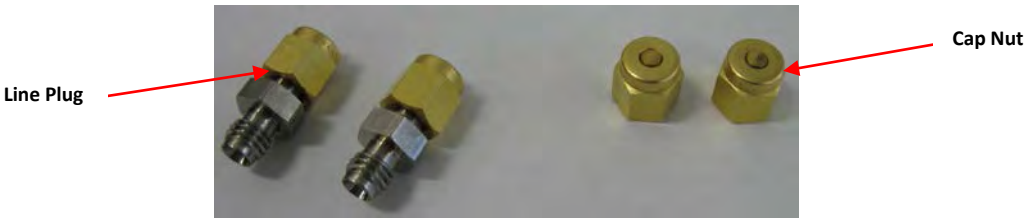


Figure G12 – Line plugs & cap nuts

5. Navigate to the Maintenance → System Calibration display on the touchscreen. To enable calibration, press on the Falex logo and enter the level 1 password (123456 is default). Select the Differential Pressure button.
6. Select Differential Pressure button and then the Begin Calibration button to start the calibration process.
7. Close the bypass valve by selecting the button labeled 'DP Bypass Valve Open'. You will hear the valve close and the button will now read 'DP Bypass Valve Closed'.
8. Allow the line from the DP calibration bottle to fill with the fluid and then attach the calibration bottle to the DP- port on the DP module assembly.
9. Set and leave the calibration bottle on the top of the DP module assembly.
10. Open the manual DP vent valve to the DP- position on the DP module assembly by turning the selector to the DP- position.
11. Wait until no air is seen leaving the DP vent line and a minimum of 50ml of fluid has run out of the calibration bottle and into the waste beaker.
12. Close the manual DP vent valve on the DP module assembly by turning the selector to the Vent Closed position.
13. Remove the cap nut from the DP+ port and set it aside.
14. Disconnect the calibration bottle from the DP- port and attach it to the DP+ port. Attach the cap nut loosely to the DP- port. Set and leave the calibration bottle on top of the DP module assembly.
15. Open the manual DP vent valve to the DP+ position on the DP module assembly by turning the selector to the Vent DP+ position.
16. Wait until no air is seen leaving the DP vent line and a minimum of 50ml of fluid has run out of the calibration bottle and into the waste beaker.
17. Close the manual DP vent valve on the DP module assembly by turning the selector to the Vent Closed position.
18. Move the calibration bottle and align the fluid level in the bottle with the lower mark on the right front side of the machine.
19. Hold the calibration bottle steady so the fluid level is level. Hold the bottle in this position for about 1-5 minutes until the DP values on the display remains constant.
20. Press the Zero button on the screen without moving the bottle. The calibrated value on the screen should now show 0.0 mmHg.

21. Raise the calibration bottle and align the fluid level in the bottle with the upper mark on the right front side of the machine.
22. The calibrated DP reading on the display should be 25 mmHg +/- 2.5 or the calculated test fluid theoretical DP +/- 5%. If there is a greater difference, the DP transducer may have a problem. However, the system should first be checked a second time to make sure that there is no trapped air that might be causing the problem. Air is the most likely cause of a suspected calibration drift. If the second calibration results still show a greater difference, then a Falex service representative should be contacted.
23. The calibration bottle may now be set down on the bench top.
24. Press the 'Continue' button to store the new calibration factors.
25. Press the 'Done' button to return the System Calibration display. The Bypass valve will open.
26. Attach cap nuts to the DP+/DP- ports or re-attach the DP+/DP- line assemblies to the DP module assembly. Leaving the ports open to atmosphere will cause fuel to drain from the unit which may cause pump damage if the unit is run without proper priming and purging.

Note: The calibration procedure uses a fluid of known density. To calculate the test fluid density corrected 400mm maximum DP value that should be read during the DP calibration check, you will need the fluid density value for the particular fluid used and plug the value into the formula below.

$$\text{Theoretical DP} = \frac{\text{(fluid density, gms/ml) (height, mm)}}{\text{(Hg density)}}$$

Example, for a fluid of 0.800 gms/ml density, at a height of 400mm:

$$\text{Theoretical DP} = \frac{\text{(0.800 gms/ml) (400mm)}}{\text{(13.53 gms/ml)}} = 23.65 \text{ mmHg}$$

Cleaning

The DP module assembly does not need to be flushed out. When the 'charging' procedure is done in preparation for the next test, the old fluid will be purged out. The pre-filter assembly and DP adaptor assembly is to be disassembled and flushed with solvent after each test. The paper filter within the pre-filter assembly and the DP filter and O-ring within the DP adaptor assembly are to be thrown away. The DP tubing line assemblies are to be disconnected from the heater tube holder assembly and from the DP module assembly and flushed with solvent after each test. The standard tubing lines that were shipped with the machine can be connected to the pump and reservoir along with the bypass cleaning line to flush the pump (refer to section 3.3 for the reservoir/pump/tubing lines cleaning procedure).

Spare Parts

- 400-027-003 Metal Pre-Filter Screen
- 450-097-008 DP filters (25 filters/bag)
- 450-105-039 Line plug
- 620-006-004 O-ring, tubing (package of 100)
- 620-008-006 O-ring, DP filter (same as heater tube) (package of 25)
- 620-210-001 O-ring, Pre-Filter (package of 5)
- 648-400-005 Pre-Filter Papers (25 filters/box)
- 977-102-001 Cap nut

Addendum 'H' – Single Pass Flow Setup & Configuration (option)

(450-200-004) – For use with bolted flange reservoirs
(450-097-010) – For use with split ring clamping collar reservoirs

Note: Only reservoirs of the same type can be used (i.e. 2 bolted flange reservoirs or 2 split ring clamping collar reservoirs). They cannot be mixed.

This option is to be used when the requirements of the test are for the test fluid to pass through the heated tube holder assembly only once. It requires a 2nd reservoir to be incorporated into the system that will catch the fluid after it has passed through the heater tube holder assembly. The reservoir return line included with this option is for the standard 'pull' flow direction. Refer to the spare parts section at the end of this addendum for the associated part number for the reservoir return line for the 'push' direction (ordered separately).

Note: It is critical that the amount of fluid in reservoir #1, configured test duration and flow rate are coordinated so that reservoir #1 does not run dry. Damage could occur to the pump should it run without fluid flowing through it.

This option must be activated within the software application (factory set) in order for it to be selectable within the test configuration. The 2nd reservoir heater jacket will heat to the operator entered setpoint (50 - 150°C). This is set during the test configuration.

Use of this option increases the width of the machine by 8". Therefore, the machine with this option requires bench space of approximately 44"W x 30"D to comfortably operate the test machine.

The single pass flow option assembly and configuration is different depending on the type of reservoir system (bolted flange or split ring clamping collar) that is incorporated on the machine. Details for each reservoir system are defined below:

- For bolted flange reservoir systems, refer to page 175.
- For split ring clamping collar reservoir systems, refer to page 181.

Bolted Flange Reservoir System

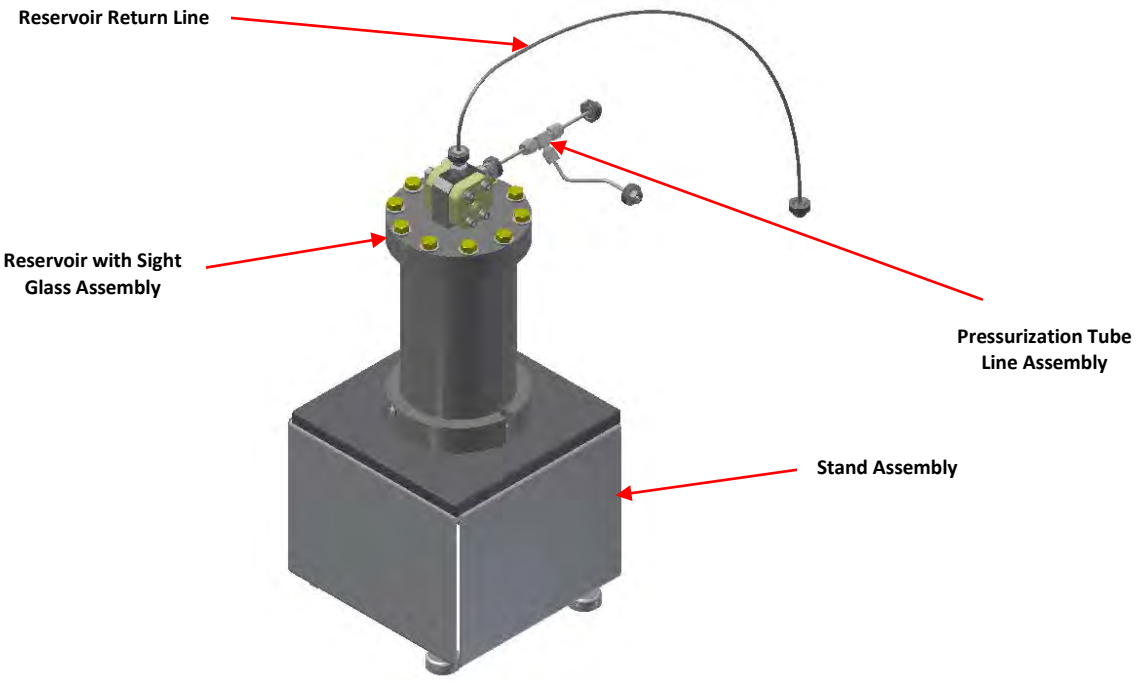


Figure H1 – Single Pass (2nd reservoir)

Figure H1 depicts the option with the reservoir lid with sight glass installed. The option comes with a reservoir lid without a sight glass. The single pass flow configuration requires that the reservoir lid with the sight glass be removed from the existing supply reservoir (reservoir #1) and placed on the single pass 'catch' reservoir (reservoir #2). The reservoir lid without the sight glass is then to be placed on the supply reservoir (reservoir #1). See figure H2 for orientation of the reservoir lids.

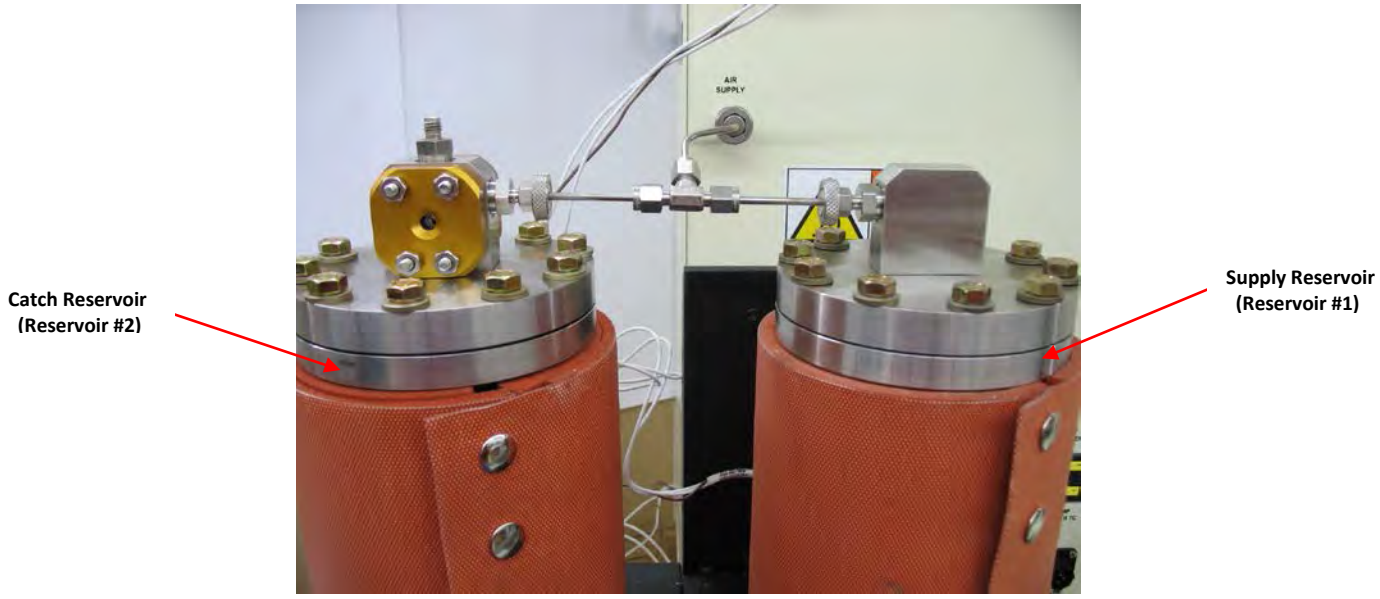


Figure H2 - Reservoir lid orientation

Note: It is critical that the amount of fluid in the supply reservoir (reservoir #1), configured test duration and flow rate are coordinated so that the supply reservoir does not run dry. Damage could occur to the pump should it run without fluid flowing through it.

Note: With this option installed there will be two (2) reservoir assemblies, one with a sight glass (supplied with standard machine) and one without a sight glass (supplied with single pass option). The reservoir with the sight glass is to be used as the 'catch' reservoir and the reservoir without the sight glass is to be used as the 'supply' reservoir.

The following parts and accessories are included with the single pass (2nd reservoir) option:

- 1 450-004-035 Reservoir stand assembly
- 1 450-105-063 Reservoir without sight glass assembly
- 1 450-105-033 Reservoir return line assembly, pull (non-heated)
- 1 450-105-057 Pressurization line assembly
- 1 450-105-038 Extended safety cover assembly
- 1 450-106-006 Reservoir heater jacket assembly (bolted flange)
- 2 824-136-250 Shoulder screw
- 1 977-102-001 Cap nut

Installation

1. Remove small side cover on left side of the machine by loosening 2 screws (figure H3).

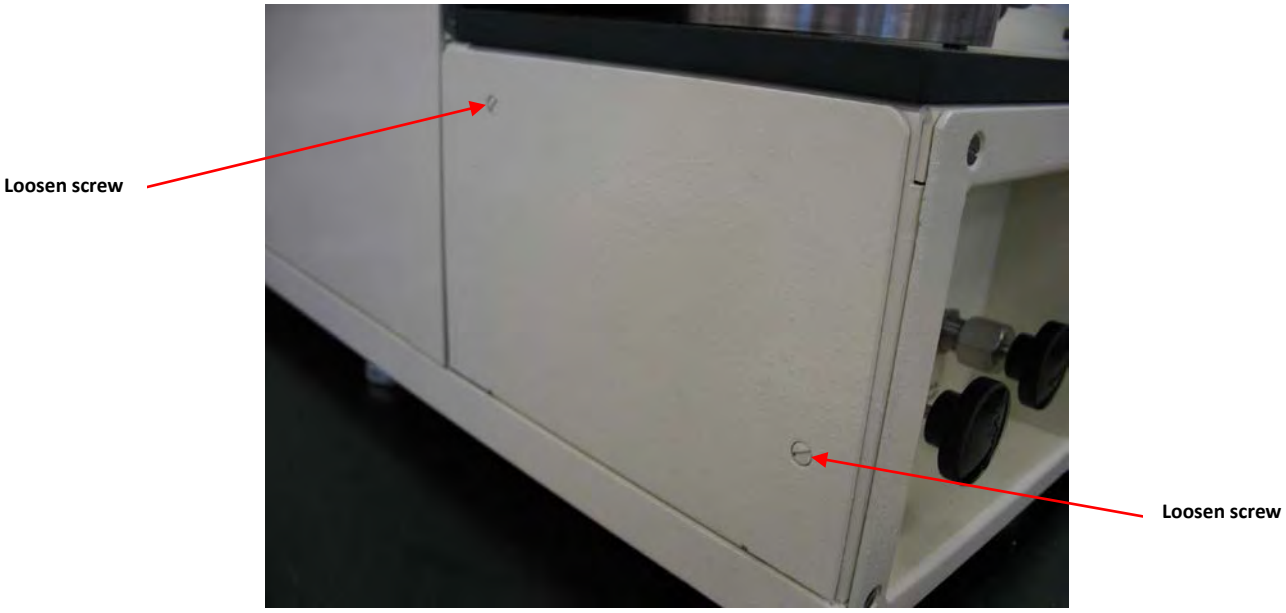


Figure H3 – Side cover removal

2. Install 2 shoulder screws into existing threaded holes in frame (figure H4).

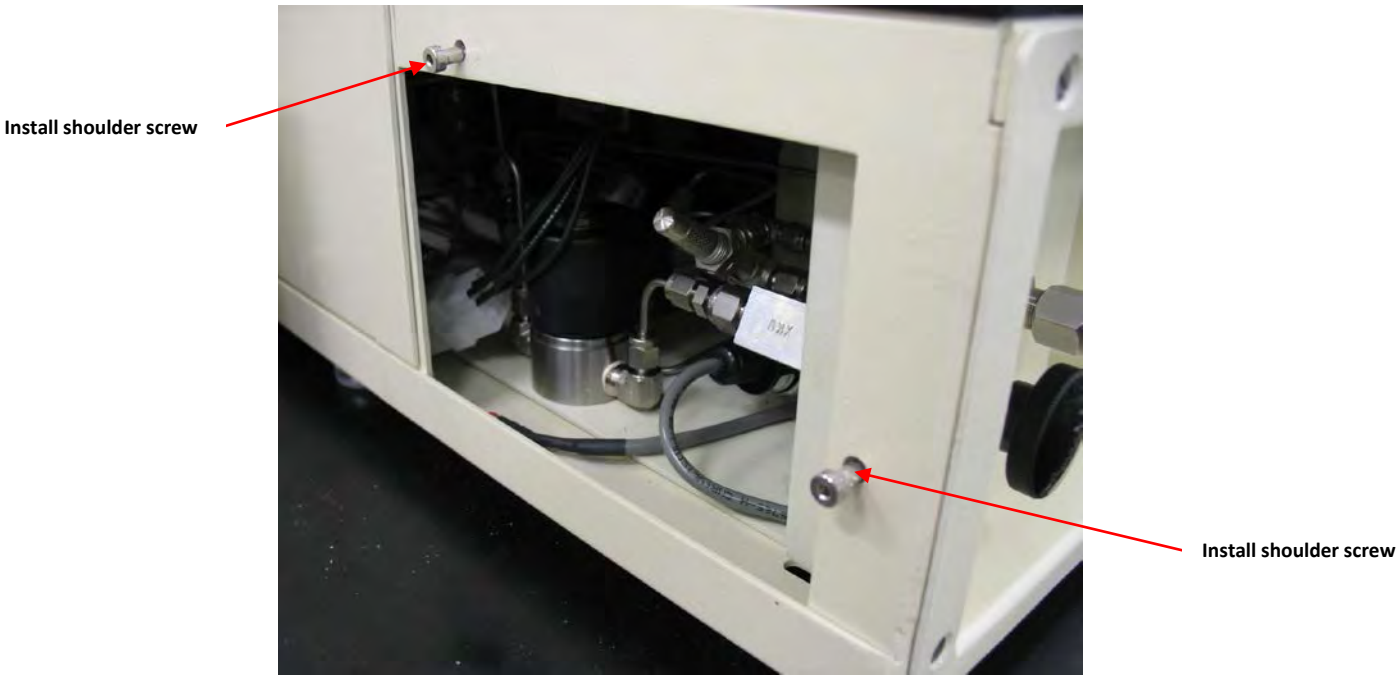


Figure H4 – Shoulder screws installation

3. Install reservoir stand assembly over shoulder screws (figure H4).

Figure H4 – Reservoir stand installation

4. Place the reservoir assembly <u>with</u> the sight glass (catch reservoir) on the stand assembly using the locator pins. This reservoir is referred to as reservoir #2.
5. Cap the reservoir #2 discharge port with a cap nut (figure H5) and securely tighten (this will be under pressure during a test).

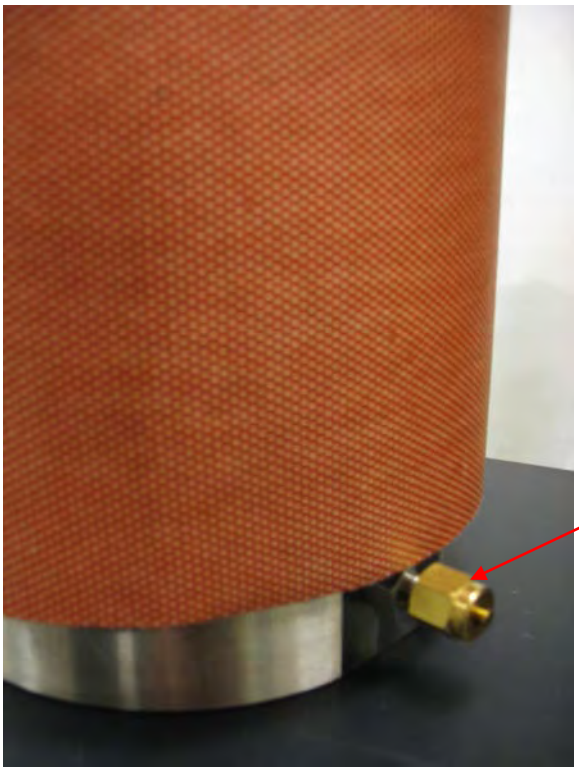


Figure H5 – Cap reservoir #2 discharge port

6. Install the reservoir #2 (catch reservoir) top so that the sight glass side connector for pressure is facing to the right (figure H6).

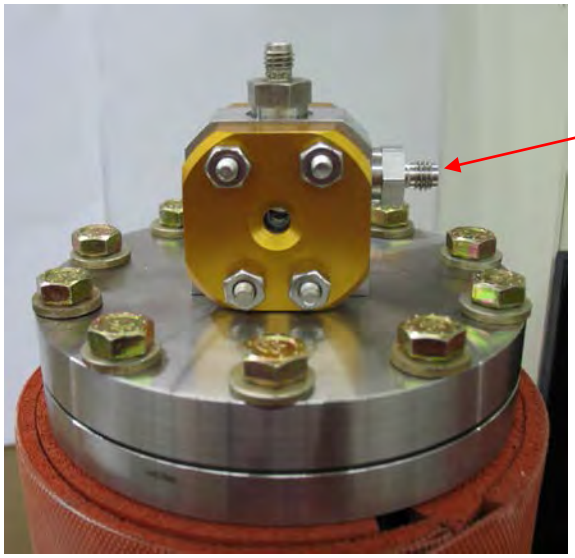


Figure H6 – Reservoir #2 top orientation

7. Place the reservoir assembly <u>without</u> the sight glass (supply reservoir) in the original reservoir location using the locator pins. This reservoir is referred to as reservoir #1. Install the reservoir #1 top so that the sight glass side connector for pressure is facing to the left (figure H7).

Sight glass pressure port is to face to the left

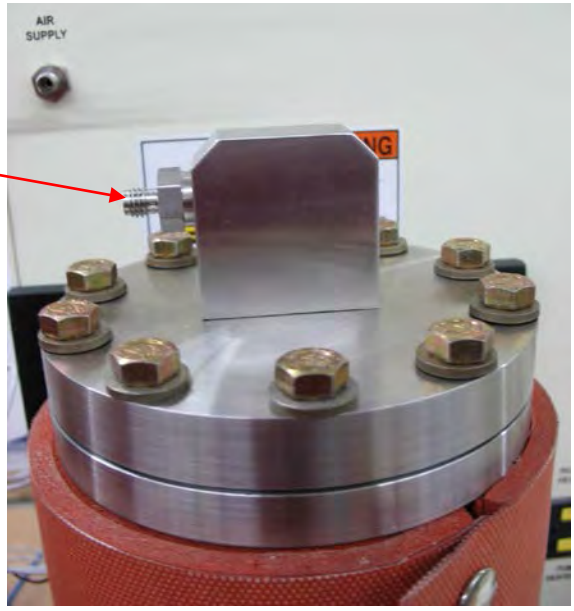


Figure H7 – Reservoir #1 top orientation

8. Connect the pressurization line assembly to both reservoirs (figure H8).

Figure H8 – Pressurization line assembly connection

9. Connect the reservoir return line assembly to the top of the sight glass of reservoir #2.
10. Install the heater jacket around reservoir #2 so that the thermocouple sensing tip on the inside of the heater jacket is located towards the bottom of the reservoir.
11. Connect reservoir #2's heater jacket power cable to the power connector on the back of the machine and the heater jacket thermocouple to its associated connector on the back of the machine (figure H9).

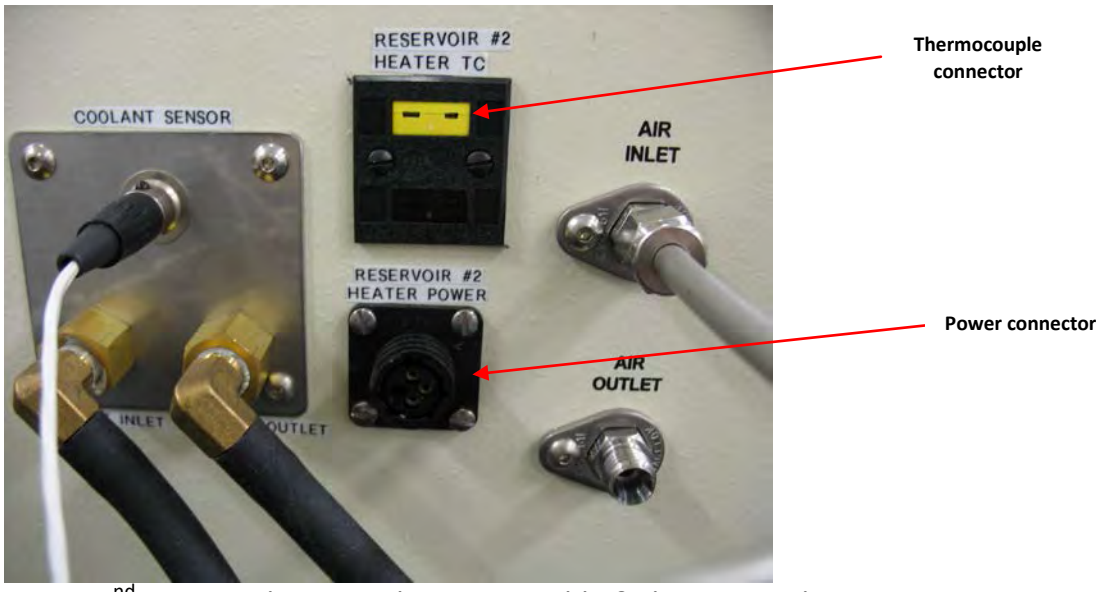


Figure H9 – 2nd reservoir heater jacket power cable & thermocouple connectors

12. Install the heater jacket around reservoir #1 and connect reservoir #1's heater jacket power cable and thermocouple to their respective connections on the front of the machine.
13. Fill reservoir #1 (supply reservoir) with test fluid.

Note: The amount of test fluid that is placed in the 'supply' reservoir must be enough to last the configured test duration at the configured pump speed. Failure to supply sufficient test fluid for the test will cause the pump to run dry and damage the pump.

14. Install the extended safety cover (figure H10).

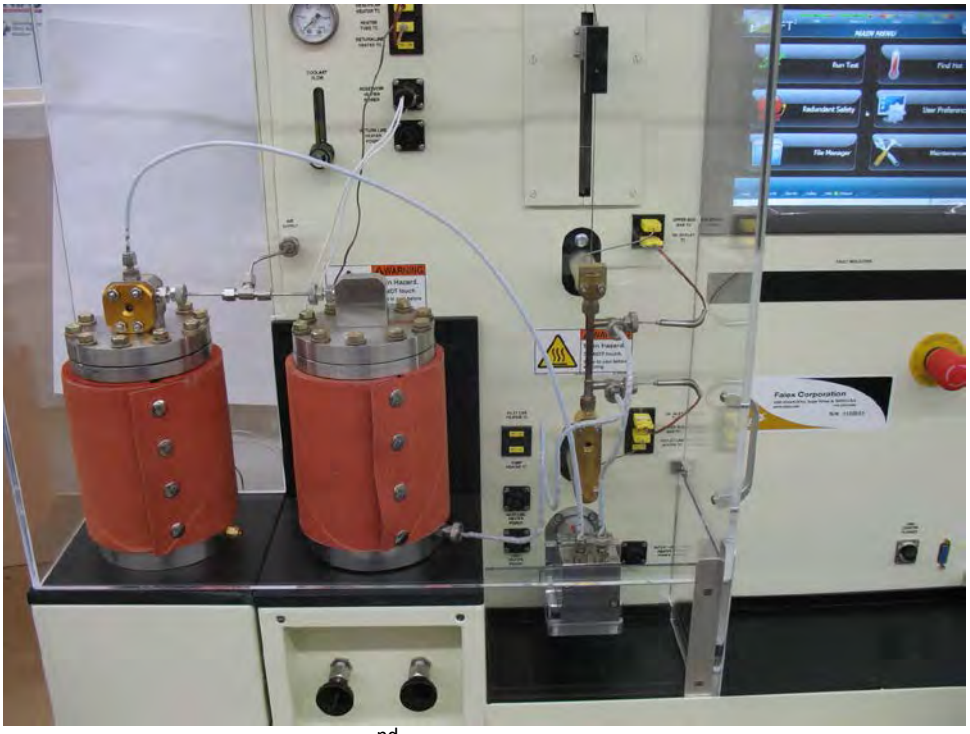


Figure H10 – Single pass (2nd reservoir) assembly with extended safety cover

Calibration

The thermocouple is to be calibrated per the process detailed in section 5.

Cleaning

The cleaning procedure can be followed as described in section 3.3. Place the 400ml plastic beaker inside the 2nd reservoir (instead of reservoir #1) to catch the fluid being flushed.

Spare Parts

- 450-105-051 Reservoir return line assembly, push (non-heated)
- 450-105-055 Reservoir return line assembly, push (heated)
- 450-105-056 Reservoir return line assembly, pull (heated)
- 620-006-004 O-ring, tubing (package of 100)

Split Ring Clamping Collar Reservoir System (mounted on attachable stand)

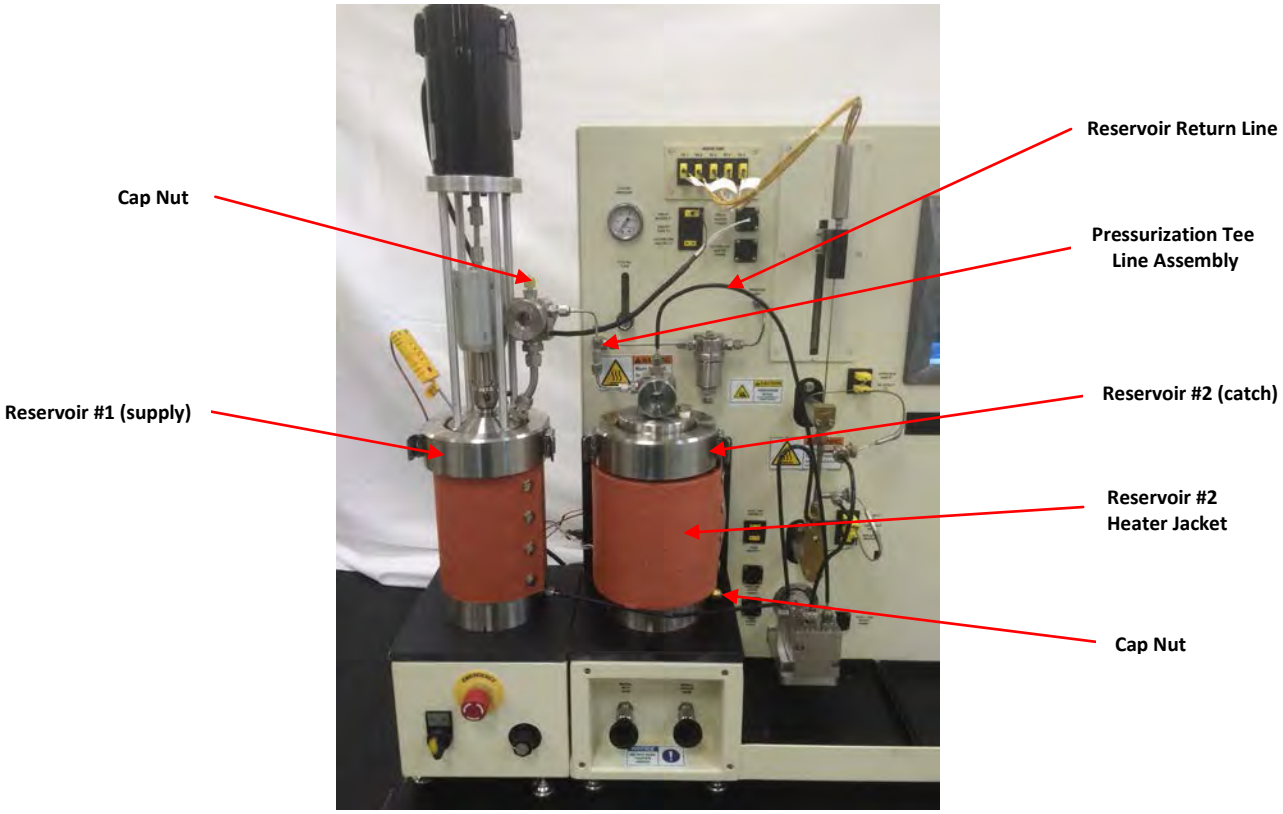


Figure H11 – Single Pass (2nd reservoir)

The single pass option on machines with the mechanical stirrer requires a 2nd reservoir (included with this option) that is to be located on the machine. ***Due to the tubing lines that are used with this option, this 2nd reservoir must be of the same type as***

reservoir #1 (split ring clamping collar). The existing reservoir #1 (located on the attachable stand) is the supply reservoir and the new reservoir #2 (located on the machine) is the catch reservoir. Figure H11 shows components of this option and the orientation of the reservoirs.

Note: It is critical that the amount of fluid in reservoir #1, configured test duration and flow rate are coordinated so that reservoir #1 does not run dry. Damage could occur to the pump should it run without fluid flowing through it.

The following parts and accessories are included with the single pass (2nd reservoir) option:

- 1 450-105-007 Reservoir return line assembly, pull (non-heated)
- 1 450-105-074 Reservoir with non-stirrer head assembly
- 1 450-105-077 Tee pressurization line assembly
- 1 450-106-008 Reservoir heater jacket assembly
- 2 977-102-001 Cap nut

Installation

1. Place the non-stirred reservoir assembly (catch reservoir) on the machine using the locator pins. This reservoir is referred to as reservoir #2. Refer to figure H12 for location of reservoir #2.

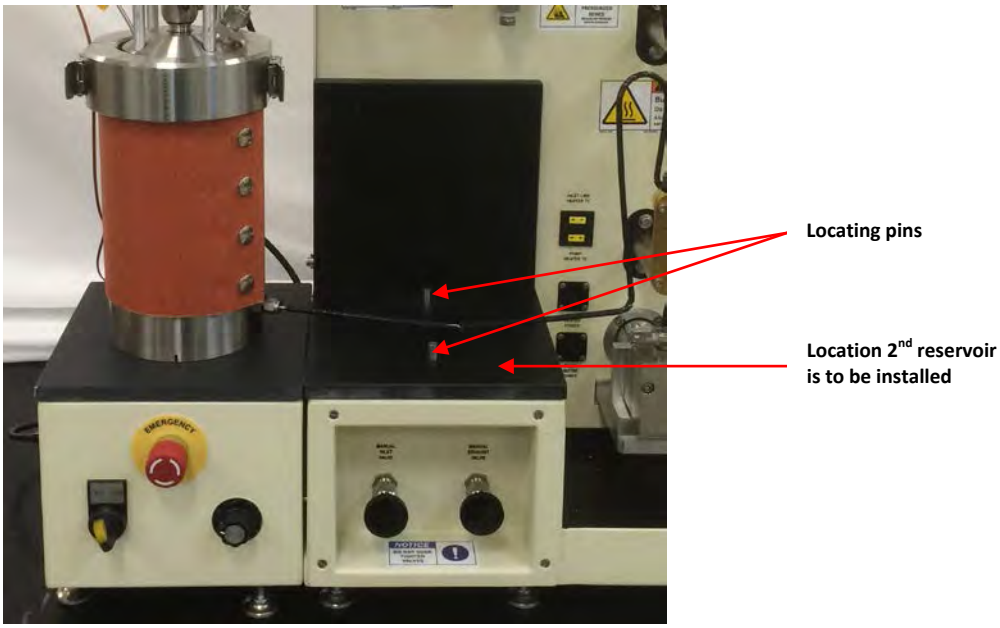


Figure H12 – Location reservoir #2 on machine

2. Cap the reservoir #2 discharge port with a cap nut (figure H13) and securely tighten (this will be under pressure during a test).

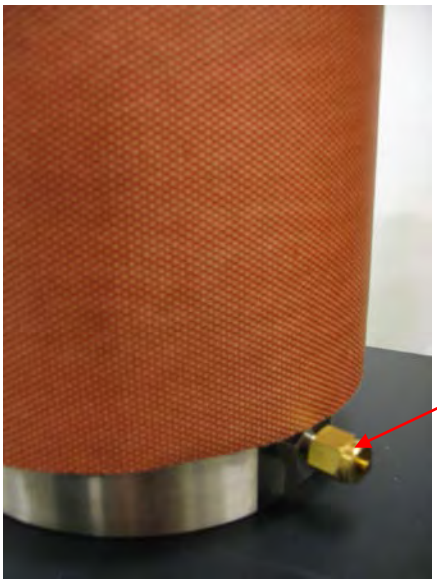


Figure H13 – Cap reservoir #2 discharge port

3. Install the reservoir #2 (catch reservoir) top so that the sight glass side connector for pressure is on the left (figure H14).

Figure H14 – Reservoir #2 top orientation

4. Place the reservoir assembly with the mechanical stirrer assembly (supply reservoir) on the attachable stand using the locator pins. This reservoir is referred to as reservoir #1.
5. Cap the reservoir #1 inlet port with a cap nut (figure H15) and securely tighten (this will be under pressure during a test).

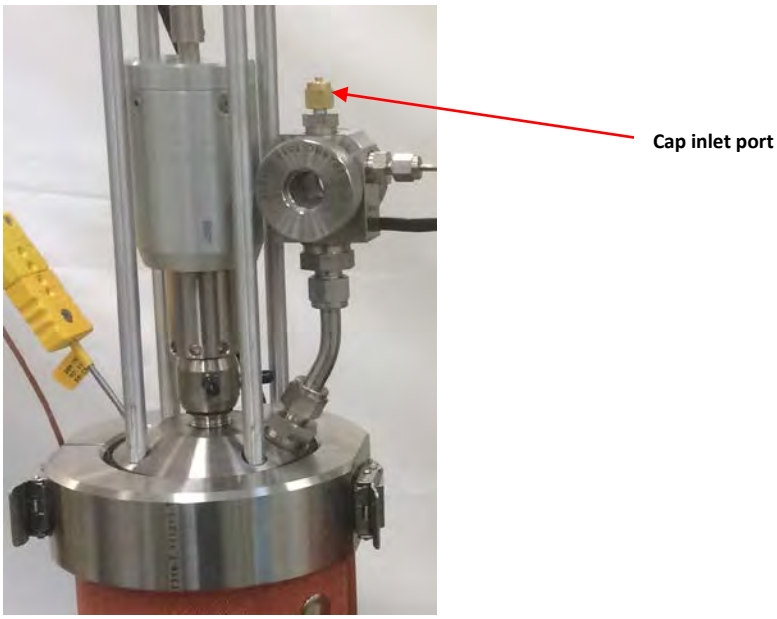


Figure H15 – Cap reservoir #1 inlet port

6. Connect the pressurization tee line assembly to both reservoirs (figure H16).

Figure H16 – Pressurization line assembly connection

7. Connect the reservoir return line assembly to the top of the sight glass of reservoir #2.
8. Install the heater jacket around reservoir #2 so that the thermocouple sensing tip on the inside of the heater jacket is located towards the bottom of the reservoir.
9. Connect reservoir #2's heater jacket power cable to the power connector on the back of the machine and the heater jacket thermocouple to its associated connector on the back of the machine (figure H17).

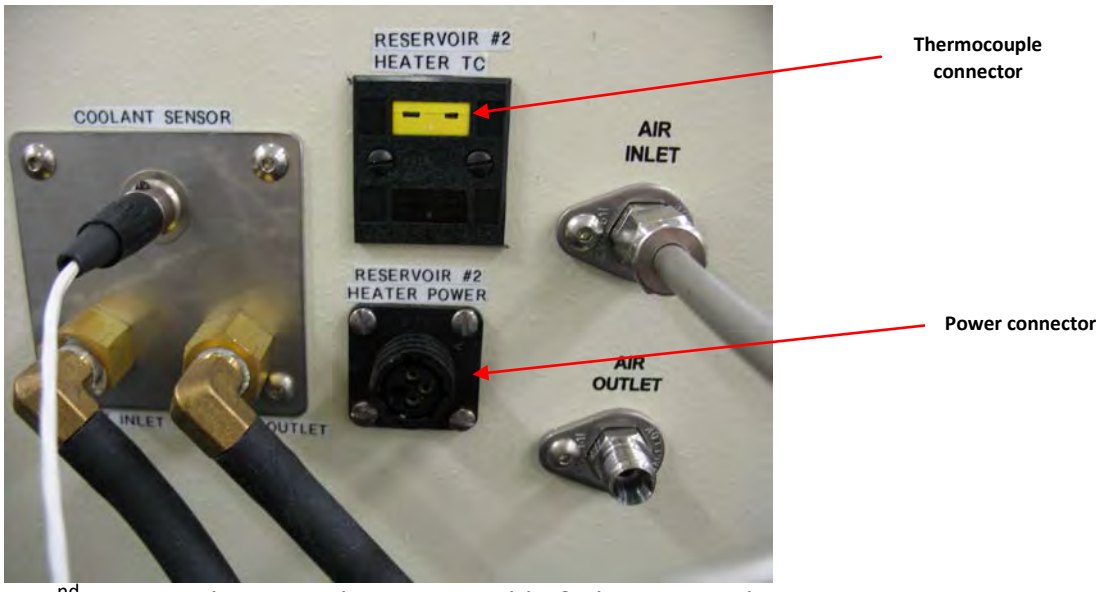


Figure H17 – 2nd reservoir heater jacket power cable & thermocouple connectors

10. Install the heater jacket around reservoir #1 and connect reservoir #1's heater jacket power cable and thermocouple to their respective connections on the front of the machine.
11. Fill reservoir #1 (supply reservoir) with test fluid.

Note: The amount of test fluid that is placed in the 'supply' reservoir must be enough to last the configured test duration at the configured pump speed. Failure to supply sufficient test fluid for the test will cause the pump to run dry and damage the pump.

12. Install the extended safety cover.

Calibration

The thermocouple is to be calibrated per the process detailed in section 5.

Cleaning

The cleaning procedure can be followed as described in section 3.3. Place the 400ml plastic beaker inside the 2nd reservoir (instead of reservoir #1) to catch the fluid being flushed.

Spare Parts

- 450-105-050 Reservoir return line assembly, push (non-heated)
- 450-105-054 Reservoir return line assembly, push (heated)
- 450-105-024 Reservoir return line assembly, pull (heated)
- 620-006-004 O-ring, tubing (package of 100)

Addendum 'I' – Pump Heater Setup & Configuration (option)

(450-106-002)

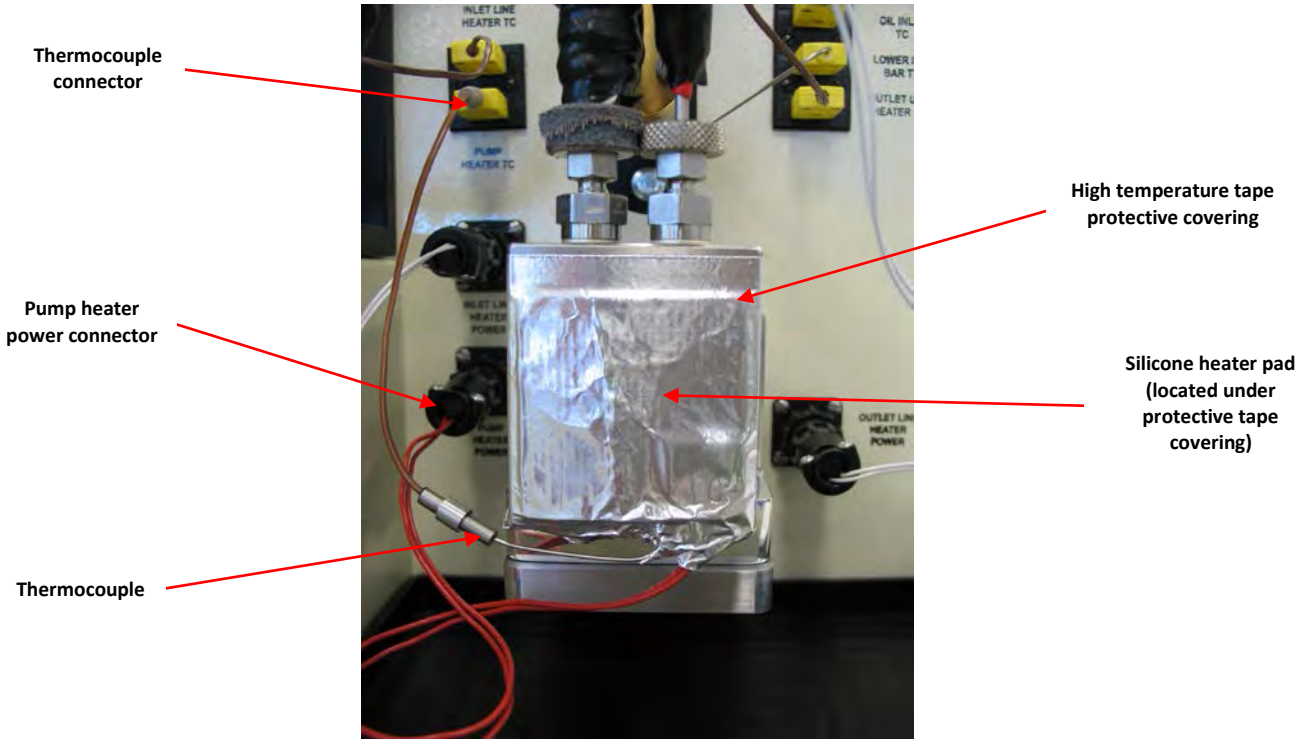


Figure I1 – Pump heater assembly

Figure I1 shows the pump heater option installed on the pump. The use of the pump heater eliminates any test fluid heat loss and keeps the test fluid's viscosity constant as it flows through the pump. This option is to be used with high viscosity fluids and requires that the pump heater and a thermocouple be installed.

This option must be activated within the software application (factory set) in order for it to be selectable within the test configuration. The pump heater will heat to the operator entered setpoint (50 - 150°C). This is set during the test configuration.

The following parts and accessories are included with the pump heater option (figure I2):

- 5 450-109-010 Silicone rubber heater assembly
- 1 450-200-006 24" roll of high temperature foil tape
- 1 650-009-064 Thermocouple

Note: Five (5) pump heaters are provided in the kit because the adhesive on the pump heater will only allow it to be placed on the pump once. Therefore, should the pump heater need to be removed, replacements are available.

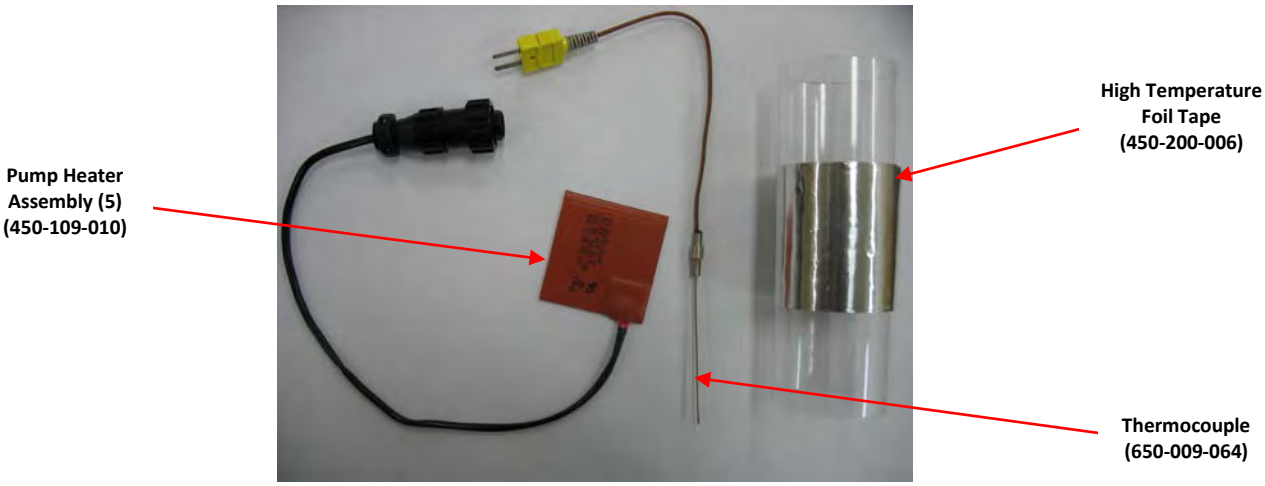


Figure I2 – Pump heater option components

Installation

1. Bend thermocouple so that the sensing tip is approximately half way up from the bottom of the pump (figure I3).

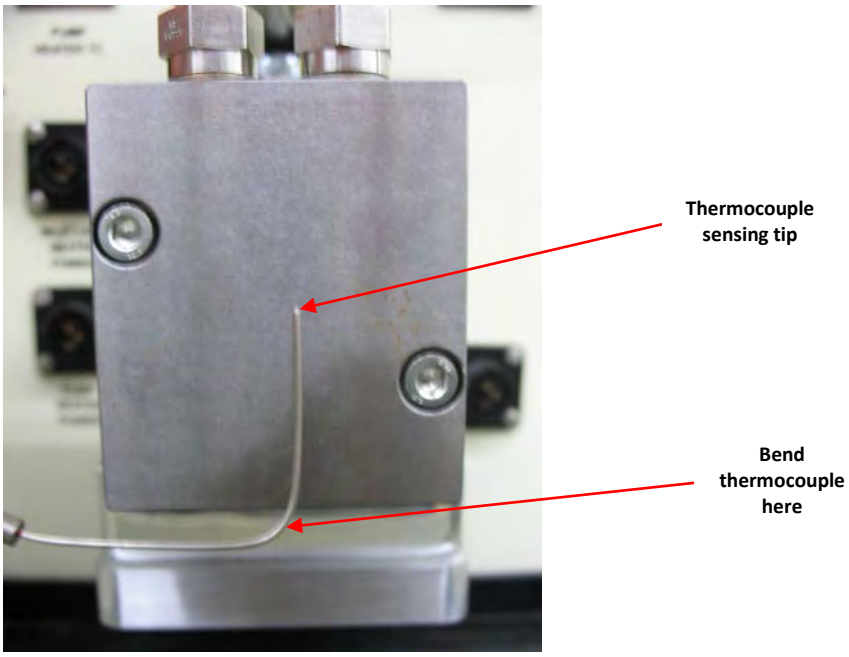


Figure I3 – Thermocouple bends

2. Remove adhesive backing and place the heater pad centered on the pump face with the power wiring oriented towards the bottom right corner (figure I4). Lightly press top of heater pad onto pump face.

Figure I4 – Heater pad placement

3. Insert thermocouple so that its sensing tip is between the pump face and heater pad and positioned in the center of the heater pad (figure I5).

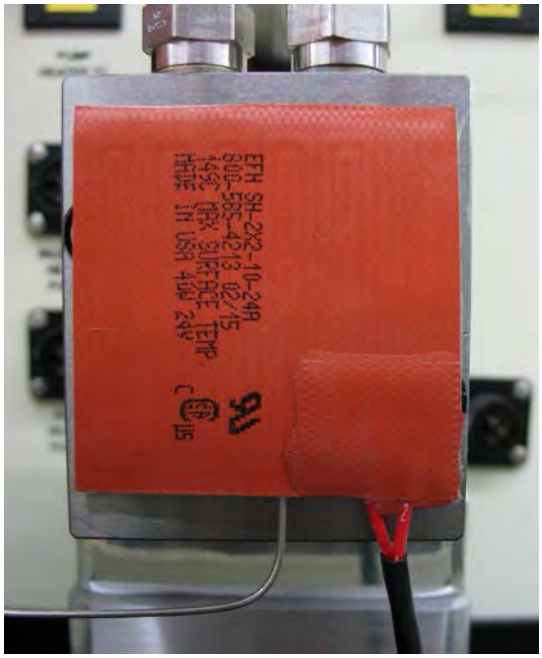


Figure I5 – Thermocouple placement

4. Firmly press all areas of heater pad onto pump face.

5. Cover heater pad with 4.5” of high temperature foil tape so that it covers entire heater pad and wraps over to each side of pump (figure I6)

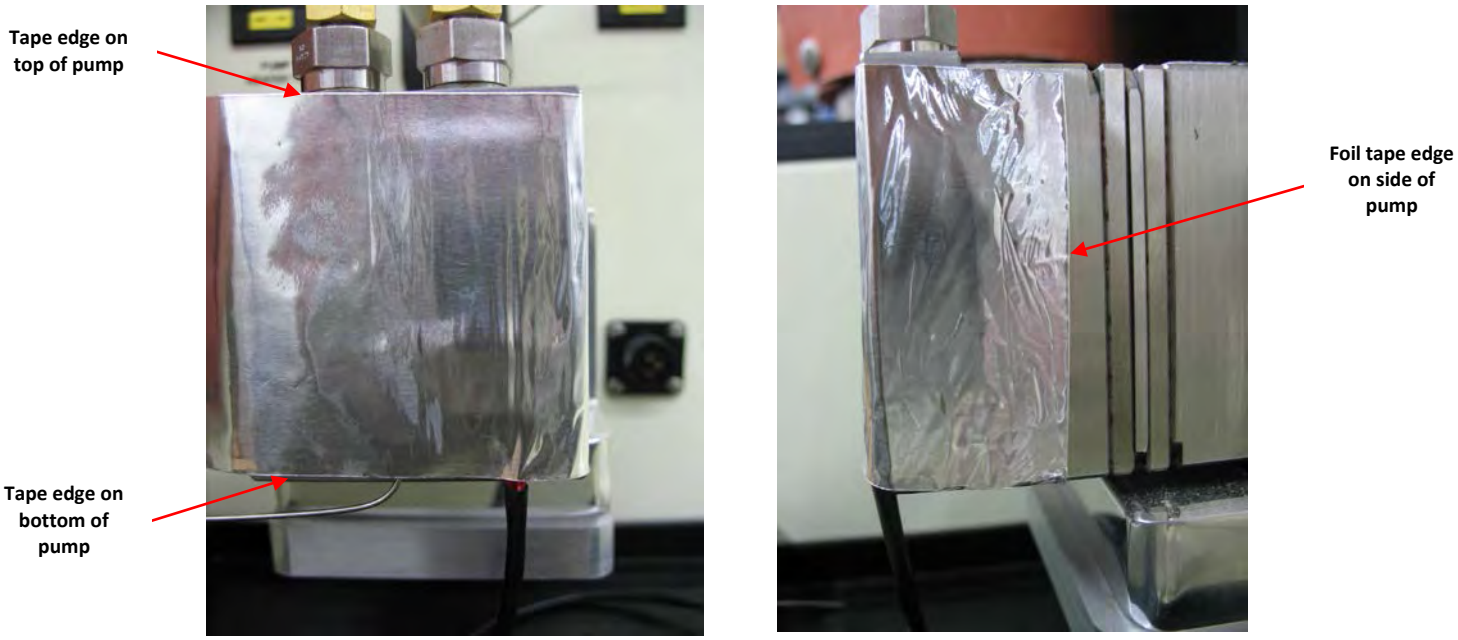


Figure I6 – High temperature foil tape placement

6. Connect the thermocouple to the ‘Pump Heater TC’ connector located above and left of the pump.
7. Connect the pump heater power connector to the ‘Pump Heater Power’ connector to the left of the pump.

Calibration

The thermocouple is to be calibrated per the process detailed in section 5.

Cleaning

- Wipe clean any fluid residue or cleaning solvent that may have gotten on the pump or the pump heater protective covering.

Spare Parts

- 450-109-010 Silicone rubber heater pad assembly
- 450-200-006 24” roll of high temperature foil tape
- 650-009-064 Thermocouple

Addendum ‘J’ – Mechanical Stirrer Setup & Configuration (option)

(400-200-007)

Note: This option is only available for use with the split ring clamping collar reservoir.

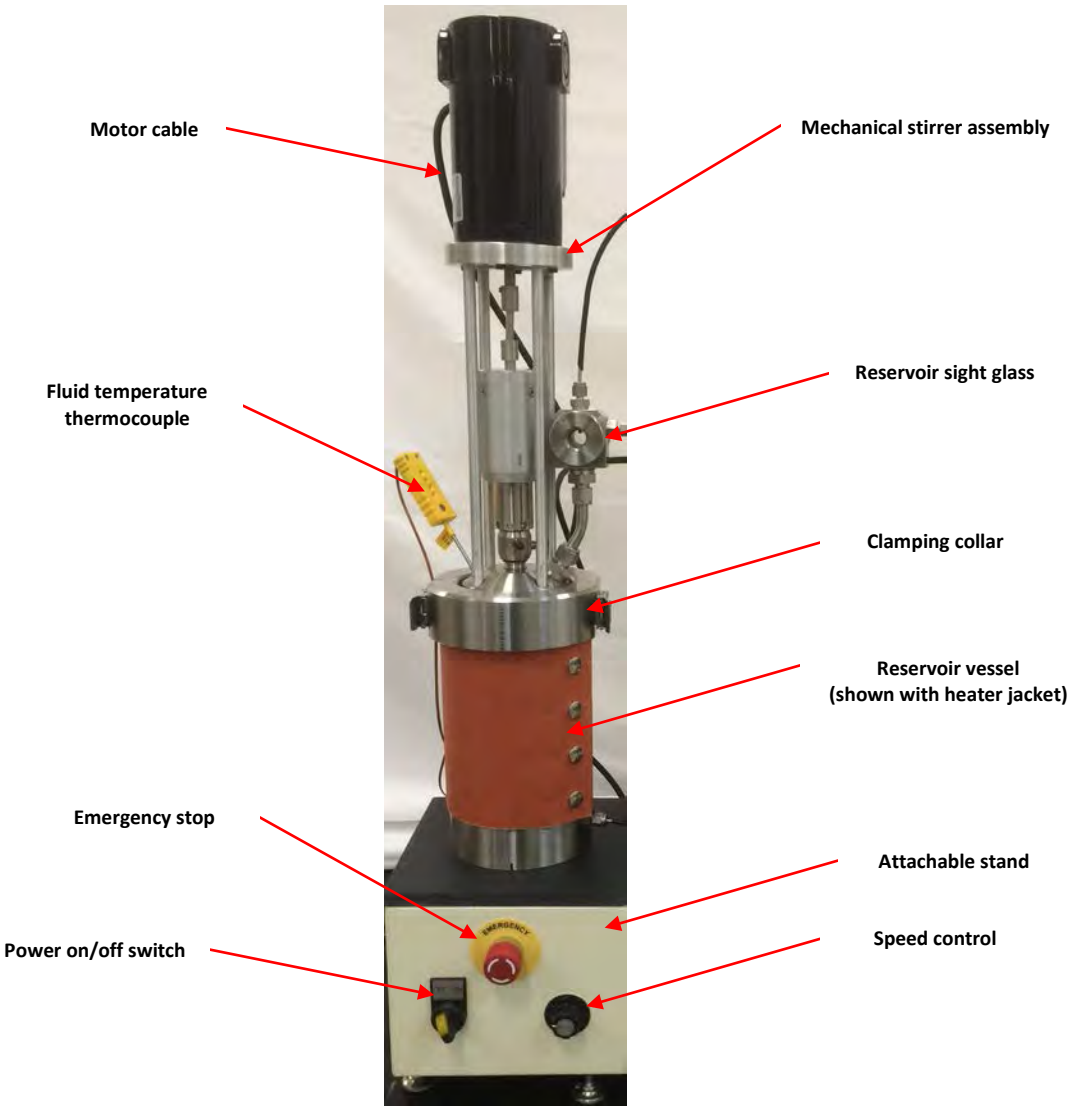


Figure J1 – Mechanical stirrer assembly

The use of the mechanical stirrer helps to keep the properties of the test fluid equally distributed throughout the duration of the test. Figure J1 shows the mechanical stirrer assembly.

This option must be activated within the software application (factory set) in order for it to be selectable within the test configuration. The mechanical stirrer assembly is an independent device and does not interface with any of the electronic controls or software application of the Falex 450 (FT^2) test machine. The stirrer controls are contained inside the attachable stand. Selection of the ‘Stirrer’ option in the test

configuration only signifies that the stirrer was used for the particular test, as shown in the test data file header.

Use of this option increases the width of the machine by 8” and the height of the machine by 4”. Therefore, the machine with this option requires bench space of approximately 44”W x 36”H x 30”D to comfortably operate the test machine.

The following parts and accessories are included with the mechanical stirrer assembly option:

- 1 450-105-073 Stirred reservoir assembly
- 1 450-105-072 Extended safety cover assembly
- 1 450-105-076 Reservoir stand assembly
- 1 450-105-033 Fluid temperature assembly
- 1 450-106-008 Reservoir heater jacket assembly (split ring clamping collar)
- 1 450-105-069 Inlet tube assembly, pull (non-heated)
- 1 450-105-021 Outlet tube assembly, pull (non-heated)
- 1 450-105-071 Reservoir return tube assembly, pull (non-heated)
- 1 450-105-078 Pressurization line assembly (recycle)

Installation

1. Remove small side cover on left side of the machine by loosening 2 screws (figure J2).

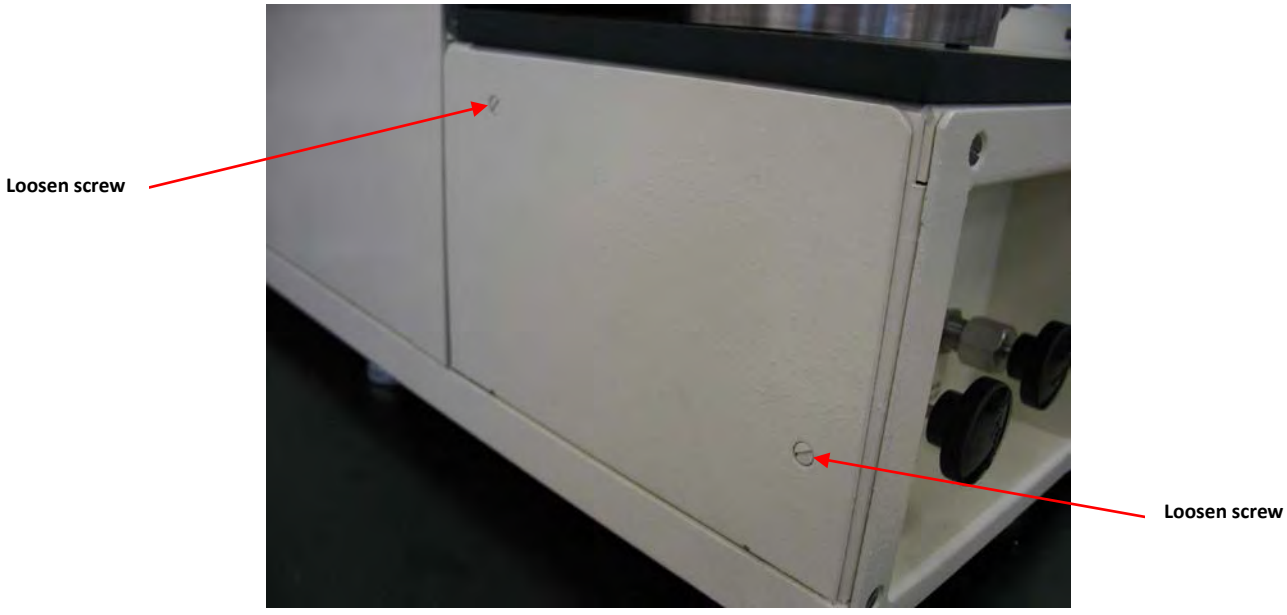


Figure J2 – Side cover removal

2. Install 2 shoulder screws into existing threaded holes in frame (figure J3).

Figure J3 – Shoulder screws installation

3. Install reservoir stand assembly over shoulder screws (figure J4).

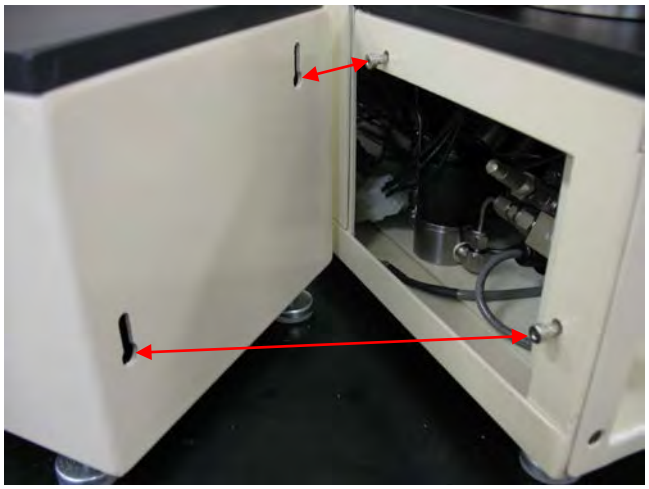


Figure J4 – Reservoir stand installation

4. Place the reservoir base on the stand assembly using the locator pins. This is the main reservoir and is referred to as reservoir #1.
5. Fill reservoir #1 (supply reservoir) with the desired type and amount of fluid required for the test.
6. Carefully place the mechanical stirrer assembly into the reservoir so that the sight glass is facing to the front.
7. Place the clamping collar pieces on the reservoir and latch them together to secure the mechanical stirrer assembly to the reservoir.
8. Install the heater jacket around reservoir #1 so that the thermocouple sensing tip on the inside of the heater jacket is located towards the bottom of the reservoir.
9. Connect reservoir #1's heater jacket power cable and thermocouple to their respective connections on the front of the machine.

10. Connect the pressurization tubing line and associated fluid flow tubing lines to the reservoir #1 sight glass.
11. Connect the stirrer motor cable to the 4-pin connector on the back of the control stand (figure J5).

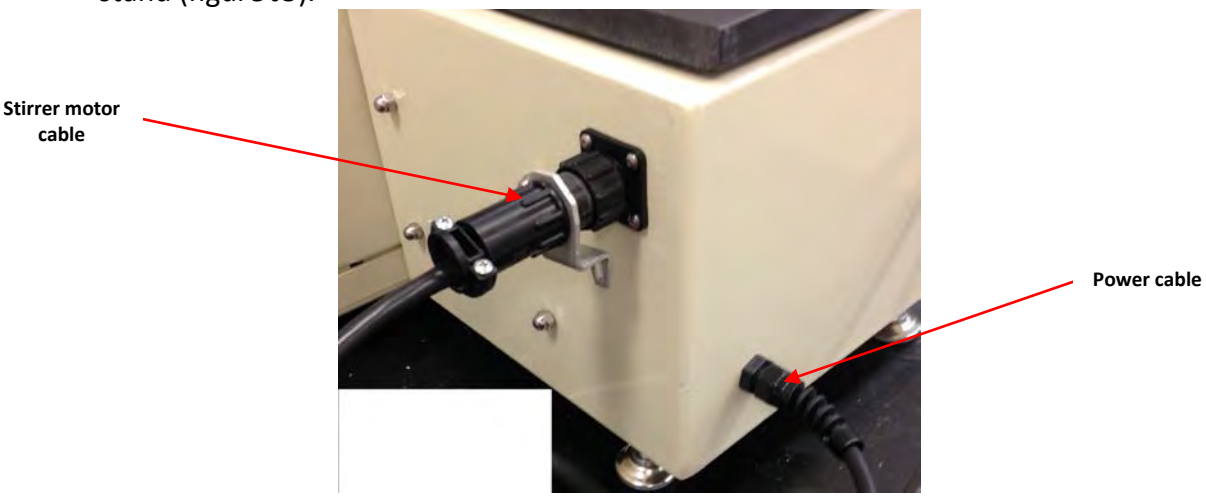


Figure J5 – Motor cable connector

12. Insert the fluid temperature thermocouple into the thermowell on the left side of the reservoir lid.
13. Connect the fluid temperature thermocouple to the associated thermocouple receptacle on the back of the machine.
14. Carefully install the extended safety cover (once the heater tube section has been assembled and installed).

Operation

1. Make sure that the speed control is turned to 0.
2. Make sure that the power switch is in the 'off' position.
3. Plug the mechanical stirrer power cord (side of control stand) into a 120 volt, single phase, 50/60Hz power source.
4. Switch the power switch to the 'on' position.
5. Slowly turn the speed control knob to start the stirrer spinning.
6. Adjust the speed control knob to the desired stirrer speed.

Note: Push emergency stop button in to turn off power to the mechanical stirrer in an emergency situation. Twist to release and restore power to the mechanical stirrer.

Calibration

The fluid temperature thermocouple is to be calibrated per the process detailed in section 5.

Cleaning

The cleaning procedure can be followed as described in section 3.3.