

LM20 Microfluidizer™ Processor

User Manual



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Important Information

- ◇ This equipment is intended to operate between 50°F-80°F (10°C - 26°C).
- ◇ The Microfluidizer processor is **NOT** designed to operate in an environment that contains explosive fumes or other flammable or hazardous conditions.
- ◇ This system is capable of normal operation under voltages listed on nameplate.
- ◇ Equipment is capable of operation within a humidity range of 30% to 80% (noncondensing).
- ◇ Equipment is capable of operation at altitudes up to 1000M above sea level.
- ◇ Wear appropriate personal protection devices when operating and servicing equipment.
- ◇ Read and understand this manual before operating equipment. Contact Microfluidics Customer Service with any questions.
- ◇ Equipment must be properly maintained and serviced.

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Revision History

REVISION	DATE	DESCRIPTION OF CHANGES
A	2015	<ul style="list-style-type: none">Initial release
B	2020	<ul style="list-style-type: none">Updated based on design changes
C	Jan-2023	<ul style="list-style-type: none">Updated graphics (section 2.4)

Model Specifications

Maximum Product Process Pressure (LM20-20)	20,000 psi (1,379bar)
Maximum Product Process Pressure (LM20-30)	30,000 psi (1,585bar)
Process/Hydraulic Pressure Ratio	21 : 1
Plunger Stroke Length	2.5" (6.35cm)
Plunger Seal Material	UHMWPE
Plunger Diameter	0.437" (1.1cm)
Approx. Stroke Displacement	0.375 in ³ (6.0mL)
Min. Product Inlet Pressure	Gravity
Approximate Unit Dimensions (LxWxH)	26" x 33" x 23" (66cm x 84cm x 58cm)
Approximate Unit Weight	230lbs (104kgs)
Check Valve Torque	See Drawings
Electrical Supply (3 Phase)	208-230/460V, 60Hz OR 190-220/380-415V, 50Hz
Noise Level	<75dB TWA
Hydraulic Oil Capacity	1.25 Gal (4.7L)
Hydraulic Accumulator Nitrogen Charge (LM20-20)	1100 psi (75 bar)
Hydraulic Accumulator Nitrogen Charge (LM20-30)	1400 psi (96.5 bar)
Maximum Hydraulic Oil Temperature	150 °F (65°C)
Minimum Sample Size (approximate)	12 mL
Maximum Ambient Air Temperature	50 – 80°F (10 - 26°C)

Chapter 1: Introduction

1.1 Inside this Manual

This manual is intended as a guide for the operator of the LM20 Microfluidizer™ Processor. It contains 5 chapters and 5 appendices. Chapter 1 gives an introduction to this manual and how to find additional support, and includes our Warranty. Chapter 2 describes a general overview of the Microfluidizer™ Processor with a description of the specific parts of the machine for operation. Chapter 3 explains proper installation and operation procedures. Chapter 4 contains a general description of the maintenance of the LM20 Microfluidizer™ Processor. Chapter 5 contains troubleshooting information which will help you obtain the best possible results with your processor. The appendices include a parts list, fluid compatibility tables, a drawings list, an options list, as well as the recommended maintenance schedule.

1.2 Disclaimers

Design changes and product improvements may subject information in this manual to change without notice. Microfluidics reserves the right to change the design at any time, which may subsequently affect the contents of this manual.

1.2.1 Design Change

Microfluidics will make every reasonable effort to ensure that this User's Manual is up-to-date and corresponds with your LM20 Microfluidizer™ processor.

1.2.2 Reproduction

Neither this manual nor any part of it may be reproduced, photocopied, or electronically transmitted in any way without the advanced written permission of Microfluidics International Corporation.

1.2.3 Shipping

Microfluidics is not responsible for damage to equipment occurring during shipping and only furnishes replacement parts against a written purchase order. It is the customer's responsibility to file a claim with the carrier.

1.3 Customer Support

The information given here is general. Some applications may require additional procedure or equipment modification. For further assistance, feel free to contact the Customer Service Department at Microfluidics **1-800-370-5452**. Hours are 8:30 A.M.- 5:00 P.M., E.S.T., Monday through Friday.

1.4 Warranty

The sole warranty provided by Microfluidics International Corporation is contained in the "Microfluidics Corporation Standard Terms and Conditions", Form M-5 provided at time of purchase.

Chapter 2: Overview

Chapter 2 includes detailed information about the principle of operation, pneumatic power system, high pressure intensifier, interaction chamber and auxiliary processing module, controls, and system specifications.

2.1 General Description

Microfluidics' LM20 Microfluidizer™ Processor is designed for the high-performance micro-mixing of emulsions and dispersions in a variety of industries. The LM20 model is specifically designed to suit laboratory environments.

2.2 Major Components

The LM20 Microfluidizer™ Processor is made up of the following major components:

- Hydraulic Power System, which drives the intensifier pump.
- High Pressure Intensifier Pump, which multiplies the pressure supplied from hydraulic power system to an optimal operating level.
- Interaction Chamber (IXC) which is where size reduction of the product occurs; the product is accelerated to a high velocity and is subjected to intense shear and impact.
- Auxiliary Processing Module (optional) to provide further control over processing of the product.
- Heat Exchanger (optional) to reduce the temperature of the product as it exits the system.

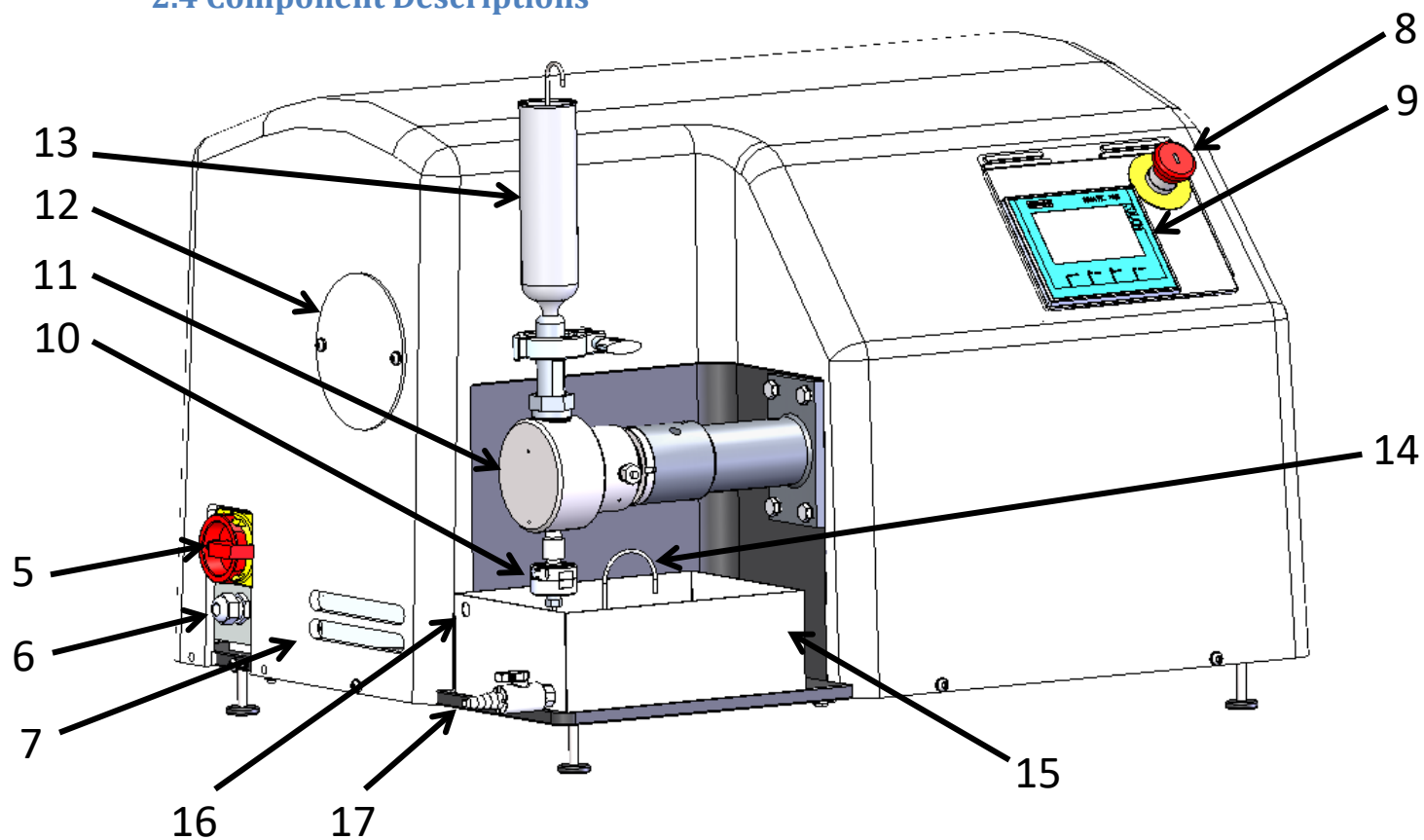
2.3 Principle of Operation

Power for the LM20 Microfluidizer™ is generated by an on-board hydraulic power system. This system supplies pressurized hydraulic oil to a single acting intensifier pump. The intensifier pump amplifies the hydraulic pressure and transfers it to process the sample. Working pressures up to 30,000 (2069 bar) can be achieved. During the suction stroke, the intensifier pump draws product from the inlet reservoir into the pressure chamber via the inlet check valve. During the power stroke, the check valve closes and the product stream is elevated to a constant pressure level. The pressurized product stream enters the interaction chamber and passes through geometrically fixed micro channels, causing it to accelerate to very high velocities. It is here that the product stream is acted upon by two primary forces, which bring about the desired results:

- Shear - deformation of the product stream; occurring from contact with channel walls at high velocity.
- Impact - collision; occurring when the high velocity product stream impinges upon itself.

A heat exchanger (optional) reduces the product stream temperature after product passes through the Interaction Chamber.

2.4 Component Descriptions



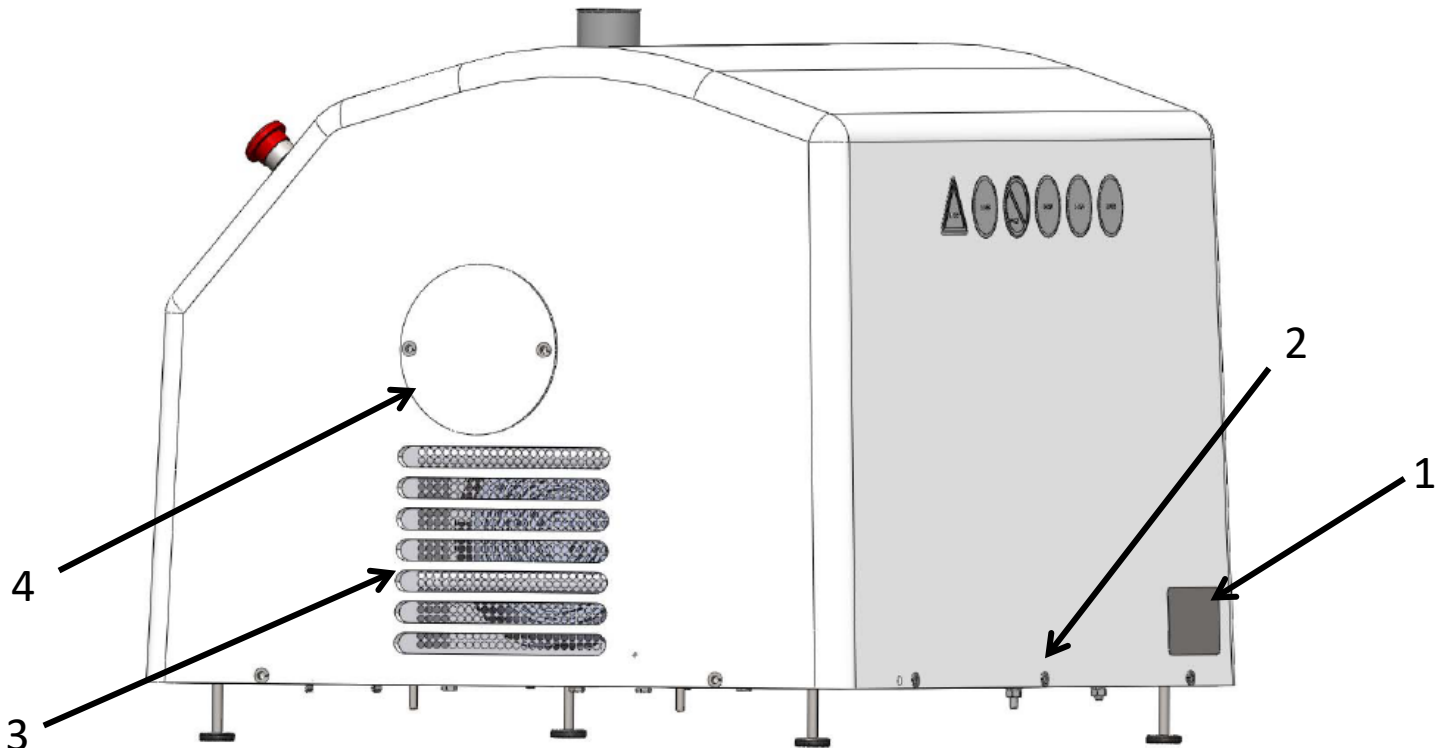


Figure 1 – LM20 Overview Diagram – shown with optional accessories

Standard Features (shown in Figure 1):

1. Machine Name Plate: Details model information and serial number.
2. Cover Fasteners: Secures the cover to the base plate.
3. Air Ventilation Inlet: Air inlet for the hydraulic cooling system. Do not obstruct air path, or system damage will occur.
4. Access Cover for Accumulator: Removing this cover will provide access to the hydraulic accumulator.
5. Power Disconnect: Lockable electrical power disconnect switch.
6. Power Cord: 10 feet (3m) cable. Customer responsible for wiring into power supply.
7. Air Ventilation Outlet: Air outlet for the hydraulic cooling system. Do not obstruct the air path or system damage will occur.
8. Emergency Stop: Emergency Stop button. Push to stop, twist to reset.
9. Touch Screen Interface: Human machine interface (HMI). Used to control machine functions, set pressure, turn intensifier and motor on/off.
10. Interaction Chamber: location of the geometrically fixed micro channels.
11. Intensifier Pump Head: Location of pressure intensification.
12. Access Cover for Oil Reservoir: Removing this cover will provide access to the hydraulic oil reservoir.
13. Inlet Reservoir: Glass reservoir (standard). Fill with preprocessed material.
14. Product Outlet: Post-processed material exits the system.

Optional Features:

15. Cooling Bath: Includes cooling coil. Allows product to be cooled after processing.
16. Product Outlet: Post-processed material exits the system here when using the cooling bath option
17. Cooling Bath Drain: Spigot drain for cooling bath cooling fluid.

Chapter 3: Operation

3.1 Safety Warnings & Cautions



! **"WARNING"** indicates that if a specific procedure or practice is not followed correctly, bodily injury could occur.



! **"CAUTION"** indicates that if a specific procedure or practice is not observed, damage to the equipment could result.

The Microfluidizer™ Processor you have purchased, rented or leased is carefully engineered and tested. Using it involves the handling of fluids at high pressure. Therefore, certain precautions must be taken. **DO NOT** proceed with this chapter until you read and understand the introduction and have completed the necessary installation requirements. Refer to chapter 2 "Overview", to identify individual parts.



! **WARNING:** NEVER TIGHTEN FITTINGS OR ADJUST THE MICROFLUIDIZER™ EQUIPMENT WHILE IT IS UNDER PRESSURE OR WHEN IT IS RUNNING.



! **WARNING:** DO NOT USE DAMAGED MICROFLUIDIZER™ PPROCESSOR EQUIPMENT OR EQUIPMENT THOUGHT TO BE DAMAGED. ALWAYS USE MICROFLUIDICS GENUINE PARTS.




! **WARNING:** DO NOT RESTRICT OR DEAD-END PIPING AFTER THE INTERACTION CHAMBER. BODILY INJURY COULD OCCUR.




! **WARNING:** USE PROPER PERSONAL PROTECTION DEVICES WHILE OPERATING THE MICROFLUIDIZER™ PROCESSOR. ALWAYS WEAR SAFETY GLASSES.





! **CAUTION:** Do not attempt to lift the Microfluidizer™ equipment by any of the mounted components. Serious personal injury and/or damage to the equipment could result. The Microfluidizer™ Processor weighs approximately 230 LBS (104KG).


 **! WARNING:** THIS EQUIPEMNT CONTAINS A NITROGEN CHARGED HYDRAULIC ACCUMULATOR. IT MUST BE DISCHARGED BEFORE SHIPPING AND BEFORE SERVICING ANY HYDRAULIC COMPONENT.

 **! WARNING:** DO NOT RESTRICT OR DEAD-END PIPING WITH BODY PARTS. BODILY INJURY COULD OCCUR.

 **! CAUTION:** If the Microfluidizer™ Processor is not going to be used for more than one month, then the accumulator nitrogen gas must be discharged and recharged prior to the next use.

 **! CAUTION:** This equipment is shipped WITHOUT hydraulic oil in the reservoir. Users MUST fill the reservoir with hydraulic fluid that has been filtered through a 10 micron filter before using the equipment (oil is included in tool kit). DO NOT start the motor without ensuring that a sufficient level of hydraulic oil is in the tank. Damage to the pump could result. During oil fill, eye protection must be worn.

 **! CAUTION:** The accumulator must be charged before the machine can be operated. See section on accumulator charging. During charging, eye protection must be worn.

 **! CAUTION:** Do not obstruct the air vents. Damage to the hydraulic components could result.

3.2 Supplied Items

The LM20 Microfluidizer™ processor comes complete with:

- High-Pressure Intensifier Pump, single acting.
- Interaction Chamber design type to fit your process.
- 300mL glass inlet reservoir.
- Power cord to connect the processor to power utilities.
- Tool Kit with all special tools necessary to service the LM20.
- Spare Parts Kit with basic parts needed to service the LM20.
- Drawings of components for ease of ordering replacement parts.

3.3 Items Not Supplied

The following items are NOT supplied with the unit:

- *Power Cord Plug.* The end user is responsible for installing a plug to suit local electrical regulations on the end of the LM20's power cord.
- *Nitrogen Charging Kit.* The nitrogen charging kit is available from your local Microfluidics representative with the correct local nitrogen adapter. Kits are available for purchase from Microfluidics, contact Microfluidics Customer Service.

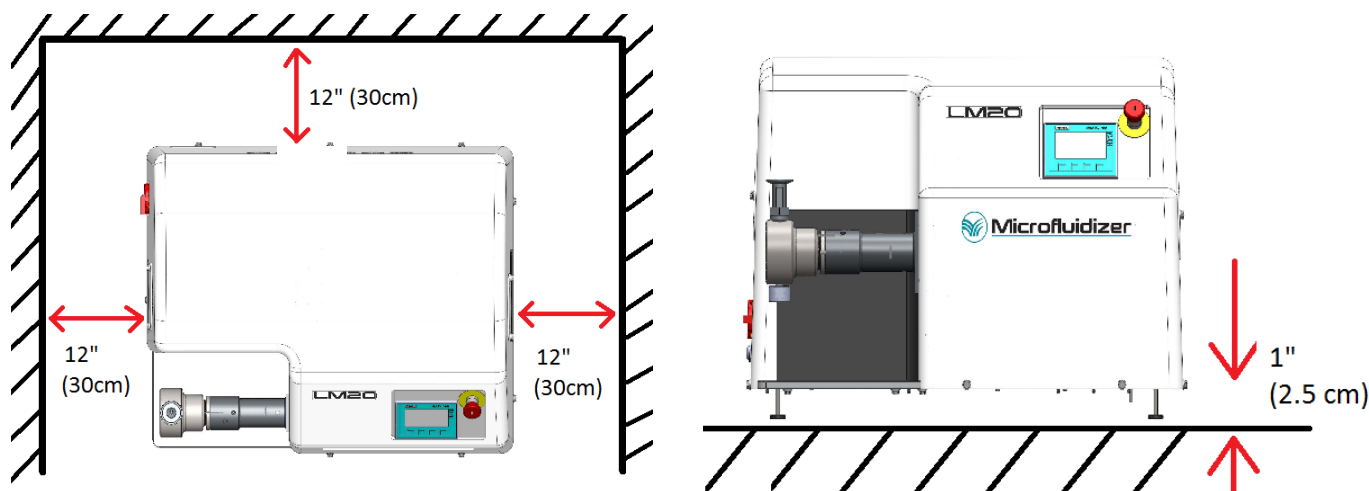


Figure 2 - Site Preparation

3.4 Site Preparation

- Locate the desired operating site and prepare sufficient space for the equipment (refer to Figure 2).
- Never place base plate directly on flat surface, always operate unit with the 4 leveling machinery feet provided to allow air exhaust to vent properly.
- Ensure that the proposed operating site meets all the environmental specifications listed in this chapter (section 3.7).
- Make available sufficient electric sources then connect all utilities to the system (refer to section 3.6).

NOTE: Check the shipping container and its contents for damage. If damage is suspected, notify both the carrier and MFIC immediately on the straight bill of landing (supplied by the carrier). If any damage is found, you may request an inspection by the carrier. Such requests should be made as quickly as possible.

- Compare the contents of the packing list against the contents of the shipping container, to ensure receipt of all components.

NOTE: We recommend saving the shipping container for possible future use.

3.4.1 Foundation

The foundation of the proposed operating site **MUST** be able to support the gross weight of the Microfluidizer™ equipment. The equipment **MUST** be placed on a flat level surface.

3.4.2 Clearances

A minimum clearance of 12 inches (30 cm) around all sides of the Microfluidizer™ equipment is required. Do not obstruct the air vents; always operate with the leveling machinery feet installed. See Figure 2.

3.5 Moving the Equipment

Care shall be taken when moving the processor. Only lift from the bottom base plate, do not lift from any mounted or attached components. Make certain a lifting device is rated for the maximum weight of the equipment (including accessories).

3.6 Utility Requirements

3.6.1 Electrical Supply

Electrical requirements vary by location. Consult the model specification section for compatible electrical supply. The Microfluidizer™ Processor must be properly electrically connected according to national and local electrical codes. The end user must supply secondary branch protection for the Microfluidizer™ Processor as required by local codes.

3.7 Environmental Requirements

3.7.1 Temperature

Avoid placing the Microfluidizer™ Processor in an area where ambient temperature is above -80°F (26°C) or below 50°F (10°C).

3.7.2 Ventilation Requirements

The Microfluidizer™ equipment vents air to the surrounding environment. The customer must provide adequate ventilation, and ensure that the venting is not restricted. The vented air will be warm and as such surfaces nearby must be compatible with this temperature.

3.8 Preparing for First Use

This section should be followed for preparation of the Microfluidizer™ Processor during new machine start up. This section can also be followed after long term storage.

3.8.1 Hydraulic System

1. Fill hydraulic reservoir with oil. Fill to the top mark on the dip stick. Filter with a 10 micron filter during filling. It will take approximately 1 gal (3.6 L) to fill.
2. Charge hydraulic accumulator with nitrogen. See section 4.5 for instructions.

3.8.2 Utility Hookups

1. Connect the electrical utility to the processor.
2. Ensure local electrical utility supply meets processor requirements.
3. Verify motor is wired for high or low voltage using motor nameplate.
4. Verify motor starter overload is rated for motor nameplate.

3.8.3 Assembly

Assemble optional and/or shipped loose components to the LM20

1. The inlet reservoir should be assembled. The O-Ring for the glass reservoir must be lubricated prior to installing the glass reservoir into the metal adapter.
2. Chamber and piping should be assembled. Tighten all high pressure fittings per applicable drawing contained in the turn over documentation.

3.8.4 Preparing Processor for Operation

1. Turn on the electrical disconnect switch. Allow the system 30 seconds to power on.
2. Fill the inlet reservoir with water.
3. Check for proper hydraulic oil level in the oil reservoir.
4. Check accumulator for nitrogen charge.



! CAUTION: Do not operate the LM20 with low oil level. System damage will occur.

1. Turn on electric motor.
2. Turn on intensifier.
3. Check motor rotation. The hydraulic pressure gauge will build pressure. If no pressure is indicated, make sure snubber valve is open.
4. If the motor is rotating in the wrong direction, change any 2 of the 3 power leads.



! WARNING: REMOVE ALL ELECTRICAL POWER FROM MICROFLUIDIZER BEFORE CHANGING THE ELECTRICAL WIRING.

5. Prime the pump. See section 3.9.1
6. Set process pressure to 10,000 psi.
7. Run the system for 5 minutes to purge the hydraulic system of air. Keep the inlet reservoir full of water during this time. If the pump runs dry, it will be necessary to repeat the priming instructions.
8. The processor is now ready for operation.

3.9 Operating the Equipment

1. Check proper utilities are available and connected to the processor.
2. Ensure the Product Inlet Reservoir is filled.
3. Turn on the electric motor with the "Motor On" button.
4. Prime the intensifier pump. See section 3.9.1
5. Input the desired process pressure on the operator interface screen.
6. Press the "Start Intensifier" button on the operator interface screen. The intensifier pump will start cycling.
NOTE: The liquid that was inside the equipment after last use may still be present at this point and will have to be eliminated first.
7. After desired volume of product has been processed or inlet reservoir is empty, press the "Stop Intensifier" button on the operator interface screen.
8. Turn off the electric motor with the "Motor Off" button.

NOTE: Do not allow any of the high pressure fitting to leak. Leaking will cause damage to the sealing surfaces of the joint. If a high pressure fitting is leaking, follow the relevant steps in the Maintenance section of this manual.

3.9.1 Prime the Intensifier Pump

Priming the intensifier pump is often needed before the first time use, after disassembly, or whenever the Intensifier Pump loses its prime.

The prime function is achieved by operating the processor at low pressure and manually opening the inlet check valve.

1. Ensure the inlet reservoir has fluid in it.
2. Set the process pressure to 5000 psi.
3. Insert priming tool into the reservoir and push down the inlet check ball.
4. Start the intensifier pump.
5. Cycle the pump for 2 cycles.
6. Remove the priming tool, liquid should begin to exit the product outlet piping.
7. Stop the intensifier pump.

This completes the prime function.

If the fluid that is being processed is very viscous, the MPPC option may help in priming the pump. Contact Customer Service to discuss the MPPC option.

If unable to accomplish a prime, see relevant help sections.

3.10 Cleaning and Storing the Equipment

The best cleaning procedure will depend on both the nature of your products and the standards for your industry. New machines are shipped from our factory thoroughly cleaned with water and rinsed with isopropanol. The isopropanol, which is then left in the processor, is used because it cuts grease and oil effectively, yet has limited negative effects on any of the sealing materials used in the equipment. The interaction chamber, the auxiliary processing module, and all of the small diameter high pressure tubing can be cleaned by simply pumping a suitable cleaning solution or solvent through the processor as though it were product. We recommend leaving the processor filled with solvent between uses.

NOTE: Consult the Fluid Compatibility Table in Appendix D.

The user shall determine the best cleaning procedure based on the product and cleaning solution. A cleaning process is as follows:

1. Add the appropriate cleaning solution liquid to the Product Inlet reservoir.
2. Run processor at a suitable pressure and flow rate to clean internal parts.
3. The product outlet flow should be clean.
4. Stop the processor.
5. To store the processor, it is recommended to fill with appropriate solvent. Cover the inlet reservoir to avoid large particles from entering.

3.11 Using the Emergency Stop

At any time when operating the Microfluidizer™ Processor, pressing the Emergency Stop Button will stop the intensifier pump and turn off the electric motor, setting the processor to a low energy. To re-set the E-Stop:

1. Twist the E-Stop Button clockwise. This will reset the button.
2. Acknowledge the alarm(s) on the operator interface screen.

Follow directions in Section 3.9 to restart processor.

3.12 Operator Interface

The operator interface controls the functionality of the processor. It is through this color touch screen that the operator will start/stop the processor, set the process pressure, and monitor the processor.

3.12.1 Home Screen

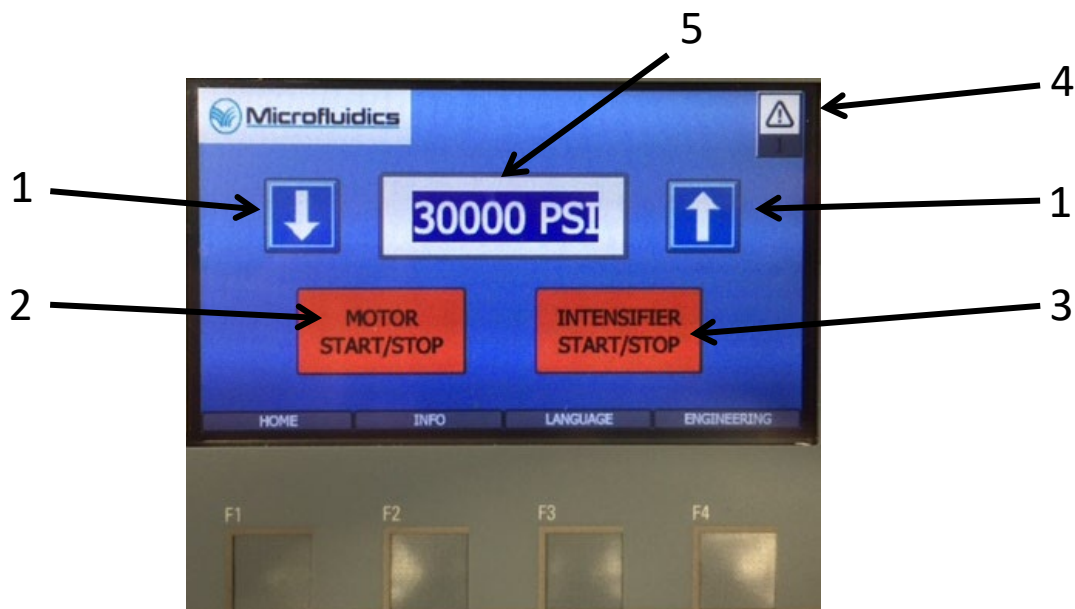


Figure 3 - Home Screen

1. Up/Down Arrows. Pressure can be increased/decreased by holding or tapping these buttons.
2. Motor Start/Stop. The electric motor is turned on/off with this button.
3. Intensifier Start/Stop. The intensifier pump is turned on/off with this button.
4. Alarm Indication. When illuminated, indicates an alarm condition.
5. Pressure Setting. Clicking the pressure will open a key pad to type in desired pressure. This is the pressure the LM20 will process at.

3.12.2 Info Screen

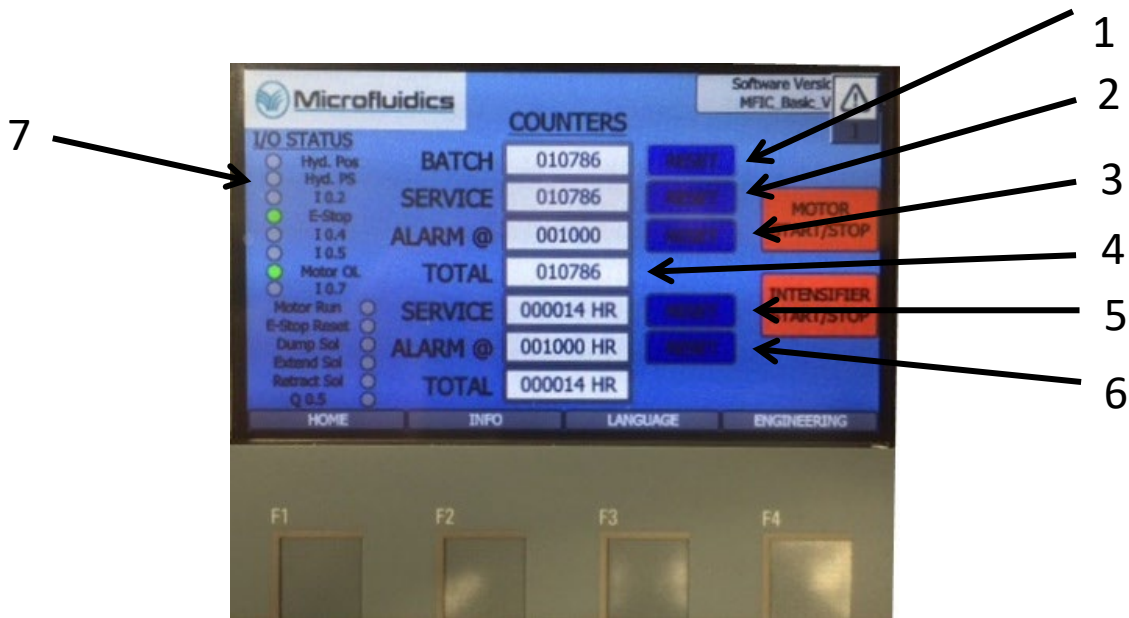


Figure 4 - Info Screen

1. Batch Stroke Counter: The number of strokes during the batch. Use "RESET" button to reset to zero.
2. Service Stroke Counter: Number of strokes since last qualified service visit. Can only be reset by trained MFIC representatives.
3. Number of strokes until next service alarm.
4. Total strokes: Lifetime machine stroke counter.
5. Service Alarm Hour Meter: Hours since last qualified service visit. Can only be reset by trained MFIC representatives.
6. Hours until next service alarm
7. Lifetime Hour Meter: The lifetime hour meter on the LM20
8. PLC Input/Output Status: Lights indicate status of I/O on PLC.

3.12.3 Alarm Screen

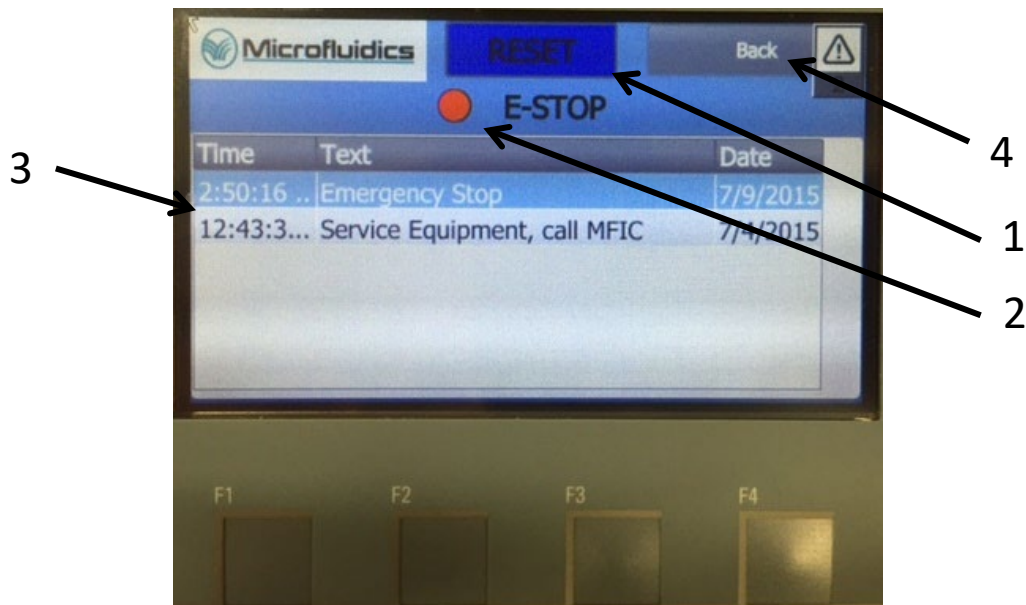


Figure 5 - Alarm Screen

1. E-Stop Reset: After twisting the E-Stop button, press the RESET button to completely reset the E-Stop event.
2. E-Stop Status Light: Red indicates an active E-stop alarm. Green indicates no E-Stop alarm.
3. Alarm Status: Active alarm descriptions will be shown here
4. Back Button: Press this button to return to the previous screen.

3.12.4 Language Screen



Figure 6 - Language Screen

Select the language by clicking on the appropriate flag.

Chapter 4: Maintenance

Chapter 4 provides user maintenance procedures. The procedures are categorized by system component. Component categories include the hydraulic power system, hydraulic filter and strainers, limit switches, plunger seal, hydraulic drive, hydraulic cylinder, tie-rods, check valves, and coned and threaded connections. A filter service schedule and hydraulic oil service schedule are included as well as procedures for making hydraulic adjustments.

- All stainless steel threaded connections should be lubricated. Microfluidics recommends Never-Seez food grade compound.
- Always make sure that the system pressure is relieved before servicing.
- Never tighten fittings while under pressure.

4.1 Pump and Plunger Seal Assembly

Replace the plunger seal when there is excessive product discharge from the drain hole in the isolator. To access the plunger seal, first remove the pump body from the isolator by carefully following the procedure below. The high pressure seal, back-up ring, and bearing must be replaced together.

4.1.1 Removing the Pump Body

1. Disconnect the power supply.
2. Disconnect any liquid quench tubing, if applicable.
3. Remove the reservoir from the check valve body by removing the tri clamp connection.
4. Using the 5/8" open-ended wrench, loosen the glands and remove the process piping and Interaction Chamber (IXC) directly below the pump body and the isolator.
5. Loosen the 2.75" locknut as follows: Obtain the spanner wrench (P/N 16.2102). Place the spanner wrench around the 2.75" locknut and insert the spanner wrench tooth into one of the locknut grooves. Obtain a rubber head mallet and strike the end of the spanner wrench handle so as to rotate the locknut in a counter clockwise direction. Back off the locknut to allow the pump body to rotate.
6. Remove the pump body. Rotate the pump body in a counter clockwise direction. Once the threads are no longer engaged, carefully pull the pump body away from the isolator and off the plunger.



Picture 1 – Removing Pump Body

4.1.2 Removing the Bearing Retainer and Bearing

1. Remove the bearing retainer. First place the pump body in a vise. It is recommended that the vise teeth be made of brass. Wrap the pump body in a rag or cloth so that the vise teeth do not scratch or damage the pump body.
2. Obtain the bearing retainer removal tool (P/N 801.13473). Place the dowel pins into the bearing retainer slots and rotate the removal tool in a counter clockwise direction. Remove the bearing retainer.



Picture 2 - Removing Bearing Retainer

3. Remove the bearing from the bearing retainer. The bearing, plunger seal and back-up ring should always be replaced together. To remove the bearing, obtain a pair of needle nose pliers. Insert the pliers' tips into the notches in the bearing retainer. Apply pressure to the bearing by squeezing the needle nose pliers until the bearing cracks. Remove all the bearing pieces and discard them. Clean the bearing cavity.

4.1.3 Removing the Plunger Seal and Back-Up Ring

1. The seal and back-up ring are located in the pump body. (Do not scratch the seal cavity when removing the seal. Do not attempt to remove the seal with a screw driver or similar tool).
2. With the bearing retainer removed from the pump body, place the flat end of the pump body on a smooth surface so that the seal cavity is visible.
3. Obtain the gland and plug from the Tool Kit. (P/N 15.2200 and 15.2000).
4. Place the .25 HP gland over the stem of the .25 HP plug.
5. Insert the plug and collar hand-tight into the outlet port on the pump body.
6. Place the pump body in a sink and fill the seal cavity with water.
7. Insert the seal removal rod (P/N 71.4007) into the seal cavity. The rod will grab onto the seal and back-up ring.
8. Place a rag over the seal removal rod and seal cavity to prevent any splashing water.
9. Obtain a blunt object and strike the seal removal rod with a quick force. With only one opening in the pump body (the inlet check valve should still be installed), the force on the rod will push the water up, thus forcing the seal and back-up ring out of the seal cavity.



Picture 3 - Seal Removal

10. Remove the seal removal rod, seal and back-up ring.
11. Rinse the pump body seal cavity with water, and dry. Also rinse the seal cavity with isopropyl alcohol or a suitable liquid. Do not use harsh chemicals or rough tools or brushes, as they can damage the pump body.
12. Install a new seal and back-up ring. Refer to Section 4.1.8.
13. Also replace the bearing. The seal, back-up ring and bearing should be replaced together. Failure to replace all three components will result in premature seal failure.

4.1.4 Removing the Plunger

Removing the plunger is necessary only when replacing the part. During routine service and seal changes, it is recommended to keep the plunger installed and clean the plunger in place.

1. Remove the bearing isolator that sits inside the isolator. Obtain the two #10-32 x 2" long screws (P/N 99.0018) and screw them into the bearing isolator. Pull the bearing isolator out by pulling on the screws. Inspect the O-rings for cuts or deep scratches; if found, replace the O-rings.
2. Remove the plastic cover.
3. Unbolt the isolator. Remove the (4) 3/8" hex head bolts that attach the isolator to the hydraulic cylinder. Take care as the hydraulic cylinder will become loose at this point.
4. Inspect the plunger. The high pressure plunger should last for many years. However, if the surface of the plunger becomes rough due to chemical attack or damage from abrasive particles in the product, it may require replacement. Look for any deep scratches or scoring marks. If such marks are found, replace the plunger.
5. To remove the plunger, first remove the snap retaining ring that holds the plunger in place. Obtain the small snap ring pliers. Insert the pliers into the snap retaining ring holes. Carefully guide the snap ring completely out of its groove.
6. Carefully pull the plunger out of the adapter. Remove the flat washer also. If the snap ring must be replaced, the flat washer should be replaced as well.

NOTE: If great difficulty is experienced trying to remove the snap retaining ring, it may be necessary to remove the hydraulic extension adapter first. If so, follow steps 6 through 8.

7. To remove the hydraulic cylinder extension adapter from the hydraulic cylinder, apply localized heat to approximately 250°C on the extension adapter. The heat will loosen Loctite that is on the extension adapter threads.



! "WARNING": HOT SURFACES. Remove extension adapter while it is hot. Wear proper personal protection.

8. Clean the threads of the hydraulic cylinder removing any Loctite debris.
9. Follow steps 4 and 5.

4.1.5 Cleaning Components

1. All the components just removed must be thoroughly cleaned. Each component should be rinsed in water or a suitable cleaner. A clean damp rag should wipe the components clean of any product, debris or lubricating agents. Particular care must be taken to thoroughly clean all threaded parts. Any debris on the threads will damage the components during assembly. It is recommended that if compatible, isopropyl alcohol be used. Obtain clean rags and dampen the rags with the alcohol and again clean all the components just removed. It is suggested that Q-tips be used for hard to reach areas. The components should be wiped clean to a spotless appearance. The threaded components must be kept clean. This strict cleaning procedure must be followed each time the plunger seal is replaced. Failure to properly clean the components will result in premature failure of seals, O-rings and cause damage to machined parts.
2. Inspect all the components. Look for any excessive scratches or wear marks. If damage is found the components must be replaced. Contact the Customer Service Department.

4.1.6 Installing the Plunger

1. Install the plunger with O-ring into the hydraulic cylinder extension. Lubricate the plunger O-ring as well as all the O-rings with tri clover spray or an equivalent lubricant. Insert the washer. Insert the snap ring using the snap ring pliers. Insert the tips of the pliers into the snap ring holes and squeeze the pliers. Push the snap ring into its groove as you squeeze the pliers. Installation may be helped by squeezing the pliers with one hand and using the tip end of a flat head screw driver with the other hand to press the snap ring in place. Make sure the snap ring is locked into its groove and the plunger is properly attached before proceeding.
2. Lubricate the plunger with tri clover spray or an equivalent lubricant.

4.1.7 Installing the Isolator

1. Mount the Isolator by first lubricating the 1.5" diameter opening at the base with tri clover spray or an equivalent lubricant. Obtain the four 3/8" hex bolts and lubricate them with Never-Seez. Then attach the isolator to the hydraulic cylinder using the four 3/8" hex bolts. (The cover plate

should be sandwiched between the hydraulic cylinder and the isolator). It is recommended that the bolts be tightened in an X pattern. It is also recommended if available, to place a level on the isolator to insure proper installation.

2. Always lubricate all threaded components and metal to metal contact surfaces with Never-Seez. Failure to lubricate parts may result in galling of components. Inspect the external and if using liquid quench, internal O-rings. If scratches or cuts appear, replace the O-rings and lubricate them with tri clover spray or an equivalent lubricant.
3. Install the bearing isolator into the isolator. If necessary insert the two #10-32 x2" long screws into the bearing isolator. As you insert the bearing isolator the screws should be facing you. Push the bearing isolator until it will not move any further. Remove the two screws.

4.1.8 Install New Plunger Seal and Back-Up Ring

1. Make certain the pump body is clean of debris or material. Obtain a new plunger seal and back up ring and lubricate them with a compatible lubricant such as tri clover spray.
2. Insert the new seal by hand into the pump body, open end of seal first. Refer to the pump assembly drawing.
3. Insert the back-up ring on top of the seal. Press the back-up ring until it sits flat touching the seal. Make certain the seal and back up ring are pressed firmly into the pump body and are sitting square. The seal and back up ring must not be sitting at an angle. Do not proceed until the seal and back up ring are properly installed.

4.1.9 Install the Bearing and Bearing Retainer

1. Place the pump body in a vise. Wrap the pump body in a rag or cloth to protect it.
2. Insert a new bearing into the bearing retainer. Make sure the bearing sits locked into the retainer cavity.
3. Lubricate the bearing retainer's threads with Never-Seez.
4. Carefully screw the bearing retainer into the pump body. The bearing retainer should easily screw into the pump body. If resistance is felt unscrew the bearing retainer, inspect its threads and the pump body threads for any debris or burrs. Do not force the bearing retainer in and be careful not to cross thread the components.
5. Using the bearing retainer removal tool, insert the dowel pins into the bearing retainer slots and rotate the tool in a clockwise direction. Tighten the bearing retainer to 55-60 ft.lbs. Do not strike the removal tool with a hammer.

4.1.10 Install the Pump Body

Apply a light coating of Never-Seez to the pump body threads.

1. With the plunger fully retracted, take the pump body with O-ring and 2.75" diameter locknut attached and carefully rotate the pump body in a clockwise direction into the isolator. Be careful not to cross thread the components. If resistance is felt, unscrew the pump body and inspect the pump body threads and the isolator threads for debris or burrs. The pump body should rotate smoothly. Screw the pump body into the isolator until it bottoms out. Back off the pump body approximately 1/8 turn so that its inlet opening is vertical.
2. Rotate the 2.75" diameter locknut by hand until it is snug against the isolator.



Picture 4 - Install Pump Body

3. Obtain the spanner wrench (P/N 16.2102) and wrap it around the 2.75" diameter locknut. Make sure the wrench tooth is inserted into one of the locknut grooves. Strike the end of the spanner wrench handle with a rubber head mallet. Two or three strikes may be required to tighten the locknut. When the locknut cannot rotate any farther it is tight.
4. Re-attach the process piping beneath the pump body.
5. Obtain the reservoir and re-attach it to the check valve body.
6. Re-attach any liquid quench tubing if applicable.
7. Make sure all process tubing, the pump body and reservoir have tight and proper connections.

4.2 Check Valve Maintenance

The Inlet Check Valve is located below the inlet fitting on top of the pump body. Its purpose is to allow flow into the pump during the suction stroke and to prevent back flow into the reservoir during the power stroke of the pump. If the pump fails to generate pressure, and there is back flow into the reservoir, then the check valve should be cleaned. If the material clogging the Check Valve can be dissolved, then use the appropriate solvent referencing chemical compatibility with the plunger seal.

NOTE: If the optional MPPC kit is purchased try first to clean the check-valve by using the Manual Priming and Purging Cylinder (MPPC) with a suitable solvent.

4.2.1 Cleaning with MPPC

1. Replace the product reservoir with the MPPC.
2. Open the Prime Relief Valve.
3. Fill MPPC with liquid.
4. Insert the Teflon® plunger into the MPPC.
5. Turn on the pump while applying manual pressure on the MPPC.
6. Shut off the pump before the plunger reaches the bottom of the MPPC.
7. Repeat above steps until product is coming out of Prime Relief Valve with no air bubbles.

If cleaning with the appropriate chemical and the use of the MPPC does not resolve the problem, or if the product is leaking out from the inlet fitting threads, then the check valve has to be disassembled. Access to the Check Valve is gained by unscrewing the inlet fitting of the pump. Remove the pump body (Section 4.1.1) and place in a vise.

4.2.1 Repairing Inlet Check Valve

1. Remove the pump body (Section 4.1.1).
2. Place the pump body in a vise. Wrap the pump body in a rag or cloth before locking it in the vise.
3. Unscrew the 1" gland that holds the check valve to the pump body. It is suggested to use an extended handle 18" adjustable wrench to make the job easy.
4. Using the tweezers supplied in the tool kit, remove the ball, spring and spring retainer.
 - a. If the ball is chipped or has deep scratches, it must be replaced.
 - b. If the spring is deformed or broken, it must be replaced. The ball seat will only need to be replaced if it was chemically attacked by product or solvent, or if large particles are imbedded into it. To remove the ball seat use the brass picks supplied in the tool kit.
5. Thoroughly clean all components with appropriate cleaning solvent.

To reinstall Inlet Check Valve:

1. Place the spring retainer in the pump body.
2. Place the spring on the spring retainer.



Picture 5 - Install Spring and Retainer

6. Place the ball on top of the spring.
7. Slide the check valve body over these 3 parts.
8. While holding the check valve body from rotating, tighten the 1" gland, first by hand then with a wrench, preferably an 18" long adjustable wrench.
9. Remove the pump body from the vise.
10. Re-attach the pump body to the isolator. Refer to section 4.1.10 installing the pump body, steps #1-12. Before re-attaching the pump body to the isolator, make sure the pump body threads are free of debris and lubricated with Never-Seez.

4.3 Replacing Hydraulic Oil

With the exception of changing oil, repair or disassembly of the hydraulic components requires special tools and training. Call our Customer Service Dept. at 1-800-370-5452 for further instructions.



! **"CAUTION":** Oil must be replaced if it becomes overheated (hotter than 150°F, 65°C) or contaminated. Failure to do so will damage the hydraulic pump and/ or other hydraulic components.

- Always use clean, filtered hydraulic oil.
- Filter the oil through a 10-micron (or finer) filter as it is added to the reservoir.
- Never return spilled oil to the reservoir.
- Protect the Microfluidizer equipment from dirty and dusty environments.
- Keep the reservoir filler breather cap in place at all times.

NOTE: When draining oil, do not crack the hydraulic fitting to break the vacuum since this adds contaminants. Instead remove the filler/breather cap

4.3.1 Servicing Hydraulic Suction Strainer

The hydraulic power unit is protected from contamination by a suction strainer. The suction strainer is located inside the reservoir. To clean the oil reservoir and suction strainer proceed as follows:

1. Drain the oil from the reservoir and discard. To facilitate drainage, remove the filler/breather cap.
2. Remove the 4 bolts that fasten the reservoir to the motor/pump adapter.
3. Pull the reservoir from the motor/pump adapter.
4. Remove the suction strainer from the oil tube attached to the pump.
5. Wipe out the inside of the oil reservoir with Stoddard solvent or high flash point mineral spirits. Do this only in an area that is well ventilated. Clean out any debris that may have collected inside the reservoir.
6. Locate magnet and clean.
7. To clean the suction strainer, wash it in high-flash point mineral spirits or Stoddard solvent. Do this only in an area that is well ventilated.
8. Use safety glasses and blow compressed air (50 psig maximum) from the inside to the outside of the strainer.
9. Dry the strainer thoroughly before reinstalling it.
10. Replace the cover and fill the reservoir with oil that has been filtered through a 10-micron (or finer) filter.

4.4 High Pressure Connections

If a coned and threaded connection is not prepared correctly, a leak will be evident through a weep hole (every coned and threaded connection has a weep hole). Usually leaks can be stopped by simply retightening the gland nut. However, if retightening the gland nut does not stop the leak, the connection **MUST** be taken apart, cleaned, and reassembled. Position the collar properly and remake the connection.



! "WARNING": TURN OFF PROCESSOR AND WAIT 5 MINUTES BEFORE TIGHTENING HIGH PRESSURE CONNECTIONS.

4.5 Charging Hydraulic Accumulator



! WARNING: THE USE OF OXYGEN WILL RESULT IN AN EXPLOSION OF THE HYDRAULIC ACCUMULATOR. CHARGE THE ACCUMULATOR WITH DRY NITROGEN ONLY.

The part number of the U.S.A charging kit is 80.0006. Kits for other countries are available.

Make sure nitrogen supply is shut off. Attach hose to nitrogen bottle.

1. Remove gas valve guard and gas valve cap from accumulator and attach valve extender if needed.
2. Back gas chuck "T" handle all the way out (counter clockwise) before attaching charging assembly to accumulator gas valve.
3. Close bleed valve.
4. Make sure not to loop or twist the hose, attach swivel nut to gas bottle valve and tighten.
5. Turn gas chuck "T" handle clockwise 1 turn. Do not turn the "T" handle all the way in, as it will damage the valve core.
6. Crack open nitrogen bottle valve and slowly fill accumulator. Open "T" handle slowly until gauge shows pressure. Shut off when gauge indicates desired pre-charge.



Picture 6 - Charging Accumulator

7. Let the pre-charge set for 10 to 15 minutes. This will allow the gas temperature to stabilize. If the desired pre-charge is exceeded, close nitrogen bottle valve, then slowly open bleed valve (Figure 7). Do not reduce pre-charge by depressing valve core with a foreign object. High pressure may rupture rubber valve seat.
8. When finished pre-charging accumulator, turn "T" handle all the way out on gas chuck (Figure 3-3), then open bleed valve.
9. Hold gas valve to keep from turning, loosen swivel nut, remove assembly. Check for pre-charge leak using a common leak reactant.
10. Replace gas valve cap (10-15 in. lbs.) (11.5-17 cm kg) and valve guard. (Gas valve cap serves as a secondary seal.)



! WARNING: NEVER TURN ON THE PUMP WITHOUT FIRST CHARGING THE ACCUMULATOR.

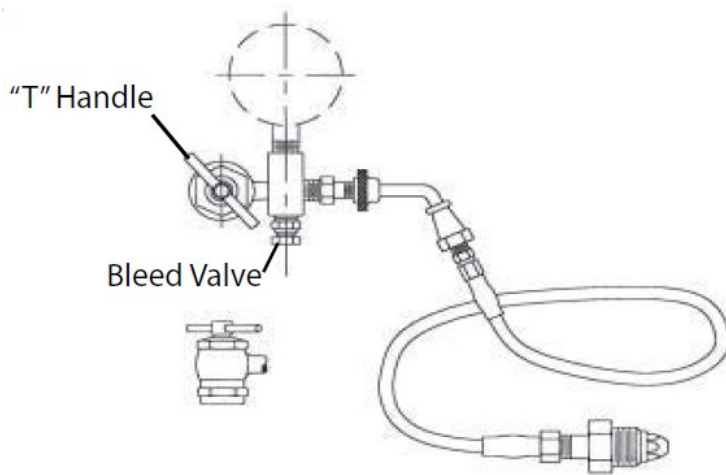


Figure 7 - Nitrogen Charging Assembly

Chapter 5: Troubleshooting

5.1 Monitoring The Flow Rate

An initial flow rate of the product at a base line process pressure (10,000psi) should be done when the unit is received. This will provide a reference point if it is necessary to compare product flow rate data in the future. The pumping system on your LM20 Microfluidizer™ Processor has been designed with enough additional capacity to allow for wear in the interaction chamber and still maintain process pressure. It is recommended that frequent checks of flow rate be performed to track any wear on the interaction chamber. Any change in flow rate over a period of time when processing identical product could indicate interaction chamber wear. Perform a flow rate check using water and compare the results with the initial flow rates found on the Data Sheet. This will indicate the amount of wear in the interaction chamber. Record this data on a regular basis.

NOTE: Testing should always be done under identical, ambient conditions. Remember, other factors such as partial plugging, temperature, and formulation change may cause flow rate change. As a general recommendation, irrespective of flow rate, if you are able to maintain sufficient process pressure to result in acceptable product processing, the interaction chamber may still be used.

5.2 Unplugging The Chamber(s)

If the interaction chamber becomes plugged, it may be cleared by reversing the fluid flow as follows:

1. Disconnect the inlet gland from the nipple before the interaction chamber.
2. If the unit is equipped with an auxiliary processing module, disconnect it at the outlet gland.
3. Turn the interaction chamber and auxiliary processing module, so that the flow goes through the auxiliary processing module first.
 - a. Rotate the IXC and APM so that product flow travels through each component opposite than what the arrow indicates.
4. Run the unit at maximum process pressure if necessary until the interaction chamber is unplugged. If the chambers do not unplug when back flushed as a set, try back flushing them individually. For a stubborn plug, sonicating the chambers in a solvent bath may help clear the blockage. If you are unable to clear the chamber(s) contact the Technical Service Department at 800 370-5452.
5. Reverse steps 1 through 4 to return the unit back to normal operation.



! CAUTION: Abrasive materials should not be run through the Microfluidizer™ processor unless the unit was specifically designed for such an application.

5.3 Maintaining Connections & Fittings

All high pressure connections on the Microfluidizer™ processor are coned and threaded connections. DO NOT use TFE tape on the fittings. These connections provide a metal to metal seal with the gland providing the sealing force. The threads on the collar and piping are left hand threads. Turn the collar counter clockwise until there are approximately 2-3 threads exposed. When assembling, tighten glands finger tight, then, with a wrench, tighten to recommend torque. For required torque, see Coned and Threaded Connections Drawing.

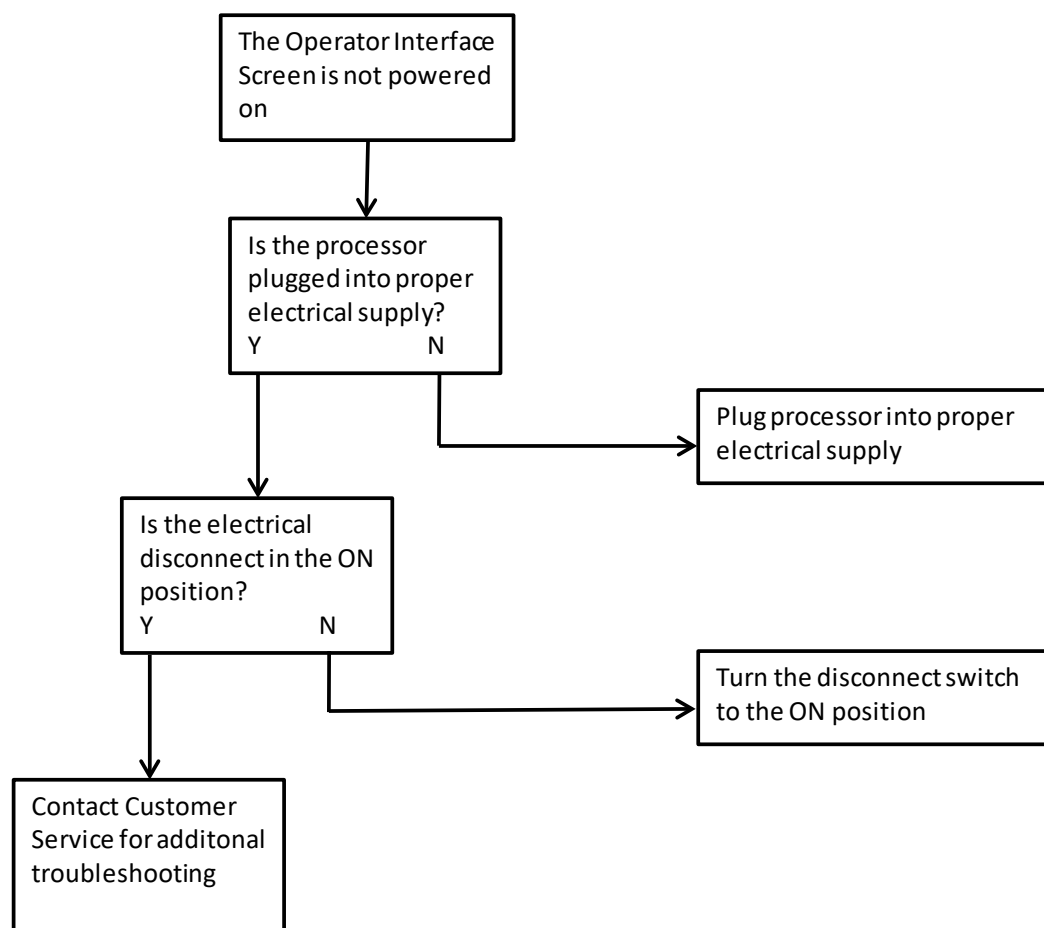


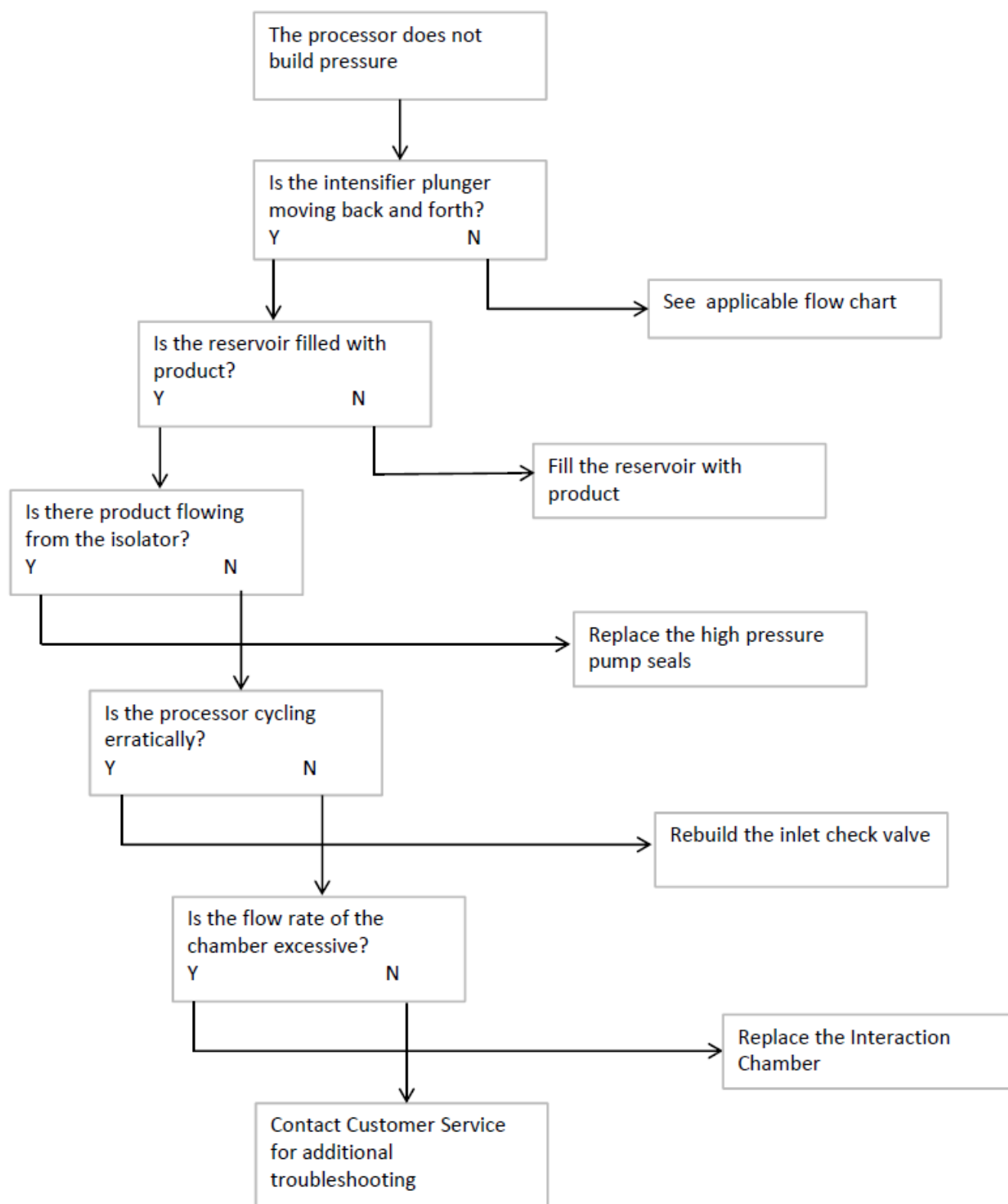
! CAUTION: Do not over tighten these fittings as excessive torque will deform the metal to metal sealing surface. Damage to the sealing surfaces of the tubing or the fitting seat will result in leakage through the weep hole in the fitting.

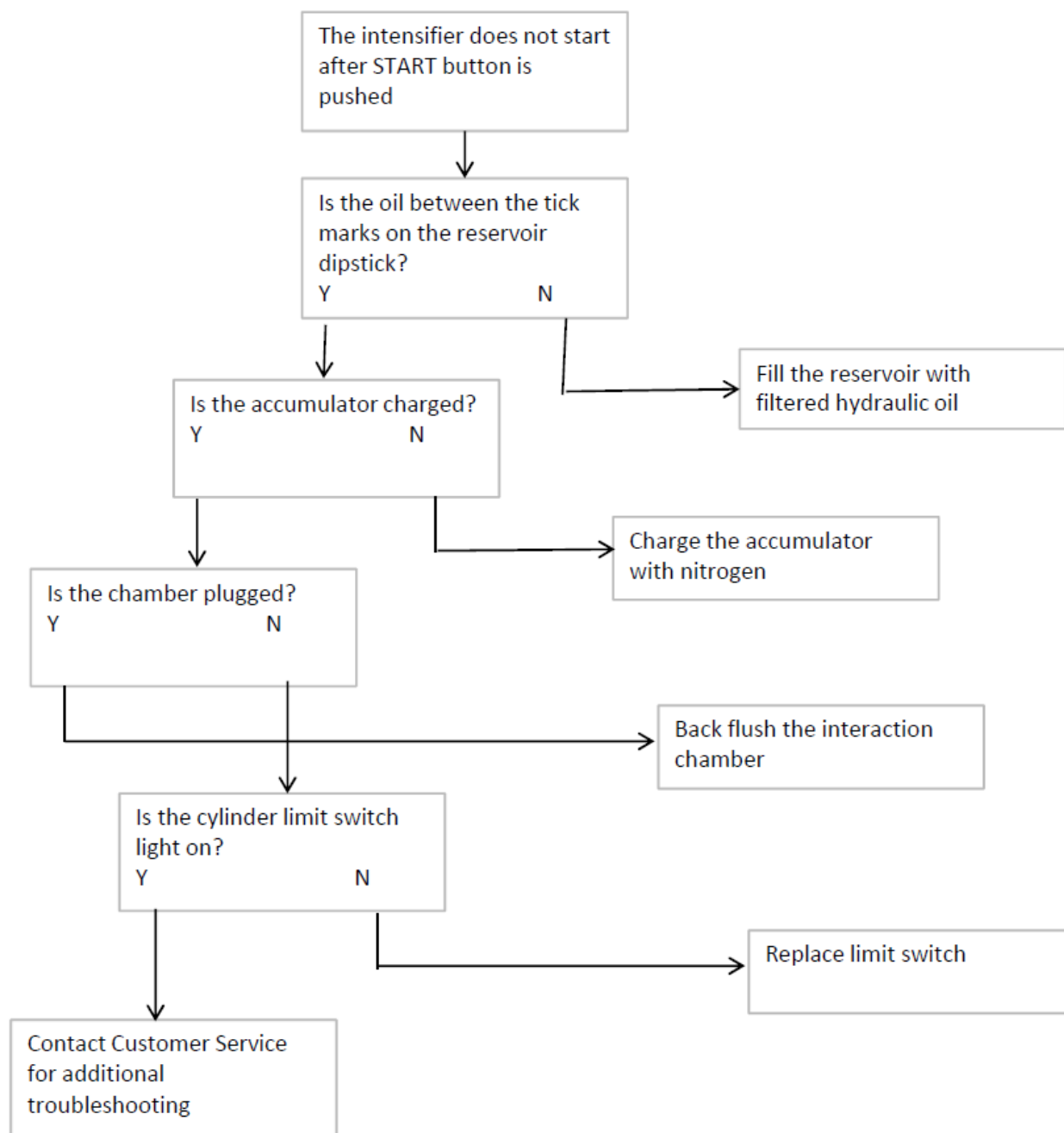
5.4 Symptom and Remedy Table

Symptom	Possible Cause	Remedy
High pressure connections leak	Gland not tight	Tighten gland to recommended torque. Refer to drawing for correct torque value
	Collar not properly installed on nipple	Thread the collar onto the nipple until 2-3 threads are exposed at the end of the nipple cone.
	Deformed nipple or mating surface	Inspect for damage and replace as necessary.
Process pressure increases but no product flows	Plugged Interaction Chamber	Follow instructions in manual to back flush chamber.
	Downstream piping is obstructed	Check piping downstream of processor to ensure no line restrictions exist.
Hydraulics makes a loud noise, whistle	Plugged Interaction Chamber	Follow instructions in manual to back flush chamber.
Product leaking from isolator	High pressure seal damaged	Replace high pressure seals
	Chemical incompatibility	Check product compatibility to materials in contact
	Improper installation of seal	Install new seals correctly, follow directions listed in this manual.
	Damaged plunger	Remove and inspect plunger. If damage is found, replace plunger.
Processor runs faster than normal	Feed reservoir empty	Fill product reservoir
	System not primed	Follow instructions in manual to prime system.
	Leaks in system	See relevant symptom remedy.
Processor does not make process pressure	No oil in oil reservoir	Fill hydraulic reservoir with recommended oil.
	Leaks in system	See relevant symptom remedy.
	No process pressure input	Input desired process pressure on operator interface screen
	Worn chamber	Measure chamber flow rate, compare to initial chamber flow. If flow increased >20%, replace chamber.
	Inlet check valve not seating	Rebuild inlet check valve
	Hydraulic oil is overheated	Check oil temperature. If temperature is >60°C (140°F) stop use and allow oil to cool to 40°C (104°F) or less
Processor does not power on	Unit not plugged into power	Connect recommended electrical utilities
	Electrical disconnect is off	Turn on electrical disconnect switch on side of processor
	Fuse/circuit breaker is blown	Replace fuse/reset circuit breaker. Investigate and remedy why fuse/breaker blew
Processor will not prime	Air in feed system	Remove air from feed system and reprime
	Inlet check valve not seating	Rebuild inlet check valve
	Product too viscous or volatile	Feed pressure is required, consult customer support for additional information

5.5 Fault Tree







5.6 Error Codes

Movement Fault - Machine has built pressure (based on switch) and Intensifier Cycle is running, but Position Limit Switch has not been on for more than the user changeable amount of time.

Low Hydraulic Pressure Fault - Intensifier Cycle is running and the machine has not built pressure in user changeable amount of time (Pressure Switch Input has not turned on).

Motor Starter Overload Fault - The Motor Starter Protector in the panel is either in the off or tripped position (motor won't run).

Emergency Stop - E-Stop Relay in not reset. The input to the PLC is thru a NC contact on the E-Stop relay.

Service Equipment, call MFIC - If the Stroke Alarm counter reaches 10000 cycles or the Hour meter reaches 500hrs, the alarm activates.

Empty Reservoir Fault - When the Intensifier Cycle is running, if the cylinder extends faster than the user changeable amount of time, the alarm activates.

Appendix A: Tool Kit

The Tool Kit includes all special tools that are needed to service the LM20 Microfluidizer™. For a complete bill of material consult the turn over documentation CD.

Tool Kit Part Number: 90.10082

Notes:

Appendix B: Options / Spare Parts

This Microfluidizer™ also includes a basic set of spare parts. For a complete bill of material for the basic spare parts consult the turn over documentation CD.

Any additional options that were purchased will be included in the turn over documentation CD.

Spare Parts Part Number: 90.10083

Notes:

Appendix C: Drawings

The turn over documentation CD/USB that is included with the LM20 Microfluidizer™ contains all the necessary drawings.

Notes:

Appendix D: Fluid Compatibility Tables

The following table is compiled primarily from data published by several manufacturers of elastomers and plastics. The ratings are intended only as a guide. In fact, different sources do not always agree, so it is best to test before committing to a particular compound. In general, most chemical attack on elastomers and plastics is in the form of swelling and softening. The function of the individual part determines how much swelling and softening can be tolerated. In addition, some materials are resistant to certain fluids at room temperature, but will be attacked at an elevated temperature. Duration of exposure is also a factor; again, it is best to test.

A considerable body of data exists beyond what is presented here. If the fluids you are concerned with do not appear in this list, please contact MFIC for our best assessment of probable compatibility.

D.1 The Elastomers

Nitrile:

Otherwise known as Buna N or NBR. This is one of the most common synthetic rubber materials. Nitrile is normally used in the air motor of the MicrofluidizerTM equipment, though it can certainly be used in fluid contact as well.

EPDM:

Also called EPR or Ethylene Propylene Rubber. A specialty elastomer with excellent resistance to ketones and most alcohols, but EPR is seriously attacked by petroleum oils, so the user must be careful about lubricating this compound. Toughness and temperature resistance are very good.

Fluoroelastomer: (Trade name, Viton)

Also called FKM, this a premium elastomer with a broad range of chemical compatibility. Excellent in oil services, but poor in ketones and some alcohols. Colored brown for easy identification. This is our commonly used elastomer for fluid contact services.

Neoprene:

Otherwise known as Chloroprene or CR, this is one of the earliest known types of synthetic rubber. Useful in applications such as ammonia and Freon.

D.2 The Plastics

UHMWPE:

Ultra high molecular weight polyethylene, an extremely tough, wear-resistant thermoplastic with good chemical resistance and moderate temperature resistance. Used for seals and gaskets.

PEEK:

Polyetheretherketone, one of the new high-strength engineering plastics. Has excellent chemical resistance and structural properties. Very high temperature capability. Used for bearings, gaskets, and back-up rings.

PTFE: (Trade name, Teflon)

Has broadest chemical resistance of all plastic materials and outstanding temperature capability. Limited strength and poor shape retention make PTFE a poor choice for sealing and load bearing applications unless combined with other fillers such as glass fibers, carbon graphite, or molybdenum disulfide.

D.3 Table of Compatibility

Fluid	Nitrile	EPDM	Neoprene	Fluoroelastomer	UHMWPE	PEEK	PTFE
Acetaldehyde	U	R	U	U	X	L	R
Acetamide	R	R	R	U	X	—	R
Acetic Acid	M	R	R	U	R	R	R
Acetone	U	R	M	U	R	R	R
Acetophenone	U	R	U	U	X	L	R
Acetylene	R	R	R	R	L	R	R
Acrylonitrile	U	U	U	U	X	R	R
Ammonia	R	R	R	U	R	R	R
Ammonium Hydroxide	R	R	R	R	L	R	R
Amyl Acetate	U	M	U	U	R	L	R
Anderol L-774	M	U	U	R	L	L	-
Antifreeze	R	R	R	R	R	R	R
Aniline	U	R	U	M	R	R	R
Ansul Ether	M	M	U	U	X	L	L
Aroclors	M	R	U	R	X	L	L
Askarel	R	U	U	R	X	L	R
Asphalt	M	U	M	R	L	R	R
ASTM #1	R	U	R	R	L	L	R
ASTM #3	R	U	R	R	L	L	R
ASTM Fuel A	R	U	R	R	L	L	R
ASTM Fuel B	R	U	U	R	L	L	R
ASTM Fuel C	R	U	U	R	L	L	R
ASTM Fuel D	M	U	U	R	L	L	R
Auto Transmission Fluid	R	U	M	R	L	L	R
Beer	R	R	R	R	R	R	R
Benzaldehyde	U	R	U	U	R	R	R
Benzene	U	U	U	R	M	R	R
Benzoic Acid	U	U	U	R	X	R	R
Benzophenone	U	R	X	R	X	X	R
Benzyl Alcohol	U	R	R	R	R	X	R
Bleach	R	R	R	R	R	L	R
Borax	R	R	U	R	L	L	R
Boric Acid	R	R	R	R	L	L	R
Brake Fluid							
(non-petroleum)	U	R	R	U	R	R	R
Bromine	U	U	U	R	X	X	R
Bromobenzene	U	U	U	R	X	L	R

R = Recommended, M = Marginal, U = Unsatisfactory, X = Insufficient Data, L = Likely to be Compatible

Fluid	Nitrile	EPDM	Neoprene	Fluoroelastomer	UHMWPE	PEEK	PTFE
Bunker Oil	R	U	U	R	R	R	R
ButaneR	U	R	R	L	L	R	
Butter	R	M	R	R	R	R	R
Butyl Acetate	U	U	U	U	R	L	R
Butyl Alcohol	R	R	R	R	R	L	R
Butyl Amine	M	U	U	U	X	X	R
Butyl Carbitol	U	R	M	M	X	X	R
Butyl Cellosolve	M	R	M	U	X	X	R
Butyl Ether	U	U	U	U	L	R	R
Butraldehyde	U	R	U	U	X	X	L
Carbitol	R	R	R	R	X	X	L
Carbitol Acetate	U	U	U	R	X	X	L
Carbon Disulfide	U	U	U	R	M	X	R
Carbon Tetrachloride	R	U	U	R	U	R	R
Carbonic Acid	R	R	R	R	L	R	R
Castor Oil	R	R	R	R	R	R	R
Cellosolve	U	U	U	U	X	L	R
Chassis Grease	R	U	M	R	R	R	R
Chloroacetic Acid	U	R	U	U	L	L	R
Chloroacetone	U	R	M	R	L	L	R
Chlordane	R	U	M	R	L	L	R
Chlorine	U	R	U	R	M	X	R
Chlorobenzol	U	U	U	R	X	X	L
Chloroform	U	U	U	R	M	L	R
Chlorosulfonic Acid	U	U	U	U	X	R	L
Chrome Plating Solution	U	R	U	R	L	L	R
Chromic Acid	U	X	U	R	R	R	R
Citric Acid	R	R	R	R	R	R	R
Cod Liver Oil	R	U	R	R	R	R	R
Coffee	R	R	R	R	R	R	R
Corn Oil	R	U	U	R	R	R	R
Creosote	R	U	R	R	R	R	R
Creosote Oil	R	U	M	R	R	R	R
Crude Oil	R	U	U	R	R	R	R
Cyclohexane	R	U	M	R	R	L	R
Cyclohexanol	R	U	R	R	R	L	R
Decalin	U	U	U	R	R	L	R
Decane	R	U	U	R	L	R	R

Fluid	Nitrile	EPDM	Neoprene	Fluoroelastomer	UHMWPE	PEEK	PTFE
Denatured Alcohol	R	R	R	U	R	R	R
Diacetone	U	R	U	U	X	X	R
Dibutylamine	U	U	M	U	X	X	R
Dibutyl Phthalate	U	R	U	M	R	X	R
Dichloroaniline	U	U	U	M	X	X	R
Dichloro Butane	R	U	U	R	L	L	R
Diesel Oil	R	U	M	R	R	R	R
Diethylamine	R	R	R	U	L	L	R
Diethyl Benzene	M	U	U	R	X	X	R
Diethylene Glycol	R	R	R	R	R	L	R
Dimethyl Ether	U	U	M	U	X	X	R
Dimethyl Formamide	U	R	X	U	R	R	R
Dimethyl Terephthalate	U	U	U	R	X	L	R
Diocetyl Phthalate	U	R	U	R	X	L	R
Dioxane	U	R	U	R	X	X	R
Diphenyl	U	U	U	R	X	X	R
Dow Corning 550	R	R	R	R	L	L	R
Dow Guard	R	R	R	R	L	L	R
Dowtherm A & E	U	U	U	R	R	R	R
Elco 28	R	U	M	R	X	X	L
Epoxy Resins	X	R	R	U	R	R	R
Ethane	R	U	R	R	L	L	R
Ethanol	R	R	R	U	R	R	R
Ethanolamine	R	R	R	U	X	X	R
Ethyl Acetate	U	R	U	U	R	R	R
Ethyl Acrylate	U	R	U	U	L	L	R
Ethyl Benzene	U	U	U	R	X	X	R
Ethyl Cellulose	R	R	R	U	L	L	R
Ethyl Chloride	R	R	R	R	X	X	R
Ethyl Ether	M	M	U	U	R	X	R
Ethyl Formate	U	R	R	R	X	X	R
Ethylene Glycol	R	R	R	R	R	R	R
Ethyl Hexanol	M	R	R	R	X	X	L
Ethyl Mercaptan	U	X	M	R	X	X	L
Ethylene Chloride	U	U	U	R	M	X	R
Ethylene Oxide	U	R	U	U	X	X	R
Ferric Chloride	R	R	M	R	L	L	R
Formaldehyde	M	R	M	U	X	X	R

Fluid	Nitrile	EPDM	Neoprene	Fluoroelastomer	UHMWPE	PEEK	PTFE
Formic Acid	M	R	R	U	R	M	R
Freon 11	R	U	M	M	L	L	R
Freon 22	U	M	R	U	L	L	R
Freon 12	M	M	R	M	L	L	R
Fuel Oil	R	U	R	R	R	R	R
Furan	U	X	U	X	L	L	L
Furfural	U	R	U	U	R	X	R
Furfuryl Alcohol	U	R	U	X	X	X	R
Gallic Acid	R	R	R	R	X	X	R
Gasoline	R	U	U	R	M	R	R
Gelatin	R	R	R	R	R	R	R
Glucose	R	R	R	R	R	R	R
Glycerine	R	R	R	R	R	R	R
Heptane	R	U	R	R	R	R	R
Hexaldehyde	U	R	R	U	X	X	R
Hexane	R	U	R	R	R	X	R
Hexanol	R	M	R	R	X	X	R
Home Heating Oil	R	U	M	R	R	R	R
Hydrazine	R	R	R	X	X	X	R
Hydrochloric Acid	R	R	R	R	R	R	R
Hydrocyanic Acid	R	R	R	R	R	X	L
Hydrogen Peroxide	R	R	R	R	R	R	R
Hydrogen Sulfide	U	R	R	U	X	R	R
Hydroquinone	M	U	U	R	X	X	R
Hypoid Gear Lube	R	U	M	R	R	R	R
Iodine	R	R	U	R	R	L	R
Isocyanate	X	X	X	R	X	X	R
Iso Octane	R	U	R	R	R	L	R
Isopar	R	U	R	R	R	R	R
Isopropanol	R	R	R	R	R	R	R
Isopropyl Acetate	U	R	U	U	X	X	R
JP-4 (MIL-J-5624)	R	U	U	R	R	R	R
JP-5 (MIL-J-5624)	R	U	U	R	R	R	R
Kerosene	R	U	R	R	R	R	R
Lactic Acid	R	R	R	R	R	L	R
Lacquers	U	U	U	U	L	L	R
Lard	R	R	R	R	R	R	R
Linoleic Acid	R	U	R	R	X	X	R

Fluid	Nitrile	EPDM	Neoprene	Fluoroelastomer	UHMWPE	PEEK	PTFE
Linseed Oil	R	M	M	R	R	R	R
Lye Solutions	R	R	R	R	R	L	R
Malathion	R	U	X	R	L	L	R
Maleic Acid	U	U	U	R	R	L	R
Mercury	R	R	R	R	R	L	R
Methane	R	U	R	R	L	L	R
Methanol	R	R	R	U	R	R	R
Methyl Acetate	U	R	R	U	L	L	R
Methacrylic Acid	U	R	R	M	X	X	R
Methyl Cellosolve	M	R	M	U	X	X	R
Methylene Chloride	U	U	U	R	M	X	R
Methyl Ethyl Ketone	U	R	U	U	X	R	R
Methyl Mercaptan	X	R	X	X	X	X	R
Milk	R	R	R	R	R	R	R
Mineral Oil	R	U	R	R	R	R	R
Mineral Spirits	R	U	U	R	R	R	R
Monovinyl Acetylene	R	R	R	R	X	X	R
Mustard	X	R	X	R	R	R	R
Naphtha	R	U	U	R	L	R	R
Naphthalene	U	U	U	R	R	R	R
Naphthenic Acid	R	U	U	R	X	X	R
Natural Gas	R	U	R	R	R	R	R
Neatsfoot Oil	R	M	U	R	R	R	R
Nitric Acid	U	M	U	M	M	M	R
Nitrobenzene	U	R	U	M	R	R	R
Nitropropane	U	R	U	U	R	R	R
Octane	R	U	U	R	R	R	R
Octanol	R	R	R	R	X	X	R
Oleic Acid	M	U	M	R	R	R	R
Oleum	R	U	M	R	U	X	R
Oxalic Acid	M	R	M	R	R	R	R
Peanut Oil	R	M	M	R	R	R	R
Pentane	R	U	R	R	L	L	R
Perchloroethylene	R	U	U	R	X	X	R
Petrolatum	R	U	R	R	R	R	R
Petroleum Ether	U	U	U	R	R	X	R
Phenol	U	U	U	R	R	R	R
Phenylthydrazine	U	U	U	R	X	X	R

Fluid	Nitrile	EPDM	Neoprene	Fluoroelastomer	UHMWPE	PEEK	PTFE
Phosphoric Acid	R	R	R	R	R	R	R
Pine Oil	R	U	U	R	U	R	R
Potassium Hydroxide	R,	R	R	U	R	R	R
Propane	R	U	R	R	R	R	R
Propanol	R	R	R	R	L	L	R
Propyl Acetate	U	R	U	U	L	L	R
Pyranol	R	U	R	R	L	L	R
Pyridine	U	U	U	U	R	L	R
Rapeseed Oil	R	R	R	R	R	R	R
Resorcinol	X	R	X	X	L	L	R
SAE10W30	R	U	M	R	R	R	R
Seawater	R	R	R	X	R	R	R
Silicone Oils	R	R	R	R	R	R	R
Silver Nitrate	R	R	R	R	R	R	R
Skydrol	U	R	U	M	L	L	R
Sodium Hydroxide	R	R	R	R	R	R	R
Sodium Hypochlorite	M	R	M	R	R	R	R
Sodium Peroxide	M	R	M	R	L	L	R
Soy Bean Oil	R	M	M	R	R	R	R
Stearic Acid	R	R	R	X	R	L	R
Stoddard Solvent	R	U	R	R	X	X	R
Styrene Monomer	U	U	R	U	R	R	R
Sucrose	R	R	R	R	R	R	R
Sulfuric Acid	R	R	R	R	R	M	R
Tall Oil	R	U	M	R	L	L	R
Tannic Acid	R	R	R	R	L	L	R
Tar	R	U	M	R	R	R	R
Tartaric Acid	R	R	R	R	X	X	R
Tetrachloroethane	U	U	U	R	X	X	L
Tetrachloroethylene	U	U	U	R	M	R	R
Tetraline	U	U	U	R	R	X	R
Toluene	U	U	U	R	M	R	R
Trichloroethylene	M	U	U	R	M	R	R
Triethanolamine	M	R	R	U	R	L	R
Turbine Oil	R	U	U	R	R	R	R
Turpentine	R	U	U	R	R	R	R

Fluid	Nitrile	EPDM	Neoprene	Fluoroelastomer	UHMWPE	PEEK	PTFE
Varnish	R	U	U	R	R	R	R
Vinegar	R	R	R	R	R	R	R
Vinyl Chloride	U	U	X	R	R	R	R
Water	R	R	R	R	R	R	R
Wheat Germ Oil	R	U	M	R	R	R	R
Whiskey & Wine	R	R	R	R	R	R	R
Wood Oil	R	U	R	R	L	L	R
Xylene	U	U	U	R	M	R	R

Appendix E: CE Information

This equipment is manufactured exclusively for Microfluidics by:
Quadro Engineering
613 Colby Drive
Waterloo, ON
N2V 1A1, Canada

See CE Certificate in attached Turn Over Documentation

Appendix F: Maintenance Schedule

To maintain the good performance, Microfluidics International Corporation recommends establishing a routine maintenance schedule, typically done annually, but we do have customers with heavy-daily usage, who schedule bi-annual preventive maintenance proposals or possibly more. Some of the benefits of having Preventive Maintenance done of your machine are:

- Extends the life of the system
- Maintains optimal performance and efficiency of your system
- Reduces / Eliminates downtime
- Reduces cost associated with unplanned repairs

The Recommended Service Intervals for the LM20 are in the table below. Note: these are subject to change based on usage, product processed, environment, and other conditions.

Interval	Recommended Service
First 50 Hours	Change Oil Clean Suction Strainer
Every 500 Hours/12 Months	Replace Oil Rebuild Inlet Check Valve Replace High Pressure Seals Replace Directional Valve O-Rings Verify Electrical Connections Verify Motor Current Draw Verify Hydraulic Connections Check Accumulator Charge
Every 1000 Hours/2 Years	Clean Suction Strainer Inspect Oil Breather Cap

Call the Microfluidics Service Department to schedule a maintenance program.
1-617-969-5452 or 1-800-370-5452.