KrosFlo® LDF-37 TFF SYSTEM

*Permeate control pump optional; computer not included

KrosFlo® LDF-37 TFF System

Product Information and Operating Instructions

Spectrum's KrosFlo® LDF-37 TFF System meets strict quality control standards and is warranted against defects in material and workmanship for a period of one (1) year from date of purchase.

The information contained herein is believed to be accurate and is offered in good faith for the convenience of the user. PRODUCTS ARE FURNISHED UPON THE CONDITION THAT THE USER ASSUMES ALL RISKS AND LIABILITIES AND THAT NEITHER THE SELLER NOR MANUFACTURER SHALL BE LIABLE FOR ANY LOSS OR DAMAGE, DIRECT OR CONSEQUENTIAL, ARISING FROM THE USE OF THESE PRODUCTS.

KrosFlo® LDF-37 TFF SYSTEM

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Introduction

Spectrum's KrosFlo LDF-37 TFF System is ideal for the control & optimization of disposable bio-separation processes ranging from 10 to 1000 liters of permeate from either MF or UF tangential flow filtration. This "all-in-one" process system combines a digitally controlled 37 LPM capacity peristaltic pump, a pressure monitor w/ 5 user-defined alarms and auto shut-off control and real-time data collection software into a single and efficient filtration system. Spectrum's KFComm is an Excel based software that records & graphs inlet, outlet, permeate and TMP pressures as well as recirculation & permeate flow rates.

Integrate sterile or non-sterile hollow filter assemblies with the LDF-37 TFF System can be completed with KrosFlo® hollow fiber modules and KrosFlo® MBTs (Module-Bag-Tubing) to create a completely disposable filtration system. The function, set-up and use of the major components will be described in the following sections of this manual. We hope you appreciate and enjoy using Spectrum's System and look forward to providing you complete TFF processing solutions during the scale-up of your process.

KrosFlo® LDF-37 TFF System Components

- Peristaltic Pump up to 37 LPM, reversible
- Digital Controller with Feed Flow Rate display in L/min
- Wash Down 0.5 HP Motor
- Racking Unit / Clamps for KrosFlo and KrosFlo Max modules
- Automatic Retentate backpressure valve (can be run manually also)
- Secondary pump (permeate control or buffer addition) with one Easy Load 2 pump head (up to 3.3 LPM)
- Mobile Unit with 2 swivel, locking casters and 2 fixed (cleanroom compatible)
- 304 SS Frame with built in laptop stand
- Digital Pressure Monitor & Data Transfer RS232 port
- RS232 Extension Cable for connection to PC
- Digital Pressure Transducers (ACPM-799-01N – 3ea) - sold separately
- Power Cables
- KF Comm Software CD
- Manual
- IQ/OQ package - sold separately

Section I. KrosFlo® LDF-37 System

A. KrosFlo® LDF-37 Pump

B. KrosFlo® LDF-37 Filter Stand

Section I.A – KrosFlo LDF-37 Pump

1. Safety Precautions

DANGER:  **High voltages exist and are accessible in the KrosFlo® LDF-37 TFF System. Use extreme caution when servicing internal components.**

WARNINGS:  **Tubing breakage may result in fluid being sprayed from pump. Use appropriate measures to protect operator and equipment.**

Turn drive off before removing or installing tubing. Fingers or loose clothing may get caught in drive mechanism.

CAUTION:  **Power must be turned off before connecting the external remote control cable to prevent damage to the drive.**

CAUTION:  **To avoid electrical shock, the power cord protective grounding conductor must be connected to ground. Not for operation in wet locations as defined by EN 61010-1.**

CAUTION:  **Risk of crushing. Keep fingers away from rotor while pump is in operation. Stop pump before loading or unloading tubing.**

Explanation of Symbols

CAUTION:  **Risk of Danger. Consult Operating Instructions for nature of hazard and corrective actions.**

CAUTION:  **Risk of electric shock. Consult Operating Instructions for nature of hazard and corrective actions.**

WARNING: PRODUCT USE LIMITATION

This product is not designed for, nor intended for use in patient connected applications; including, but not limited to, medical and dental use, and accordingly has not been submitted for FDA approval.

2. Specifications

Output:	
Speed:	12 to 321 rpm
Torque Output, Maximum:	1440 oz-in (104 kg•cm)
Speed Regulation:	Line ±0.25% F.S.
Load	±0.25% F.S.
Drift	±0.25% F.S.
Display:	Four-digit, seven-segment LED
Input:	
Voltage (110 V)	90 to 130 Vrms @ 50/60 Hz
Voltage (220 V)	200 to 260 Vrms @ 50 Hz
Current, Max (110 V)	6.5A
Current, Max (220 V)	3.3A
Construction:	
Drive Dimensions (L x W x H)	28.25” x 15.88” x 15.13” (718 mm x 403 mm x 384 mm)
Controller Dims. (L x W x H)	9” x 11” x 4.5” (229mm x 279mm x 114mm)
Weight:	89 lb (40.37 kg)
Enclosure Rating:	IP 56 per IEC 60529/NEMA 4 (Indoor Use)
Tubing Compatibility	BT 87 or 91
Flow Range	up to 10 GPM (37.85 LPM)
Environment:	
Temperature, Operating:	0° to 40° C (32° to 104° F)
Temperature, Storage:	–45° to 65° C (–49° to 149° F)
Humidity (non-condensing):	10% to 90%
Altitude:	2000 m or less
Pollution Degree:	Pollution Degree 3 (Indoor use – sheltered locations)
Chemical Resistance:	Exposed material is painted aluminum, plastic and vinyl
Compliance:	110 V: UL508C, UL 778 CSA C22.2, No. 14, No.108
	220 V (For CE Mark):
	EN61010-1 (EU Low Voltage Directive) and
	EN61326 (EU EMC Directive)
	EN809 (EU Machinery Directive)

3. Description

The KrosFlo® LDF-37 Peristaltic Pump provides flow rates from 0.67 to 17 LPM for 0.5" ID tubing (#87) and 1.4 to 37 LPM for 0.75" ID tubing (#91). The pump is mounted on a base and attached to a NEMA 56C frame motor through a 5.45:1 gear head and adaptor (see Figure 1). The maximum rotor speed is 321 rpm. The pump rotor

FIGURE 1

The maximum rotor speed is 321 rpm. The pump rotor can turn either clockwise or counterclockwise. When turning clockwise (FWD) the top connection is for suction and the bottom is for discharge.

WARNING: ⚠ **To reduce the risk of injury, use hose clamps on all tubing connections.**

Silicone or C-FLEX® tubing, because of their highly elastic natures, can expand very quickly if back-pressure is present and could create leakage at the fittings if not securely retained. It is this same elastic nature, however, that makes them such excellent materials for this peristaltic type pump. Other tubing types including PHARMAPURE® yield longer life, especially under pressure. Do not attempt to use other tubing sizes in lieu of these, as pump performance could be severely compromised with possible damage to the pump.

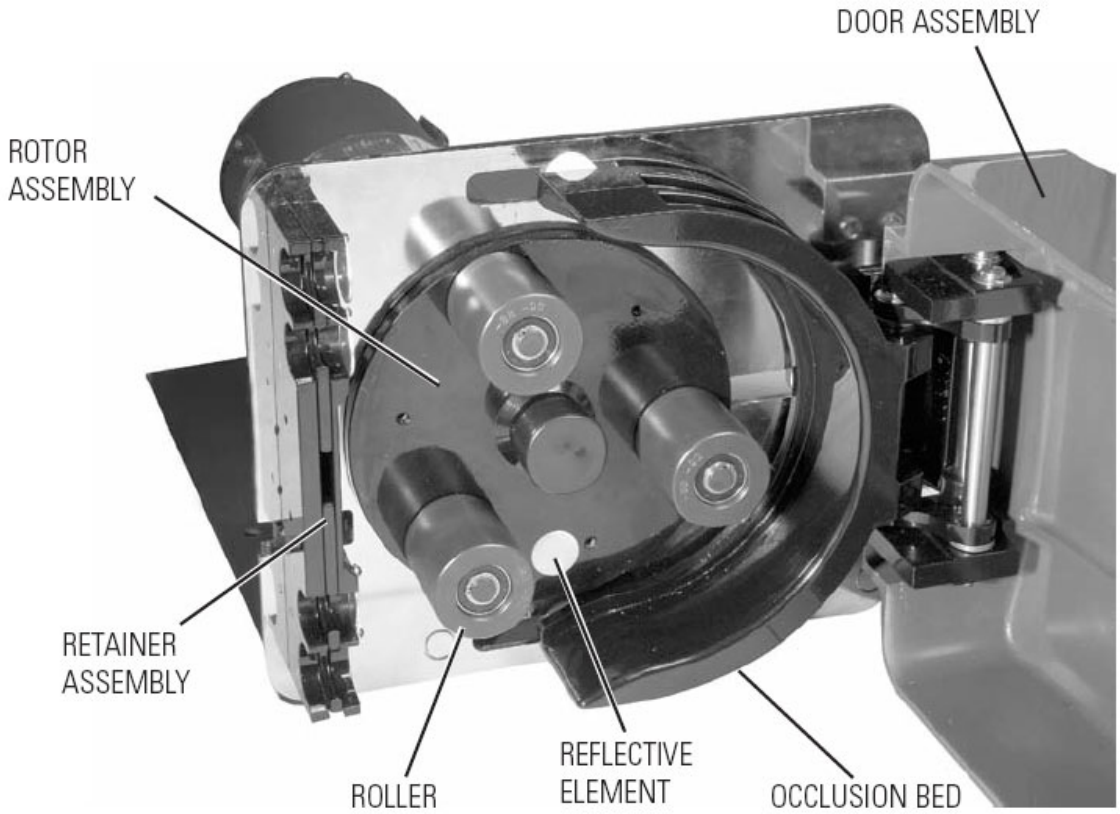


FIGURE 2 – INTERNAL COMPONENTS

4. Setup

4.1. Tubing

These pumps are designed to use Masterflex® *PerfectPosition* B/T tubing sizes #87 and #91. The tubing sizes refer to the last two digits of the MasterFlex® *PerfectPosition* B/T tubing model number. Use of other tubing may void applicable warranties.

Table 1. Tubing Types

	Tubing Size	
Characteristics	**B/T 87**	**B/T 91**
Inside Dia. in (mm)	0.5 (12.7)	0.75 (19.05)
Hose barb size in (mm)	1/2″ (12.7)	3/4″ (19.0)
Flow Range (with 321 rpm drive)	0.17-5.0 GPM (0.010-18.9 L/m)	0.37-10 GPM (1.40-37.85 L/m)
Nominal Flow Per Revolution	70.46 mL	141 mL
Maximum Vacuum	28.5 in Hg	28.5 in Hg
Maximum Pressure	35 PSI	30 PSI

4.2. Installing the Pump Tubing

WARNING: ⚠ **Power must be removed from pump before removing or installing tubing. Fingers or loose clothing could get caught in the drive mechanism. Do not operate this pump without cover or interlock door properly closed and latched. Rotating parts can cause serious injury.**

1. Cut off power to the pump by disconnecting line cord or, if wired permanently, by removing the fuse. Do not assume that turning off the switch at the motor (or controller) is "safe enough."

2. Unlatch the door latch and open the cover.

3. Insert the tube in the appropriate upper tube retaining pocket (see Figure 5). Line up the "*PERFECTPOSITION*" placement marks printed on the tube with the outside edge of the retainer assembly (see Figure 3).

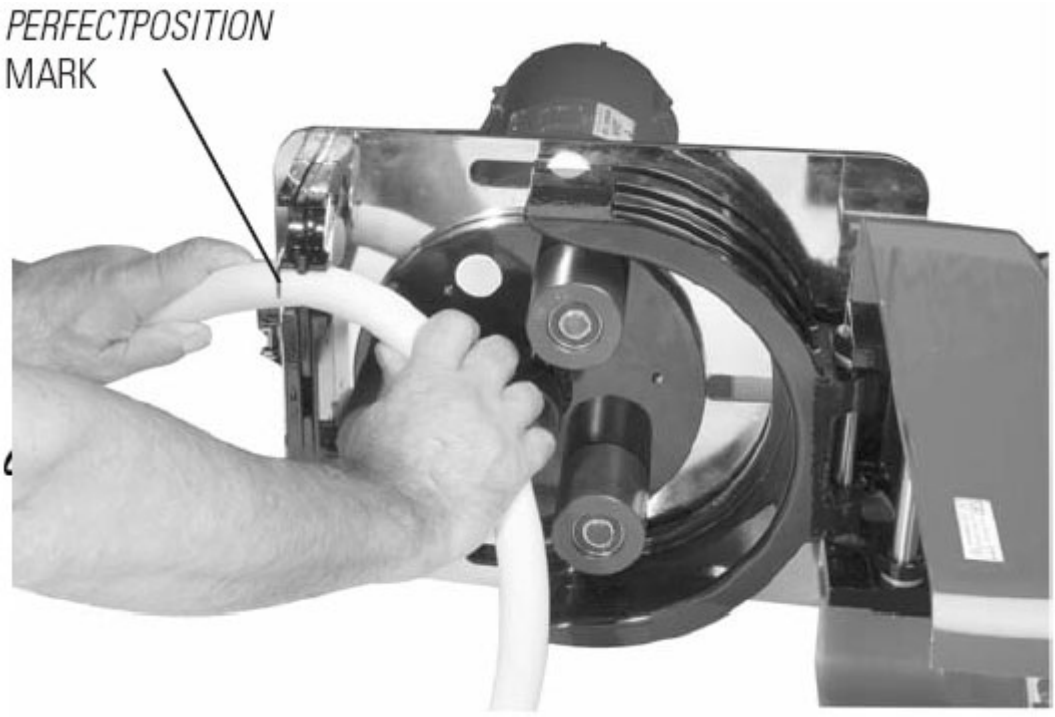


FIGURE 3 – TUBING RETAINING POCKETS

4. If the new tube must be cut from a length of approved replacement tubing, a minimum of 32 inches will be required for a new tube.

5. Going with the natural lay or curvature of the tubing, wrap the tubing around the rotors and insert the tubing in the lower retaining pocket.

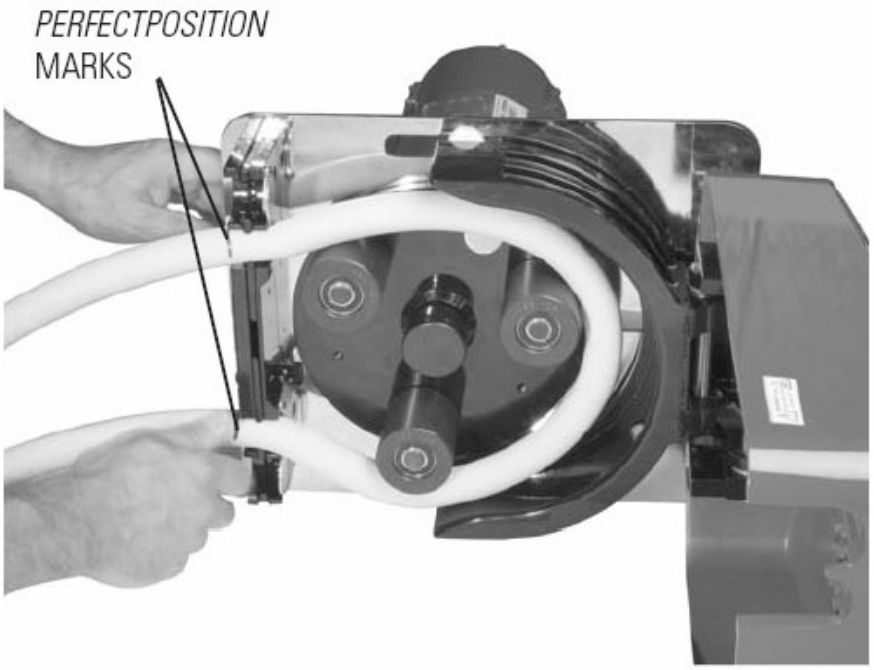


FIGURE 4 – *PERFECTPOSITION* MARKS

6. Close the door and insure that door latch is engaged and locked.

WARNING: ⚠ **Do not operate this pump without cover or interlock door properly closed and latched. Rotating parts can cause serious injury.**

7. Restore power to the pump.

WARNING: ⚠ **To reduce the risk of injury, use hose clamps on all tubing connections. All tubing must be made outside of the pump.**

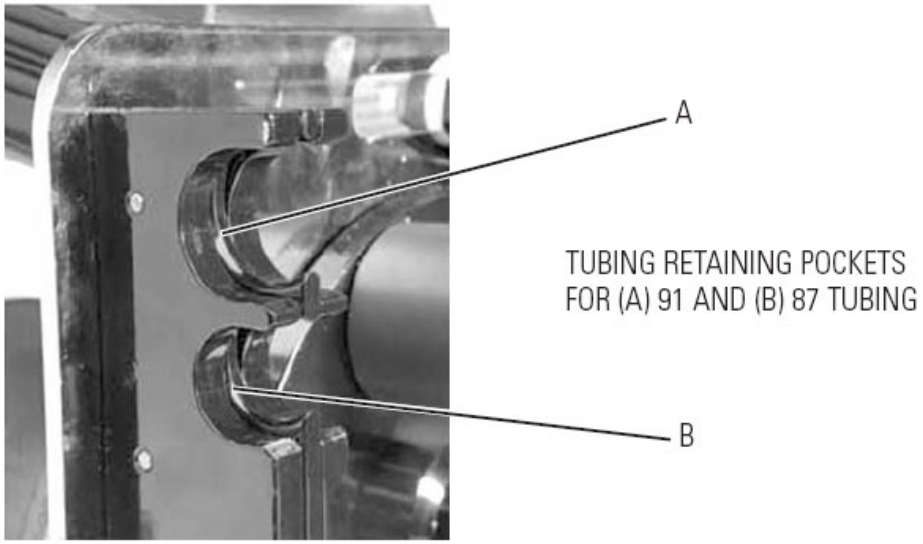
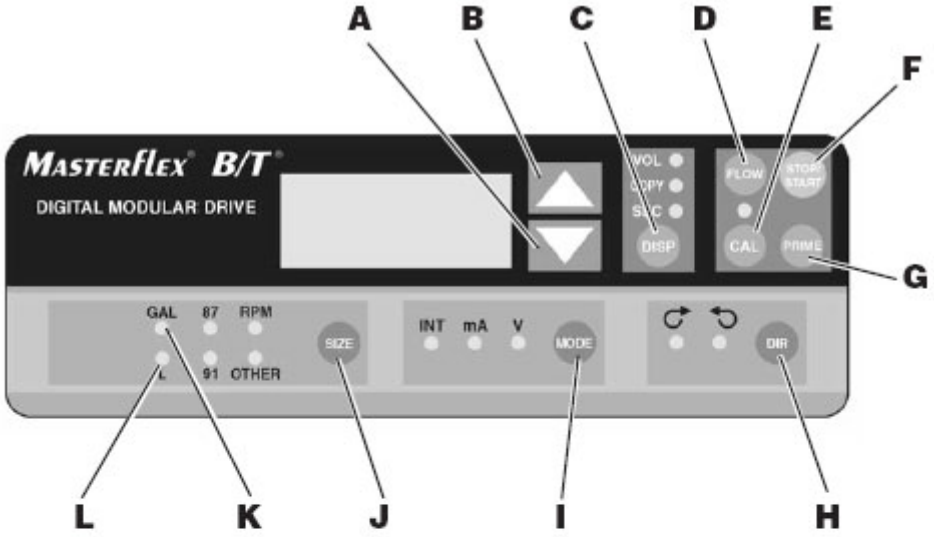


FIGURE 5 – TUBING RETAINING POCKETS

5. Operation

5.1. Pump Control/Display Functions



A) DOWN ARROW (DECREMENT)—Decrease value of a flashing display.

B) UP ARROW (INCREMENT)—Increase value of a flashing display.

C) DISPENSE/COPY—Set dispense volume, copy amount, or dispense time.

D) FLOW CONTROL—Set flow rate for selected tubing size. To change flow rate, press ▲ or ▼ arrows. (If pump is running, its speed will change with new settings.)

E) CAL CONTROL—Refine built-in calibration, using a measured volume.

F) STOP/START—Stop/Start motor.

G) PRIME—Run pump at full speed to fill or clear lines.

H) DIRECTION—To change motor direction.

I) MODE SELECT—INT for internal control; mA for remote current control; V for remote voltage control.

J) SIZE—Select tubing size and flow units, also displays maximum flow rate.

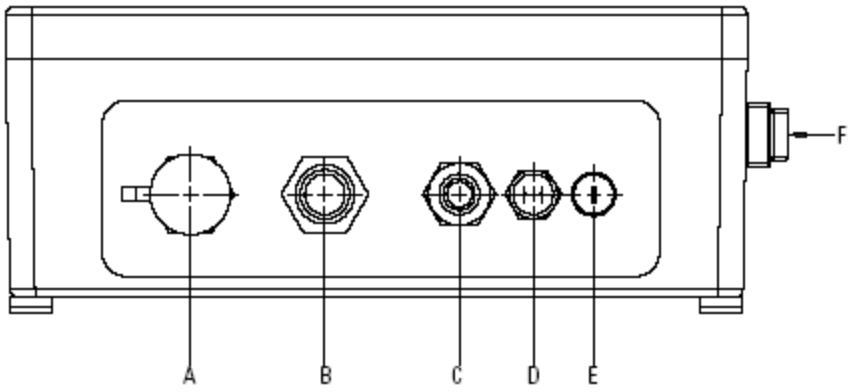
K) GALLONS—Flow and Volume units indicator.

L) LITERS—Flow and volume units indicator.

FIGURE 6 – CONTROL PANEL

1. Press keys to activate function.
2. Use up/down (▲, ▼) arrow keys to correct or change a flashing display.
3. Press STOP/START to enter new values.

5.2. Controller Setup



A) EXTERNAL RECEPTACLE
B) MOTOR RECEPTACLE
C) LINE CORD
D) INTERLOCK CONNECTOR
E) T8A FUSE (115V AC); T4A FUSE (230V AC)
F) POWER SWITCH — ALL SETTINGS ARE RETAINED IN MEMORY

FIGURE 7 – CONNECTORS AND SWITCH ON CONTROLLER SIDE PANEL

1. Connect Motor Cable plug to mating receptacle on the controller.
2. Connect Interlock Cable plug to mating receptacle on the controller.
3. Connect power cord of controller to grounded power line outlet.
4. Turn on controller and select TUBING SIZE.

NOTE: If CAL LED is lit, that tubing size has been previously field calibrated. If LED is not lit, the drive is operating with the built-in factory calibration. To clear a field calibration, press and hold the CAL switch until the CAL light goes out. This will take about 3 seconds. To recalibrate for better accuracy, refer to following Calibration section.

5. MODE selection (INT, mA, V)
6. Select MOTOR DIRECTION (CW or CCW)
7. PRIME and CALibrate the pump (if required).
8. Press Flow Press FLOW key and watch display to set the flow rate with UP/DOWN (▲, ▼) arrow keys.
9. Press START/STOP key to begin pumping.

NOTE: Pump will restart automatically after a brownout or powerout condition.

NOTE: Under some circumstances, tubing may creep into pump. If this problem occurs it can be remedied by installing a hose clamp or fitting immediately upstream of and very close to the inlet port.

6. Calibration

6.1. Standard Tubing

1. Select correct tubing size and flow rate.
2. Press CAL, calibration volume appears.
3. Press START/STOP, the pump will use its stored memory to dispense the specified calibration sample quantity. The pump will stop automatically.
4. Weigh/measure the sample.
5. Use UP/DOWN (▲ , ▼) arrow keys to correct the volume on the flashing display.

NOTE: If the adjusted calibration is too great, "Err" will appear in the display. If this occurs, press the CAL control and repeat the calibration procedure. The microprocessor will retain one special calibration value per tubing size, even when power is turned off. The next calibration will replace the existing value.

6. Press SIZE to exit the calibration cycle.

6.2 Maximum Flow Rate for Other Tubing

1. Press TUBING SELECT to select OTHER.
2. To set the maximum flow rate for non-standard pump heads or tubing sizes, press CAL, then FLOW. The maximum flow rate will then flash on the display.
3. Use UP/DOWN (▲ , ▼) arrow keys to set desired flow rate.
4. Press SIZE to exit.

7. Keypad Lock Enable/Disable

Press and hold FLOW. After five (5) seconds, display will change to all dashes. Then, while holding FLOW, press PRIME five (5) times to enable or disable the keypad lock.

The MODE “INT”: annunciator will flash when the keypad is locked out.

8. Maintenance

8.1 Replacing Motor Brushes

WARNING: ⚠ **Power must be removed from motor before performing this procedure.**

1. Cut off power to the pump by disconnecting the line cord or, if wired permanently, by removing the fuse. Do not assume that turning off the switch at the motor (or controller) is “safe enough”.
2. To access the motor brushes, remove six screws securing the access plate (see Figure 8)
3. Loosen screw terminal at top of brush housing and disconnect brush wire.
4. Press down on brush retainer to disengage tabs then rotate brush retainer slightly toward the front of motor and remove brush retainer.
5. Slide brush assembly out of housing.
6. Install new brush assembly with wire brush toward rear of motor and spring assembly on top.
7. Insert brush retainer against brush springs and push down, then rotate retainer slightly toward rear of motor to engage tabs of retainer under rear edge of brush housing.
8. Attach brush wire to screw terminal at top of brush housing. Be sure wire is clear of access opening.
9. Attach cover plate with six screws.

NOTE: Always replace both brushes at the same time.

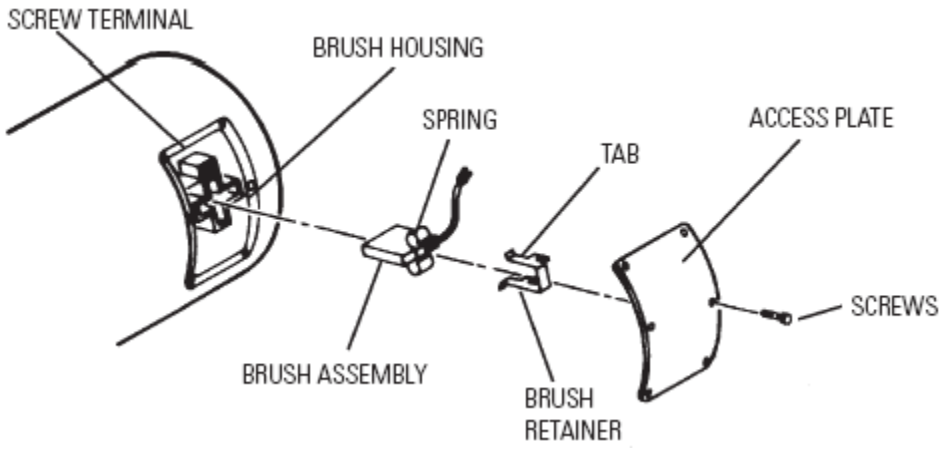


FIGURE 8 – MOTOR BRUSH

8.2 Replacing Rollers

1. Using a retaining ring tool (Contact Spectrum for Part Number), remove the retaining rings from the ends of the roller axles and slide the rollers off. Take care to avoid opening the retaining rings too wide.
2. Check to be sure that the wave washers are installed on the axles against the rotor plate.

3. Slide the new rollers (Contact Spectrum for Replacement Roller Kit) onto the axles, placing the ends with the flush bearing surface inward toward the rotor plate against the wave washers, and the etched ends with the recessed bearing surface outward toward the free ends of the roller axles.
4. Replace the retaining rings. You may have to push the rollers in to compress the wave washers to allow the retaining rings to engage the grooves in the axles.

8.3 Replacement Parts

Contact Spectrum Laboratories at 1-800-634-3300 or through our website www.spectrumlabs.com

8.4 Cleaning

Keep the drive enclosure clean with mild detergents. Never immerse or use excessive fluid.

9. Troubleshooting

For problems arising during pump drive operation, refer to the following list for possible corrective actions you can take. If these do not correct the problem, contact your dealer.

SYMPTOM	CAUSE	REMEDY
Motor does not rotate. Display does not light.	No power	1. Check fuse and replace if defective. 2. Check that unit is plugged into a live power supply. 3. Check connection of power cord. 4. Check the line cord for continuity and replace if defective. 5. Return for servicing.
Motor does not rotate. Display lights.	MODE control not properly set	1. Check that the MODE control is set to INT for operation with front panel control or to mA or V for operation with remote control 2. If the motor still does not rotate return for servicing

Error Messages

If an error message is displayed, refer to the following list for possible corrective actions you can take. If these do not correct the problem, contact your dealer.

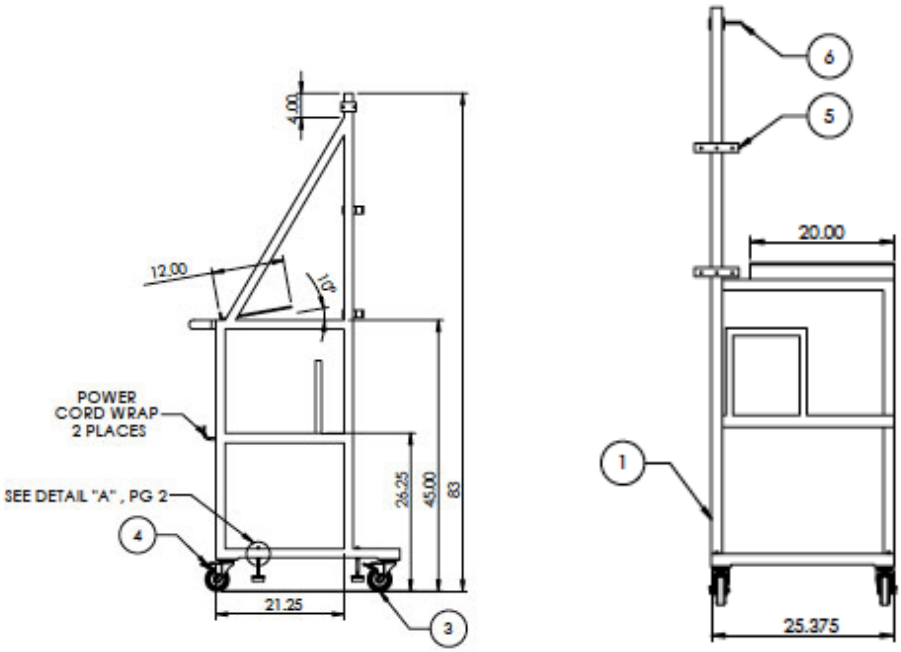
ERROR MESSAGE	CAUSE	REMEDY
“Err 1”	Changing speed reference too fast (motor undershoots) No encoder pulses from motor	Clear by pressing Stop/Start Check all motor/encoder connectio
“Err 2”	Changing speed reference too fast (motor overshoots) Motor over-speed	Clear by pressing Stop/Start Check all motor/encoder connections
“Err 4”	Bad PROM	Return unit for repair
“Err 5”	Bad zero crossing detector or crystal	Return unit for repair
“Err 6”	Bad EEPROM data, operator parameters set to default values	Avoid fast switching of power to the unit
“Err 7”	Bad EEPROM data, A/D span cal, span cal set to default	Return unit for repair
“Err 8”	EEPROM write/verify error	Return unit for repair

Section I.B - KrosFlo® LDF-37 Cart and Filter Stand

1. Materials of Construction

Component	Material/Description
Cart	304 SS, 1.5” Tubular SS, welds ground smooth
Casters	Non-marking, Cleanroom compatible, locking, 2 swivel, 2 fixed
Module Supports	Delrin, height adjustable

84" Tall x 35" Deep x 26" wide



2. Setup and Use

The system comes ready to use and no setup is required except for assembling the flowpath including the tubing, fittings, pressure sensors and filter.

Two module supports for holding KrosFlo size modules and two module supports for holding KrosFlo Max size modules are included. Use only one set at a time. Insert the middle section of the filter into the supports clamp the supports together.

Section II. KrosFlo® LDF-37 TFF System Pressure Monitor

II. KrosFlo® LDF-37 TFF System Digital Pressure Monitor

1. Introduction

During tangential flow filtration, the KrosFlo Digital Pressure Monitor performs several important functions that greatly enhance process control, facilitate scale-up and optimize product recovery. These functions include High and Low Pressure Alarms, High Pressure Stop (pump shut-off) and direct output of pressures and flow rates into Microsoft® Excel®. The user defined pressure alarm and shut-off points are safety features that help ensure maximum sample recovery and help protect membrane integrity. The KrosFlo® Digital Pressure Monitor also comes with KF Comm, a software program that allows the user to collect real time data from the pump and pressure monitor into Microsoft® Excel® spreadsheet format. The Inlet, Retentate, Permeate and Transmembrane pressures (TMP) along with feed and permeate flow rates are recorded at user defined time intervals eliminating the need for manual recording most parameters. In doing so, this monitor enables quick analysis using Excel® graphs and facilitates optimization, scale-up and process documentation. This section explains the functions and setup of the Pressure and Flow Monitor.

2. KrosFlo® Pressure Monitor Contents

The KrosFlo® LDF-37 TFF System uses Spectrum's Disposable Pressure Transducers (Cat.No. ACPM-499-03N) to measure the Inlet, Retentate and Permeate pressures. The transducers come sterile (ETO), 3 per pack. The transducers have luer connections and can be attached to special connectors in custom designed KrosFlo MBTs (Module, Bag and Tubing sets)—please contact Spectrum Laboratories for custom disposable filtration systems.

Specifications:

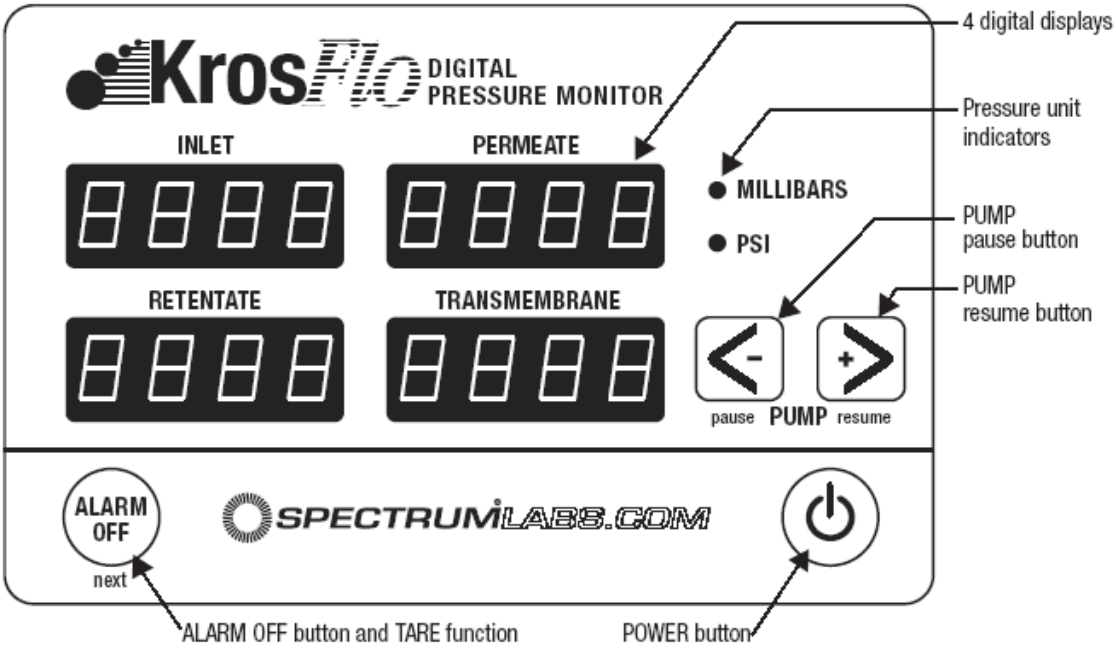
- Suggested Operating Pressure Range: -465 to 1293 mmHg
- Sensitivity: 5µV/V/mmHg, ±2% (typically ±1%)
- Non-linearity and Hysteresis: ±2% of reading or ±1mmHg, whichever is greater
- Zero Thermal Effect: ±0.3 mmHg/degree C

Verify that all components listed below are included.

KrosFlo® Pressure Monitor	Rubber Feet (4)
Transformer	Double-sided Foam Tape
Monitor/Pump Interface Cable	Pressure Transducers (3)
RS232 Cable	
KF Comm Software CD	

3. Panel Controls and Features

a. Front Panel



Power Button: Turns the pressure monitor on (first press) and off (second press). When the monitor first comes on, the digital displays should come on as well as the 'MILLIBARS' and 'PSI' indicator. When the monitor is unplugged it will remember whether it was last on or off.

Pressure Unit Indicators: One of the two indicators will be lit to indicate the units of pressure, “PSI” or “MILLIBARS” for the displayed measurements. The pressure units may be changed during the Pressure Monitor Setup (see Section 5.1).

ALARM OFF Button: The monitor is equipped with both high and low inlet pressure alarms. The trigger points for the alarms can be set from 0 to 50 PSI. The trigger points are set during the monitor setup (see Sections 5.2, 5.3 and 5.4). When an alarm is triggered by either a high or low pressure, an audible alarm will sound. You can silence the alarm by momentarily pressing the ALARM OFF button. Once an alarm is triggered, it will continue to sound until the ALARM OFF button is pressed or the monitor is turned off or unplugged.

Tare Function: The monitor can be manually tared by holding the ALARM OFF button down for about 8 seconds until the word “tare” appears on the displays. It is recommended to tare (or zero) the monitor occasionally to ensure that the transducers have a good zero point. There is an option that can be set during the monitor setup (see Section 5.5) to force the monitor to tare every time it is turned on.

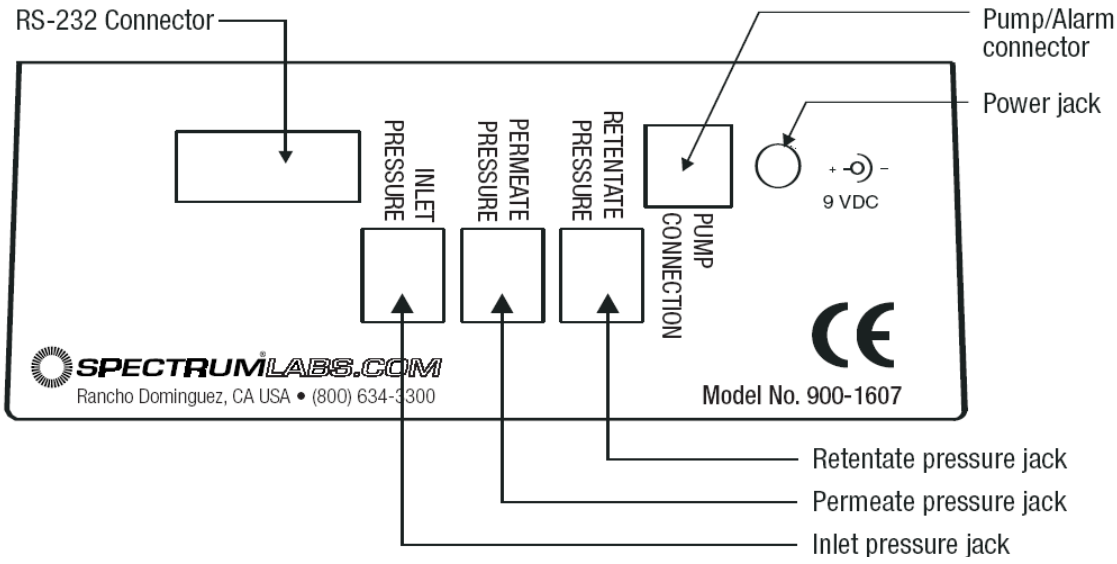
***Caution**: Tare the unit when all of the pressure transducers are either disconnected from the liquid line or are not exposed to any pressure. Taring the unit while non-zero pressure conditions exist will give the monitor a false zero and result in inaccurate pressure displays. To correct this condition, simply disconnect all the transducers from the liquid lines and then hold the ALARM OFF button down until the word “tare” appears on both displays.*

Pump Pause Button: If you are using the KrosFlo® Research II Pump with the pressure monitor, pressing this button will stop the pump. The pump will also stop when the high

stop limit pressure is reached or when the low pressure alarm sounds. This button may not be effective when used with other pumps. This button is also used during the monitor setup as described in Section 5.

Pump Resume Button: If you are using the KrosFlo® Research II Pump with the pressure monitor, pressing this button will start the pump. This button will not start the pump while the alarm is sounding. If the alarm is sounding you will need to press the ALARM OFF button to silence the alarm before starting the pump. This button is also used during the monitor setup as described in Section 5.

b. Back Panel



Power Jack: The power jack is located on the back of the monitor. It accepts the plug from the included AC/DC adapter. The adapter should supply 12 VDC and be a positive center 2.5 mm style of plug.

Pressure Transducer Connectors: The back panel has 3 jacks for connecting pressure transducers to the monitor. The jacks are labeled “Inlet Pressure”, “Permeate Pressure”, and “Retentate Pressure”. This monitor should only be used with Spectrum ACPM-499-01N transducers. These transducers are suitable for use up to 30 psig.

Pump/Alarm Jack: There is a 6 Pin mini-DIN jack on the back panel labeled “PUMP CONNECTION”. This jack is connected to the LDF-37 Pump with the supplied 18-pin cable. When the pump is connected, the pressure monitor can be used to start and stop the pump as well as record the pump speed.

Serial Communications: The monitor can communicate with the serial port on a computer. The communication settings normally used by the monitor are:

Data Rate: 19200, Data Bits: 8, Parity: None, Stop Bits: 1, Flow Control: None

The RS232 port can also be used to control the KrosFlo® Automatic Backpressure Valve.

No special software is required to access the RS232 output. Microsoft Windows operating systems include a terminal emulation program called HyperTerminal. This program is normally located under the accessories and communications menu.

When the monitor is first turned on, it will periodically output the pressure readings. These can be recorded and saved with your manufacturing or research documents. Each line sent will record and display the inlet pressure, retentate pressure, permeate pressure, transmembrane pressure, pump speed in RPM, high pressure alarm setting, low pressure alarm setting, and current time and date. If an alarm is triggered, "**ALARM**" will follow. The units are not indicated in the RS232 output; they are the same as those shown on the front panel.

Additional information about the RS232 communications is in the Serial Communications and Calibration sections.

4. Pressure Monitor Connections

    1. Connect the transformer to the Power jack on the back of the monitor and a suitable power source.
    2. Make sure the Monitor/Pump Interface Cable is connected from the PUMP CONNECTION on the back of the pressure monitor to the Control box of the KrosFlo® LDF-37 Pump. This will allow the pressure monitor to start and stop the pump.
    3. Optional: Connect the pressure monitor to a PC via the RS232 Cable.
    4. Optional: The KF Comm software collects process data directly into an Excel® spreadsheet. Download the KF Comm software by inserting the disc into the CD Drive on the PC and following instructions. Refer to the KF Comm Software Installation instructions in this manual if it does not start.

5. Pressure Monitor Setup

    The pressure monitor has both high and low pressure alarms, can display pressures in either PSI or BAR, and can display the permeate flow from either a low or high flow permeate meter. The monitor ships from the factory with all of the alarms disabled, pressure units displayed in PSI and set to automatically tare when powered on. The following procedure can be used to change any of these default settings.

    a. Setup Mode

        To enter the setup mode while the unit is on hold the ALARM OFF button down and press the up/down (▲,▼) arrow keys at the same time.

    b. Setting Pressure Units

        While in setup mode the display should read "Pressure Units". To change between PSI and BAR press either the (▲) or (▼) keys. When you are satisfied with your selection, press the NEXT key to move to the next step.

c. Setting High Pressure Stop

1. After selecting the appropriate pressure units, you will be able to either enable or disable the High Pressure Stop alarm. Press either the (▲) or (▼) button to change between On and Off. The High Pressure Stop is intended to stop the pump and sound an alarm if the inlet pressure becomes high enough to potentially damage the filter or adversely affect the process. When the High Pressure Stop is enabled and the inlet pressure exceeds its set point, the pump will stop and the alarm will sound continuously until the ALARM OFF button is pressed or the monitor is turned off. When you are satisfied with your choice, press the NEXT button to move to the next step.
2. If the High Pressure Stop is On, you can now set the pressure Stop Point. Press the (▲) or (▼) button to increase or decrease the Stop Point. A typical value might be 12 psi (0.827 bar). Once the desired value is displayed, press the NEXT button to save the value and move to the next step.

d. Setting High Pressure Alarm

1. After the High Pressure Stop is set, you can either enable or disable the High Pressure Alarm. You can press either the (▲) or (▼) button to change between On and Off. The High Pressure Alarm is intended to warn the operator that the inlet pressure is approaching the High Pressure Stop. When the High Pressure Alarm is enabled and the inlet pressure exceeds its set point, an intermittent alarm will sound until the ALARM OFF button is pressed or the monitor is turned off. The pump, however, will be allowed to continue running. When you are satisfied with your choice, press the NEXT button to move to the next step.
2. If the High Pressure Alarm is On, you can now set the pressure High Alarm Point. Press the (▲) or (▼) button to increase or decrease the High Alarm Point. A typical value might be 10 psi (0.689 bar). Once the desired value is displayed, press the NEXT button to save the value and move to the next step.

e. Setting Low Pressure Alarm

1. After the High Pressure Alarm is set, you can either enable or disable the Low Pressure Alarm. Press either the (▲) or (▼) button to change between On and Off. The Low Pressure Alarm is intended to warn the operator that the inlet pressure is falling below what might be expected during the process run. This could be caused by a vacuum, a leak or a restricted feed line to the pump. When the Low Pressure Alarm is enabled and the inlet pressure falls below its set point, the pump will stop and the alarm will sound continuously until the ALARM OFF button is pressed or the monitor is turned off. When you are satisfied with your choice, press the NEXT button to move to the next step.

2. If the Low Pressure Alarm is On, you can now set the pressure Low Alarm Point. Press the (▲) or (▼) button to increase or decrease the Low Alarm Point. A typical value might be 1 psi (0.069 bar). Once the desired value is displayed, press the NEXT button to save the value and move to the next step.

f. Setting Low Permeate Stop

1. After selecting the low inlet pressure alarm, you will be able to either enable or disable the Low Permeate Pressure Stop. Press either the (▲) or (▼) button to change between On and Off. This control is intended to stop the pump and sound an alarm if the permeate pressure becomes too low and pulls a vacuum on the fibers. This happens when a vacuum pump is placed on the permeate line to increase the TMP. When the Low Permeate Stop is enabled and the permeate pressure goes below the set point, the pump will stop and the alarm will sound continuously until the ALARM OFF button is pressed or the monitor is turned off. When you are satisfied with your choice, press the NEXT button to move to the next step.
2. If the Low Permeate Stop is On, you can now set the pressure Stop Point. Press the (▲) or (▼) button to increase or decrease the Stop Point. A typical value might be -3 psi (-0.206 bar). Once the desired value is displayed, press the NEXT button to save the value and move to the next step.

g. Setting Low Permeate Alarm

1. After the Low Permeate Stop is set, you can either enable or disable the Low Permeate Alarm. You can press either the (▲) or (▼) button to change between On and Off. The Low Permeate Alarm is intended to warn the operator that the inlet pressure is approaching the Low Permeate Stop. When the Low Permeate Alarm is enabled and the inlet pressure exceeds its set point, an intermittent alarm will sound until the ALARM OFF button is pressed or the monitor is turned off. The pump, however, will be allowed to continue running. When you are satisfied with your choice, press the NEXT button to move to the next step.
2. If the Low Permeate Alarm is On, you can now set the pressure Low Permeate Alarm Point. Press the (▲) or (▼) button to increase or decrease the Low Permeate Alarm Point. A typical value might be -1 psi (-0.069 bar). Once the desired value is displayed, press the NEXT button to save the value and move to the next step.

h. Setting the Auto Tare

1. Set the Auto Tare to On or Off using the (▲) or (▼) button. If this is set to On, the pressure monitor will automatically tare (reset the readings to 0) every time it is turned on. If this is set to Off, it will not automatically tare but will instead use the most recent tare. When you have made your choice, press the NEXT button to move to the next step.

2. If the Auto Tare is set to Off, you can manually tare the monitor when you need to by holding the TARE button. When you are satisfied with your choice press the NEXT button to save the value and move to the next step.

CAUTION: You should only tare the unit when all of the pressure transducers are either disconnected from the liquid line or not exposed to any pressure. Taring the unit while non-zero pressure conditions exist will give the monitor a false zero and result in inaccurate pressure displays. To correct this condition, simply disconnect all the transducers from the liquid lines and then press the TARE button.

6. Serial Communications

The KrosFlo® LDF-37 TFF System has two main components—Pump Drive and Pressure Monitor—each of which has their own internal hardware and software. The Pressure Monitor component is used to communicate with an external computer, the transducers, the flow meter, and the Pump Drive component. The Pump Drive hardware and software control the internal functionality of the drive and do not communicate with the external sensors or a computer. This section explains the process of setting up and using the communication function within the Pressure Monitor component of the KrosFlo® LDF-37 TFF System.

a. KF Comm Software

The KrosFlo® LDF-37 TFF System is provided with a software program that collects data from the monitor and displays it in a Microsoft® Excel® workbook. For more information on how to use the software refer to Section III *KF Comm Software*.

b. Pressure Monitor - Computer Communications

1. To connect the Pressure Monitor to a computer for data logging (if not using KF Comm software) or control, use the supplied RS232 cable to connect the RS232 connector on the octopus cable to a serial port on your computer. RS232 to USB adaptors are commercially available if no serial port exists.
2. Open the HyperTerminal program (installed under Start/Accessories/Communications on most Windows installations). Pick a name and an icon so that you can save the settings you make below.
3. On the Connect To dialog, go down to the Connect Using item and select the Com port you used for the connection and click OK. On the Port Settings dialog select “19200” for the Bits per second, “8” for the Data bits, “None” for the Parity, “1” for the Stop bits and “None” for the Flow control; then click OK. You can use File/Save to save the settings for easy use later.

4. When you have connected the Pressure Monitor to your computer, you should see it periodically print a line of the current pressure readings on the screen. The periodic output records and displays the inlet pressure, retentate pressure, permeate pressure, transmembrane pressure, pump RPM, high pressure alarm setting, low pressure alarm setting, and current time and date. If there is no periodic output, make sure that the cable connecting the pressure monitor to the PC is good. It should be a null modem cable. Also check that the correct COM port on the computer is selected. Use File/New Connection on the menu to select a different COM port.
5. The RS232 communication is used as a data output for monitoring a log of the process readings as well as to control and calibrate the pressure monitor function of the KrosFlo® LDF-37 TFF System. In order to better serve the dual purpose, the RS232 port has two different modes or states. When the KrosFlo® LDF-37 TFF System is first turned on the RS232 port is in the locked state. In this locked state, it periodically outputs the current pressure readings and ignores most input. The only way to change from the locked to unlocked state is by pressing the computer's ENTER key, type "Unlock" and press the ENTER key again. The pressure monitor does not echo the keystrokes mixed in with the pressure readings. Make sure to type a capital "U" and lower case "nlock". The periodic output will continue while you are typing.
6. While the monitor is unlocked, it will respond to a small set of commands. When it is ready for another command it will display a prompt of ">" and wait for the next command. In all cases the commands are case sensitive. Each command line is ended by pressing the ENTER key.

?: Typing "?" will provide a list of the available commands.

Lock: Typing "Lock" returns the RS232 port to the locked state. It will then periodically output the current pressure readings.

Ver: Typing "Ver" will cause the pressure monitor to display the version identifier of its software.

Show: Typing "Show" will cause the pressure monitor to display the values of many of the variables that can be set with the RS232 port.

Reset: Typing "Reset" will cause the pressure monitor to reset itself as if it had just been turned on.

Default 171: Typing "Default 171" will reset all of the pressure monitor parameters to those set by the factory. This includes resetting the Baud Rate to 19200 as well as the calibration and zero points of all of the transducers since it does not reset the monitor. Some changes will not take place until the monitor is turned off and then on (or the "Reset" command is given).

Rate #: While the RS232 port is locked it periodically outputs the current pressure readings. The rate is the number of seconds per reading output. Typing the word “Rate” by itself will cause the current rate number to be displayed. Typing the word “Rate” followed by a space and a number will cause the rate to be set to your new value.

Sep C: The Sep command is used to set the character displayed between the pressure readings in the periodic output. Normally this is a space. You may, however, want to set it to a tab or a pipe ('|') character. Typing the word “Sep” by itself displays the current separator character. To set a different separator character type the word “Sep” followed by a space and the new character to use. The separator cannot be set to a null, line feed, or return character; any other character can be used.

When displaying the current separator character, characters that might not print visibly are mangled to make them display legibly. For example, a space is shown as “[ ]” while a tab is shown as “[/I]”. The mangled form should not be used to specify the separator, simply type “Sep”, a space, and then the character to use.

Cal S ##.##: The Cal command is used to calibrate one or more of the pressure channels. To calibrate the monitor to a transducer, plug the transducer in to the monitor and connect it to a known pressure source. Then type “Cal” followed by a space, the appropriate pressure channel (either “retentate”, “permeate” or “inlet”) and finally the respective pressure value in the format of ##.##, e.g. “5.3”. When calibrated to a particular transducer, the calibration is only for that transducer on that jack. See the section on Calibration for more information.

Date ##/##/##: Typing the word “Date” by itself displays the current date in the real time clock. To set the date, type the word “Date” followed by a space and the current date in mm/dd/yy format. (mm should be a number from 1 to 12 indicating the current month, dd should be a number from 1 to 31 indicating the current day of the month and yy should be a number from 0 to 99 indicating the last 2 digits of the year.)

Time ##:##:##: Typing the word “Time” by itself displays the current time in the real time clock. To set the time, type the word “Time” followed by a space and the current time in hh:mm:ss format. (hh should be a number from 0 to 23 indicating the current hour, mm should be a number from 0 to 59 indicating the current minute and ss should be a number from 0 to 59 indicating the current second.)

RTC #: The RTC command is used to control whether the date and time are shown. Type “RTC 1” to have the date and time shown, “RTC 0” to prevent the date and time from appearing.

c. List of Error Messages

That didn't look like a command to me - Returned whenever the monitor cannot parse your input usefully. If you provide a number out of range or negative, this is usually returned. If you format the date or time wrong (when setting the date or time), this is usually returned. The monitor does not understand backspace or rubout. If you try to backspace, you will almost without fail see this message when you press ENTER. If use the wrong case (upper or lower) for a command, you will also see this message when you press ENTER.

Bye - Returned after the Lock command is accepted. It lets you know that the console is now locked and you should only see the periodic output.

Bad combination - The Default command must be followed by a space and the number 171 to take affect. If you do not include the 171 you will see this message.

I don't like the separator you've picked, please try again - There are some characters that should not be used as the separator character (see the Sep command). Currently these characters are ENTER and rubout. Trying to use these characters returns the “That didn't look like a command to me message”.

I'm sorry I can't update the clock right now - The real time clock is connected to a shared bus. It is possible (although not likely if the monitor is operating properly) that the shared bus could be busy when you try to update the clock. If this occurs you will see this message and the clock will not be updated.

7. Pressure Calibration

NOTE: For field calibration follow the instructions in this section or if necessary the system can be returned to Spectrum. You can contact Spectrum by phone at (800) 634-3300, fax at (310) 885-4666, or email at customerservice@spectrumlabs.com to make arrangements for the calibration.

If you experience an error in a pressure or flow measurement, the cause is most likely the transducer or sensor and not the monitor. Please check pressure readings with a new transducer prior to recalibrating the monitor.

a. Pressure Calibration

To calibrate one or more pressure channels you will need a computer with an available serial port, one or more pressure transducers and a source of

known pressure. If you have all of these items available, the following procedure may be used:

1. Disconnect all pressure transducers and flow meters from the unit.
2. Connect power to the unit and turn it on. The digital displays should light up as well as the Pressure Unit indicators.
3. After the power-on sequence has completed and pressure values are being displayed, press the TARE button. After the tare is complete, all displays should show “0” readings.
4. Use the supplied RS232 cable to connect the monitor to a free serial port on a computer and establish communication.

    i. Open your HyperTerminal program (installed under Accessories/Communications on most Windows installations). Pick a name and an icon so that you can save the settings you make in the following steps.

    ii. On the Connect To dialog, go down to the Connect Using item and select the Com port you used for the connection and click OK.

    iii. On the Port Settings dialog select “19200” for the Bits per second, “8” for the Data bits, “None” for the Parity, “1” for the Stop bits and “None” for the Flow control; then click OK. You can use File/Save to save the settings for easy use later.

    When you have connected the unit to your computer, you should see it periodically print a line of the current pressure readings on the screen. If you do not see this periodic output, check that you are using a good cable to connect the monitor to the PC. You might also want to check that you've selected the correct COM port on your computer. You will need to use File/New Connection on the menu to select a different COM port.

5. Plug a new pressure transducer (ACPM-499-03N) into each pressure jack on the octopus cable. All pressure readings should change and no longer be “0”. The following steps should be performed for each transducer (inlet, retentate and permeate), one at a time.

    i. With no pressure applied to the transducer, press the TARE button.

    ii. Using a calibrated pressure gauge and pressure source, apply about 6 psi to the inlet pressure transducer.

    iii. Unlock the monitor by pressing the ENTER key on the computer, typing “Unlock”, and then pressing the ENTER key again. Be sure to type a capital “U” followed by a lower case “nlock”.

    iv. Type “Cal inlet” ##.## (where ##.## is the pressure on the transducer) and press ENTER. The inlet pressure reading on the front of the monitor should change to the value you have entered. If the calibration value is a magnitude that indicates a hardware

problem then an error message will be displayed and the calibration will not be performed.

v. Type “Lock” and press ENTER to have the monitor return to periodically sending the current pressure readings.

vi. Repeat steps i through v to calibrate both the retentate and permeate transducers.

The pressure monitor is now calibrated. You may now disconnect the pressure transducers from the octopus cable.

8. Real Time Clock

The pressure monitor includes a real time clock that is accurate to better than 2 minutes per month when the monitor is stored and used between 0 and 40ºC.

The real time clock is separate from the timing used to periodically output the pressure and flow readings to the RS232 port. Because the periodic output clock is much less accurate than the real time clock, its frequency error can be as large as 100 ppm (5 minutes per month).

Because these clocks are separate, several times per month one clock will pass the other. If you are recording the pressure and flow readings once per second, you will record up to 420 times per month where either the same second is reported twice or a second seems to be skipped. This is a result of the relative error in these two clocks and not a hardware defect.

Section III. Transmembrane Control Valve

Instructions for Use

The KrosFlo® Automatic Backpressure Valve controls transmembrane pressure (TMP) or permeate pressure during tangential flow filtration processes when used in conjunction with the KrosFlo® Digital Pressure Monitor as provided with this LDF37 System. The valve is designed to pinch flexible tubing on the retentate or permeate line based on digital pressure readings and maintain the user-set pressure.

Installation

1. Connect the cable from the KrosFlo® Automatic Backpressure Valve to the back of the KrosFlo® Digital Pressure Monitor. There are two legs one will connect to the power input and the other will connect to the RS232 port (female). Connect the second RS232 port on the opposite side (male plug) to the serial cable for sending data to a PC (Please refer to the Digital Pressure Monitor manual for data collection).
2. Plug in the transformer and connect to the power supply on the Automatic Backpressure Valve.

Power Requirements

ACPC-F82-01N, 1” (max) OD tubing valve with 1/4" Wall → 1.0A @ 12V

Operation

Automatic TMP Pressure Control

1. To operate the backpressure valve in the auto TMP mode switch the toggle on the top of the valve to the “TMP” setting. Press the OPEN button to load the tubing and reset the pressure controls.
2. Set the desired TMP using the INC and DEC buttons.
3. With the pump running at the desired speed for the tangential flow filtration process press the GO button and the valve will start to pinch the tubing until the desired TMP is reached (this may take a few minutes until it equilibrates).
4. Pausing the valve.
    a. To pause the valve press the GO button (the light will turn off). To resume press the GO button (the light will turn back on).

NOTE: If the valve is not in the fully open position it will adjust the pinch in a slow mode to avoid the potential pressure spikes. To manually force it to the fast mode hold the GO button down for >3 sec until the lights begin to blink (this is now the manual control mode) and then press the GO button again.

b. If the KrosFlo Research II Pump is turned to off or to 1/2 the rpm when the GO button was pressed the valve will exit the control mode and will maintain the same pinch distance. The valve will flash “SLO” while in this paused state. The valve will resume the normal pinch control when the pump is turned on or to atleast 1/2 the original rpm.

Automatic Permeate Pressure Control

1. To operate the backpressure valve in the auto PERMEATE mode switch the toggle on the top of the valve to the “Permeate” setting. Press the OPEN button to load the tubing and reset the pressure controls.
2. Set the desired Permeate Pressure using the INC and DEC buttons.
3. Press the GO button before starting the recirculation pump—the valve will pinch shut (when using the maximum tubing size rated for the valve). Begin the process and then the valve will start to open/pinch the tubing until the desired Permeate pressure is reached (this may take a few minutes to equilibrate).

Manual

To control the valve manually hold down the GO button for >3 sec. The light will begin to flash and then the INC and DEC buttons can be used to adjust the pinch.

Communications

Serial Communication

The Valve has a serial input cable for communication and control.

The communication parameters are 19200 baud, 1 stop bit, no parity, no flow control.

When communicating with an external PLC the valve should receive about 1 line of data per second. The lines should end with a return character and a line feed character.

Each line should have several values, each separated from the next by a single space:

<InletPressure><space><RetentatePressure><space><PermeatePressure><space> <TMP><space><RPM><space><return>

(1) Inlet Pressure: This should contain a decimal and may have a leading - sign for negative pressures. There should be no sign provided for positive values. If the - sign is included, there should not be a space after the - sign. The number will not be less than 2 characters nor more than 5 characters in length. The number will contain a decimal point. If in units of millibars there will be no digits to the right of the decimal. If in psi there will be 1 or 2 digits to the right of the decimal. The pressure must not be more than 50 psi nor less than -9.99 psi.

(2) Retentate Pressure: Formatted same as the inlet pressure.

(3) Permeate Pressure: Formatted same as the inlet pressure.

(4) Transmembrane Pressure (TMP): Formatted same as the inlet pressure.

(5) Pump speed in RPM. This is a number with no decimal point and no possible leading - sign. It is the unsigned pump speed in RPM. It may be 0. When the Go button is pressed the pump speed is remembered. If the speed drops by 50% or more the valve stops adjusting position until the pump speed again tops the 50% mark. If the RPM is 0 when the Go button is pressed then the pump speed will never fall below the 50% limit and the Pump Slow mode will never be entered.

Note: The pump speed should be followed by a space. This space may be followed by other characters but they are ignored by the valve.

The line should be no more than 78 characters in length.

Fine Tuning

The valve positioning and timing can be modified using HyperTerminal communication software (Microsoft).

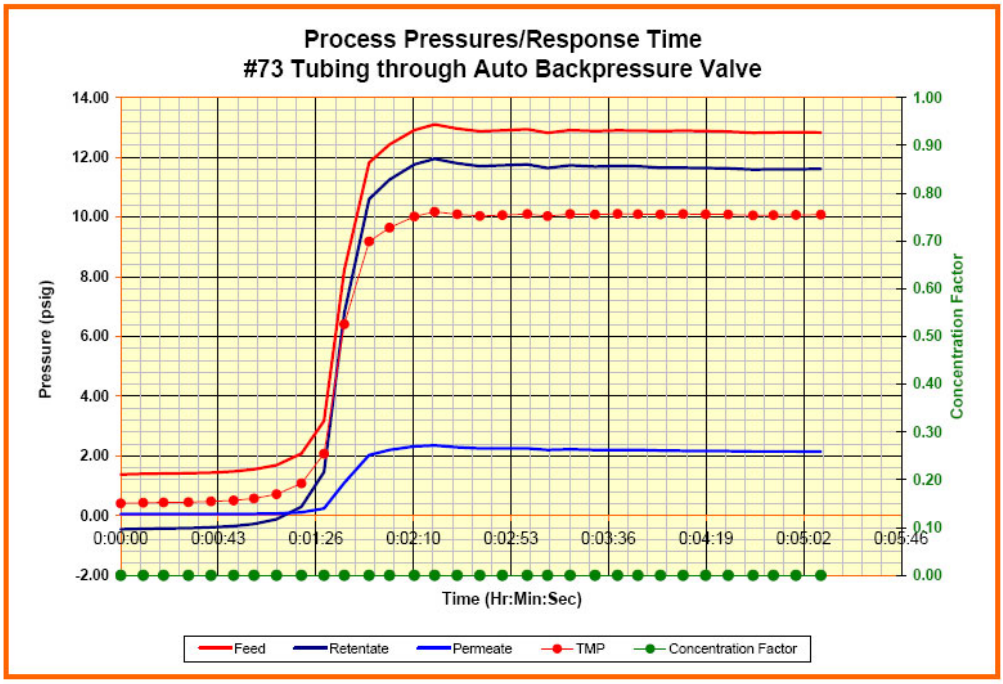
To set the start position connect the valve to the computer using a serial cable (or USB to serial adapter if no serial connector is available on the computer). Do not plug the serial connector into the pressure monitor. Turn on the valve and wait 60 seconds. Press and hold the OPEN button for about 6 seconds until the display is all - signs. Use HyperTerminal to communicate with the valve, the settings are the usual, 19200 baud, 8 data bits, no parity, 1 stop bit, no flow control. Select the correct COM port and make sure that the KF Comm software is not running.

Once connected press the enter key and then type:
<Start><space><*start position number*> ➔ Example: Start 98
and then enter key to set the start position. The default number is usually 80. Larger numbers are more closed. Numbers bigger than 255 get squished to a number less than 256.

To display the current start position type <Start> and press enter. When the correct start position number has been entered type <Lock> and press enter to go back to normal valve operation. The number will be stored and the valve will close to the new position when Go is pressed.

There are 4 other parameters that can be tuned if needed:
1) “Change” is the minimum number of seconds after a change in the sign of the pressure error before a change is made in the position. The default is 3.
2) “Interval” is the minimum number of seconds between changes in position. The default is 4.
3) “Step” is the number of steps to take in the same direction before the movements get larger. The default is 5.
4) “Reverse” is the minimum number of seconds to wait after the first movement in a new direction. The default is 9.

Sample Pressure Control Response Time



Requires:
3 each - ACPM-799-01N: Digital Pressure Sensor, Polysulfone

Section IV. KF Comm Data Acquisition & Graphing Software

1. License

2. Installation

The KrosFlo® LDF-37 TFF System is accompanied with a disc of software that can be used on Windows® PCs. You will need to have Microsoft® Windows 95 or newer and Microsoft Excel XP to use this software.

The supplied software includes an ActiveX control that allows other applications to easily communicate with the LDF-37 TFF System and a spreadsheet template for automatically recording your process separation conditions.

To start the software installation, all that is normally necessary is to put the software disc into a CD drive. If it does not automatically start, you'll need to double-click on the icon for the CD drive and then double click on the Setup.exe item. (The Setup.exe item looks like )

After the installation starts, you'll need to accept the terms of the software license to continue. The license terms are listed in SECTION III.1 of this manual.

If you agree to the terms of the license you can then select the installation location, normally C:\Program Files\Spectrum Chromatography\KFComm. One copy of each spreadsheet will be installed in this location; additionally the KFComm control will be installed in your windows system directory (typically C:\Windows\System) and duplicate copies of each spreadsheet will be installed in your My Documents folder.

If you do not have administrator privileges on the computer, the installation will fail without giving you notice that it has not completed successfully.

Windows® is a registered trademark of Microsoft Corp.
Microsoft® is a registered trademark of Microsoft Corp.

3. Instructions for Use

3.1. Opening File

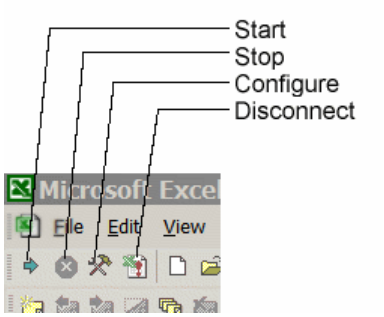
The workbook template that can be used to automatically record your process conditions is named TFF Trial Template. This Excel® workbook contains programming that automatically collects and graphs real-time run data.

The macros that allow you to record the pressure and flow readings during the course of your experiment have been signed by Spectrum. Depending upon your security settings and the particular version of Excel that you are using, you may be prompted to allow macros to run when you open the template. If your Excel security level is High, then you will need to check the "Always trust macros from this source." box before you can click the "Enable Macros" button. If you are not an administrator on the computer you are using, you may need to contact an administrator and have them accept the certificate used to sign the macros.

If you do not enable macros then you will not be able to collect new data. If you are opening a workbook that already contains data, you will be able to work with the data whether or not you enable macros.

3.2. Data Collection Tools

The TFF Trial Template has both data collection worksheets and automatic graph worksheets (see Section III.3.4 below). When one of the data collection worksheets is open, and a Pressure Monitor is connected to the computer, the first row of the spreadsheet will always display the most current readings from the Monitor. If the Monitor is connected and turned on and the first line remains blank, then you'll need to use the configure control to use a different serial port.



The first 4 controls on the standard toolbar can be used to control the data collection. The same items will also appear on the Data menu at the top of the window.

Configure Collection. This is used to set how the data is collected. Clicking on this will bring up a dialog. Use this to set the number of seconds per line collected, the default is 1 second per line. A 3 hour run at 1 line per second would produce about 10,000 data points. To collect fewer points, you would need to set a larger number for the seconds per line parameter. An Excel sheet can only contain about 65,000 rows; this limits collection to about 18 hours at 1 second per line.

You also use this control to indicate to which serial port your Pressure Monitor is connected. If you are unsure to which port number it is connected, click the Find Comm button. The control will cycle through the free serial ports on your computer looking for a Pressure Monitor. If a Pressure Monitor is turned on and connected to the computer, it should be found within 1 cycle of the available ports. The control will continue looking at the available ports for a Pressure Monitor until one is found or until you click the Cancel button. If you are using another program to communicate with the Pressure Meter, you'll need to close that program before selecting the Configure tool so that the serial port becomes available to the workbook.

Start Collection. This is used to start collecting the pressure data. Once the first row of the KrosFlo® Pressure Data sheet is properly showing the current pressure information, clicking this will begin saving the pressure data in the worksheet. The amount of time per saved point is set using Configure Collection. After clicking on the Start collection button, you will not be able to use Configure Collection until you first click on Stop Collection.

Stop Collection. This is used to temporarily stop collecting the pressure data. After clicking on Start Collection to start saving data, you can click on this to suspend collection. If you select Start, Stop, and then Start again, collection will resume where it left off; it does not begin again at the top of the sheet.

End Collection. This is used to end data collection. Because of the way Excel works, you will have difficulty manipulating the contents of the KrosFlo® Pressure Data sheet. Clicking this will stop the spreadsheet from updating the first line, stop the data collection, and disable the other controls. You will then be able to manipulate the data as you wish.

If you click this once and then save the workbook, the next time you open the workbook, data collection will again be available. If you click this twice and then save the workbook, data collection will no longer be available for this workbook.

3.3. Navigating the Worksheets and Charts

3.3.1. General Info

In the TFF Trial workbook there are three different worksheets for data collection (orange tabs at bottom of Excel® page):

These three worksheets are used for collecting data for different stages of a filtration process:

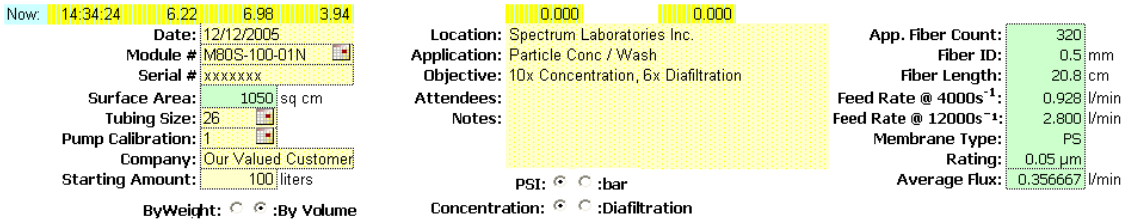
Module Characteristics – For analyzing initial water flux

Integrity Test – For performing test to ensure membrane integrity

Trial Data – For collecting run data

Note: Data is only collected in the worksheet that is open

These worksheets have a header where the correct filter and tubing size can be selected from a pull down menu. Once the appropriate filter is chosen the table on the right side will display the filter characteristics. Other information regarding the run can be entered and the proper units (PSI or bar) can be selected. The data entered in the 'Module Characteristics' worksheet will also be seen in the 'Integrity Test' and 'Trial Data' worksheets.



Note: Correct tubing size must be selected for proper feed flow rates to be captured in the spreadsheet. If the pump is calibrated (see Section I.A.6) then the correction factor will need to be adjusted to get the correct feed flow rate.

The seven remaining worksheets with the green tabs (not all are shown on the above picture) are automatic graphs. Here is a brief overview:

GRAPH	SOURCE
NWP (Normalized Water Permeability)	**Graphs data from 'Module Characteristics' worksheet for analyzing initial water flux**
Flux Rate vs. Time **Feed Flow Rate vs. Time** **Pressures vs. Time** **Pressures vs. VT (Volumetric Throughput)**	**Graphs data from 'Trial Data' worksheet to analyze process conditions**

TMP (Transmembrane Pressure) vs. VT **CF (Concentration Factor) vs. Flux**	

3.3.2. Module Characteristics

The 'Module Characteristics' worksheet collects data to measure the NWP of the filter. The header for the data collection in the worksheet looks like this:

Initial NWP													
Time	P_{inlet} (psig)	$P_{retentate}$ (psig)	$P_{permeate}$ (psig)	TMP (psig)	DP (psig)	Q_{inlet} (l/min)	$Q_{permeate}$ (l/min)	Temp (°C)	TCF	Water Flux LMH	Water Flux LMH @ 20°C	WP (LMH/psig)	NWP (LMH/psig)
0:00:10	5.55	2.41	0.00	3.98	3.14	0.580	0.200	23	0.931374	114.29	106.44	28.72	26.74
0:00:20	5.55	2.41	0.00	3.98	3.14	0.580	0.200	23	0.931374	114.29	106.44	28.72	26.74
0:00:30	4.48	2.37	0.20	3.23	2.11	0.580	0.200	23	0.931374	114.29	106.44	35.44	33.01
0:00:40	4.48	1.78	0.20	2.93	2.70	0.580	0.200	23	0.931374	114.29	106.44	39.01	36.33

Here is a breakdown of the abbreviation descriptions:

Column Abbreviation	Description
Time	Time (H:MM:SS)
P_{inlet}	Inlet Pressure
$P_{retentate}$	Retentate Pressure
$P_{permeate}$	Permeate Pressure
TMP	Calculated Transmembrane Pressure
DP	Pressure Drop through filter
Q_{inlet}	Feed Flow (calculated from Pump rpm and tubing size)
$Q_{permeate}$	Permeate Flow (measured and inputted by user at specific times)
Temp	Temperature (measured and inputted by user at specific times)
TCF	Temperature Correction Factor (calculated from Temperature)
Water Flux	Liters of permeate per m^2 of surface area per hour (calculated from permeate flow/SA)
Water Flux @20 C	Corrected Water Flux
WP	Water Permeability
NWP	Normalized Water Permeability

Note: For the data collection worksheets there are three different types of columns: collected data (yellow), calculated data (light green) and user inputted data (tan)

When a filter has been properly rinsed and/or wetted according to the instructions on the insert titled 'Hollow Fiber Filter Preparation Guide' then the initial water flux data can be measured. Making sure that the first row is reading the current pressure data click on the 'Start Collection' button. Continue collecting data points at different transmembrane pressures (TMP's) by increasing the resistance on the retentate line. Input the temperature. The 'NWP' worksheet will automatically graph the NWP vs. TMP.

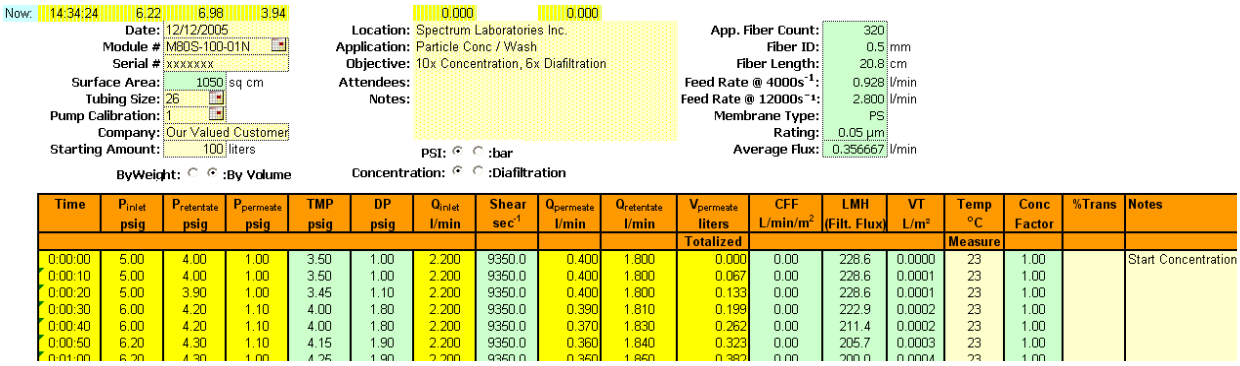
3.3.3. Integrity Test

The 'Integrity Test' worksheet measures the inlet pressure at set time intervals and calculates the ΔP over time. If the psi/min change is not > than 0.5psi/min then the filter is integral. A sharp decrease in pressure over time shows either a broken filter or the filter was not properly wetted

out. Follow the instructions in the “Hollow Fiber Filter Preparation” insert for proper wetting and integrity testing procedures.

3.3.4. Trial Data

The ‘Trial Data’ worksheet is used to log and calculate the filtration run data (see sample below).



Now: 14:34:24 6.22 6.98 3.94 0.000 0.000

Date: 12/12/2005
Module #: M80S-100-01N
Serial #: xxxxxxx
Surface Area: 1050 sq cm
Tubing Size: 26
Pump Calibration: 1
Company: Our Valued Customer
Starting Amount: 100 liters
ByWeight: :By Volume

Location: Spectrum Laboratories Inc.
Application: Particle Conc / Wash
Objective: 10x Concentration, 6x Diafiltration
Attendees:
Notes:
PSI: :bar
Concentration: :Diafiltration

App. Fiber Count: 320
Fiber ID: 0.5 mm
Fiber Length: 20.8 cm
Feed Rate @ 4000s^{-1}: 0.928 l/min
Feed Rate @ 12000s^{-1}: 2.800 l/min
Membrane Type: PS
Rating: 0.05 µm
Average Flux: 0.356667 l/min

Time	P_{inlet} psig	$P_{retentate}$ psig	$P_{permeate}$ psig	TMP psig	DP psig	Q_{inlet} l/min	Shear sec^{-1}	$Q_{permeate}$ l/min	$Q_{retentate}$ l/min	$V_{permeate}$ liters	CFF L/min/m^2	LMH (Filt. Flux)	VT L/m^2	Temp °C	Conc Factor	%Trans	Notes
										Totalized				Measure			
0:00:00	5.00	4.00	1.00	3.50	1.00	2.200	9350.0	0.400	1.800	0.000	0.00	228.6	0.0000	23	1.00		Start Concentration
0:00:10	5.00	4.00	1.00	3.50	1.00	2.200	9350.0	0.400	1.800	0.067	0.00	228.6	0.0001	23	1.00		
0:00:20	5.00	3.90	1.00	3.45	1.10	2.200	9350.0	0.400	1.800	0.133	0.00	228.6	0.0001	23	1.00		
0:00:30	6.00	4.20	1.10	4.00	1.80	2.200	9350.0	0.390	1.810	0.199	0.00	222.9	0.0002	23	1.00		
0:00:40	6.00	4.20	1.10	4.00	1.80	2.200	9350.0	0.370	1.830	0.262	0.00	211.4	0.0002	23	1.00		
0:00:50	6.20	4.30	1.10	4.15	1.90	2.200	9350.0	0.360	1.840	0.323	0.00	205.7	0.0003	23	1.00		

The columns are the same as the ‘Module Characteristics’ with the following additions:

Column Abbreviation	**Description**
Shear	Shear rate of the liquid flowing through the fibers (with fixed viscosity) in sec^{-1}
$Q_{retentate}$	Retentate Flow
$V_{permeate}$	Total volume of permeate. This can be changed to total weight of permeate when using a scale instead of the permeate flow meter by clicking on the ‘By Weight’ button on the header.
CFF	CrossFlow Filtration. This is a measure of the feed flow in relation to surface area.
LMH	Filtrate rate in liters per m^2 per hour
VT	Volumetric Throughput (a measure of the total permeate per m^2 of SA)
Pump	RPM of the pump
Temp	Temperature (user inputted)
Conc. Factor	Concentration Factor – this is calculated from the initial volume (input into the header) and the totalized permeate volume. When running the filtration system in dialfiltration mode select the ‘Dialfitration’ button on the top of the worksheet. This turns off the Conc. Factor calculation. To turn it on again during the run click on the ‘Concentration’ button.
% Trans.	Percent transmission of particle to pass through with permeate. This data will be entered after the proper assays are performed on the permeate samples.

NOTE: The permeate rates are to automatically measured by the permeate flow meter. It is possible to use a scale (not provided) to measure the weight of the permeate and manually input the total weight at specific times. This spreadsheet will then automatically back calculate and populate the permeate flow rate column.

4. Compliancy

Spectrum offers an additional software program that enables the KF COMM program to comply with 21 CFR Part 11 regulations. Please contact Spectrum at 800-634-3300 for further information or visit www.OFNIsystems.com

Section IV. Ordering Information

PART NUMBERS	DESCRIPTIONS
SYKL-037-110	**KrosFlo® LDF-37 TFF System, 110V**
	Integrated Components:321 RPM Pump Drive
	Digital Display Feed Flow Rate
	Digital Pressure Monitor
	KF Comm Data Collection Software and Cables
	Stainless Steel Cart
	UL, CE Listed Pump and Pressure Monitor
	IP56 Washdown Rating for Motor
SYKL-037-220	**KrosFlo® LDF-37 TFF System, 220V**
	Integrated Components: 321 RPM Pump Drive
	Digital Display Feed Flow Rate
	Digital Pressure Monitor with 3 Transducers
	KF Comm Data Collection Software and Cables
	Stainless Steel Cart
	UL, CE Listed Pump and Pressure Monitor
	IP56 Washdown Rating for Motor

Accessories Included:

SYM3-011-01N	**Permeate Control Pump**
	Built in pressure sensors replace the KrosFlo Digital Pressure monitor
	13 LPM Digital Peristaltic Pump
ACPC-F82-01N	**Automatic Backpressure Valve**
	Automatically controls TMP and/or Permeate pressures when used with KrosFlo Digital Pressure monitor
	For use with Flexible tubing up to 1” OD

Available for Purchase:

ACPX-KT3-01N	**Proconnex Fittings Kit**
	3” to 1.5” TC adaptors, 3” TC clamps/gaskets, 1.5” TC clamps/gaskets, 1.5” x 0.5” HB x FLL Proconnex fittings for pressure sensors

Disposable, Irradiated Filter, Bag and Tubing Assemblies (MBT™) are custom. Please contact Spectrum Labs for design and a quotation.

KrosFlo®

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