PendoTECH® TFF Process Control & Data Acquisition System

PENDOTECH

Adding Value To Your Process

Product Features:

- Ideal for many applications in biopharmaceutical processing:
  — Ultra-Filtration / diafiltration (UF/DF) of proteins and viruses
  — Clarification
- Adds automation, in-line process monitoring and data collection to your processes
- Complete batch control with 6 built-in programmable recipes
- System interaction via a PC-based Graphical User Interface
- Real time trending and all data is written to a file for permanent record
- "Air in tube detector" used for "Fed-batch" process where product is fed to the main vessel and dynamically concentrated - achieve greater than 20x concentration factor
- Features use of PendoTECH Pressure Sensors™ that are available from a luer size to 1inch inner diameter that can be cleaned and re-used extensively; also available in Sanitary Flanges
- No process scale limitations
- Integrates with different types of pumps and different brands of scales
- Built in conductivity, pH & temperature measurements
- Options for filtrate flow/flux measurement in addition to ability to measure other process parameters via configurable inputs
- An excursion feature where 40 conditions of flow and pressure can be executed automatically and graphed to visualize optimal condition
- Several advanced features afford additional system utility
- Built-in data server to exchange data with OPC client software such as PI from OSI soft®
- IQ/OQ templates available
- Control System interfaces to PendoTECH VF-DF software for additional utility

**IDEAL FOR** Process Development

CE
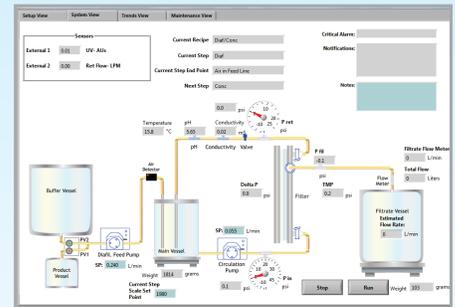
Benchtop System

Process Development

Pilot System

- Completely and efficiently automates your TFF/Crossflow Filtration Process

- Recipe based control of entire concentration and diafiltration process with multiple options for automated diafiltration end point (filtrate weight, conductivity, pH, air in buffer feed line, total flow)

- Pressure measurement in psi or bar and calculation of trans-membrane pressure (TMP) and delta-P with PendoTECH Pressure Sensors that are available from a luer size to 1 inch inner diameter that can be cleaned and re-used extensively or other sensors such as stainless steel transducers

- Interact with the system via an easy to use graphical user interface (GUI) that includes a trending module with many advanced features

- Data collection to a file that is opened with Excel

- Alarms for all process parameters that shut-down the pumps

- Alarm features include a delayed detection on the minimum inlet pressure that can stop the system if the inlet pressure drops due to a flow path problem

- Automation and alarm features allow the system to be operated with minimal user interaction

- Condition Excursion function where 40 conditions of flow and TMP can be executed automatically and simultaneously flux versus TMP versus concentration is graphed to visualize optimal condition. Designed for DOE

- Stainless steel design with completely sealed front panel for use in clean environments where frequent wipe-down is required and NaOH is used

- Process control via integration of industry standard scales and pumps

- Can be used at any process scale

- pH probe input via a BNC connector for the PendoTECH pH probe and the GUI includes an easy to use probe calibration wizard

- PendoTECH Single Use Conductivity Sensor input with temperature compensation; sensors are available in a range of sizes

- Air detector end-point can be used for "Fed-batch" process where product is fed to the main vessel and dynamically concentrated - achieve greater than 20x concentration factor

- Filtrate flow meter input for optional rotary flow meter, ultrasonic flow meter, or other that includes the ability to totalize flow

- Temperature sensor input for an "in-line" sensor or for diptube sensor

- Two inputs available for other sensors with 4 - 20 milliamp outputs to enable collection of additional process data that can be configured for advanced features and alarms points such as UV or the retentate flow meter

- The system may be controlled remotely via a PC, iPad or smart phone by using 3rd party software. Process details are visualized on the graphical interface and the system interaction is via the PC so remote control is possible by simply accessing the PC

- Notifications appear on software screen when parameters are out of range and with built-in email client can send email/text message alerts.

- Retentate flow may be controlled by use of a retentate flow meter

- System has TMP output signal that can be connected to external non-invasive control valve to control system TMP

- Built-in data server to exchange data with OPC client software such as PI from OSIsoft®

- Control System also interfaces to PendoTECH Normal Flow (VF-DF) PC Software for additional utility in a process development environment

- CE tested for EMC and LVD
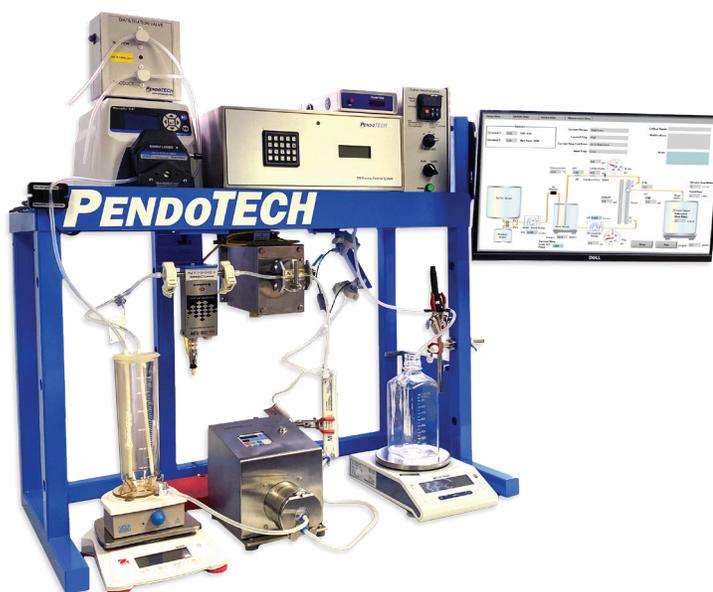
System shown with space-saving benchtop stand

TFF/Cross Flow Filtration Process Overview

A tangential flow filtration (TFF) or cross flow filtration process using a hollow fiber filter module (versus a plate & frame cassette flat sheet device) is represented in Figure 1.

Liquid is fed from a product vessel by a circulation pump to a filter module containing numerous hollow fibers and the liquid flows into the inner cross section of the individual fibers.

The wall of the hollow fiber is the filter membrane. As is shown in Figure 2, a certain amount of liquid and liquid components smaller than the pore size of the fiber wall "permeates" through the wall (the filtrate). The filtrate collects in the module shell and the shell has ports for removal of filtrate from the shell (the void area between the fibers is closed at both ends to prevent the liquid that is entering the filter module from going directly into the shell). The feed pressure (P_{IN}) is higher than the retentate pressure in (P_{OUT}) because of the pressure drop as liquid flows through the narrow fibers and returns to the vessel. There is also a pressure drop across the fiber wall and the filtrate pressure is measured at P_F. Monitoring of these pressures is critical to measure process performance and for process control. The cross flow rate is orders of magnitude above the filtrate flow rate and it is this phenomena that prevents a membrane filter from clogging from material that would rapidly clog a membrane filter operating in "normal flow" filtration. In flat sheet devices, even though the geometry of the device is different, the operation of the process is similar. TFF is a very effective process selection in many areas of biopharmaceutical processing. Depending on the process, a filtrate pump may be used to limit the filtrate flow and prevent rapid filter fouling. A throttling valve may be used on the retentate tube to create back pressure to drive liquid through the membrane. In a TFF process, as filtrate is removed, the vessel contents are concentrated. In a diafiltration process, liquid is added to the product vessel as the same rate of filtrate removal.

Figure 1

Figure 2
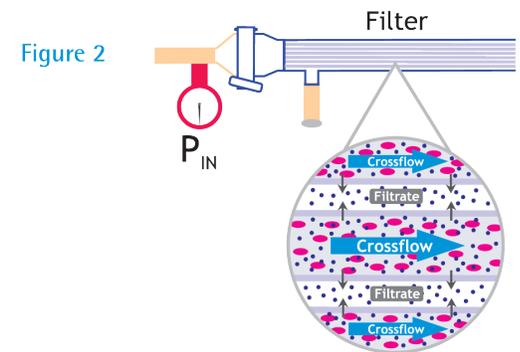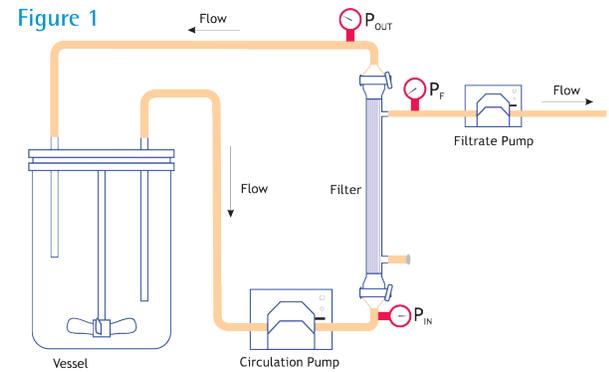
TFF Process Control System Process Schematic with Available Inputs and Outputs
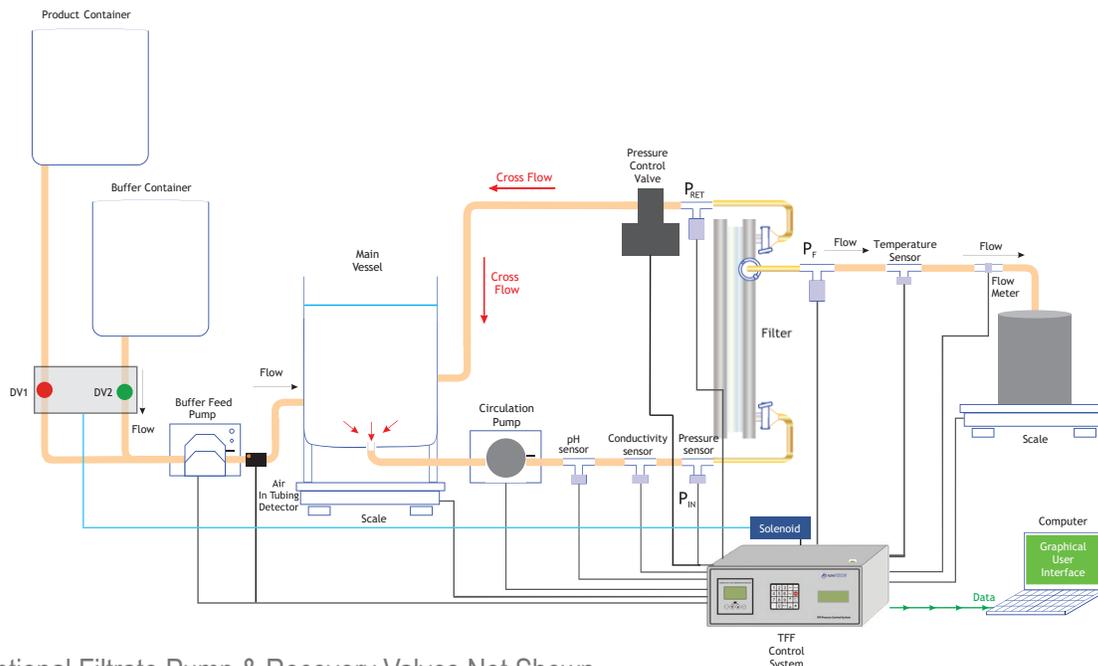
Note: Optional Filtrate Pump & Recovery Valves Not Shown

Graphical User Interface - Simplifies Control System Interaction

The GUI is designed for use with a mouse or touch-screen operation. Clicking a numeric field is followed by appearance of a pop-up key pad for data entry. Values entered that are out of range are rejected with a message. There are eight tabs for easy navigation:

Multiple tabs for Fast and Easy Navigation (System View shown)
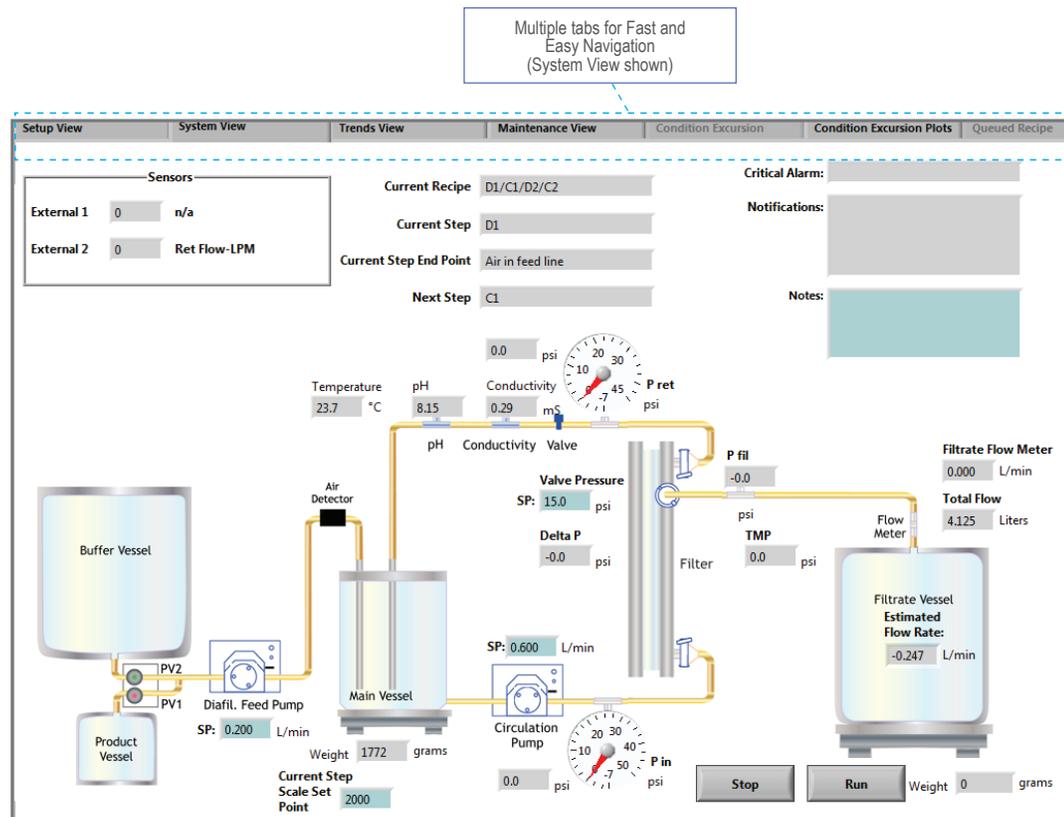
1. Setup View- used to enter experiment information, program recipe, set alarms and to create a data file where all process data will be stored

2. System View- used to view current process values and change pump flow rates*

3. Trends View- utility to trend process variables that is loaded with features to dynamically view the data of interest, and ability to export a trend of interest either as data or a graphics file; ability for instant opening of data of interest in Excel

4. Maintenance View- used to set up pumps based on pump parameters, calibrate pH and conductivity via easy to use wizards, configure flow meter and more

5. Condition Excursion - The excursion feature is for Design of Experiments to determine optimal process condition by programming 40 conditions at different combinations of pump flow rates, TMP setpoints and concentration to be run automatically

6. Condition Excursion Plots - F lux versus TMP versus concentration is graphed to visualize optimal condition

7. Queued Recipes - Software feature where up to 4 consecutive Recipes can be programmed and each with Diafiltration Valve selection to enable the ability run a more custom automated process without any special programming required

8. Concentration Plot - Ability to enter starting concentration and from there the concentration is estimated by changing scale weights as the process progresses and the Flux version Concentration is plotted and from there, which can assist in determining the optimalconcentration point to conduct the diafiltration step

* The System View can be customized with selection of a hollow fiber or cassette module graphic and with the ability to enable/disable the filtrate pump.

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System

View current process values and change pump flow rates

Critical Alarm - Critical alarm that stops pumps appears here in RED.

Notifications - Give notifications but do not trigger an alarm. These can be enabled to send email alerts also.

Notes - Click here and a pop-up box appears where an electronic note can be entered. The note is written to the data file one time and time-stamped.

External sensor readings

Gauge ranges set by min/max alarm set points

All process variables are displayed including calculated values such as TMP and DeltaP

Flow only appears if flow meter configured

Pumps rotate while running

Indicators in blue can be changed while running by clicking on the indicator

Estimated flow rate can be calculated by an algorithm based on the change in filtrate scale rate.

Setup View | System View | Trends View | Maintenance View

Sensors
External 1   0.01   UV- AUs
External 2   0.00   Ret Flow- LPM

Current Recipe   Diaf/Conc
Current Step   Diaf
Current Step End Point   Air in Feed Line
Next Step   Conc

Recipe Info

Critical Alarm:
Notifications:
Notes:

Temperature 15.8 °C   pH 5.65   Conductivity 0.02 mS   0.0 psi   P ret 25 psi

pH   Conductivity   Valve

Buffer Vessel

Air Detector

P fil -0.1 psi

Filtrate Flow Meter   0 L/min
Total Flow   0 Liters

Delta P 0.0 psi   Filter   TMP 0.2 psi   Flow Meter

Filtrate Vessel Estimated Flow Rate: 0 L/min

PV2
PV1
Diafil. Feed Pump   SP: 0.240 L/min

Product Vessel

Main Vessel
Weight 1814 grams

Current Step Scale Set Point 1980

SP: 0.055 L/min

Circulation Pump

P in 45 psi
0.1 psi

Stop   Run   Weight 103 grams

Setup

Enter experiment information, program recipe, set alarms and creates a data file where all process data will be stored

Information is written to header of data file when data collection is started; then it becomes uneditable

When Start Process Data Collection is selected, a dialog box appears so a file name and location can be entered. All process data is saved to a CSV file that can be opened later in software such as Excel.

When selected, data logging is stopped and a PDF is created

6 Options Available
- Manual
- No Recipe
- Concentration
- Diafiltration, Concentration
- Dilafiltration 1, Concentration 1, Diafiltration 2, Concentration 2
- Recovery

Settings for selected recipe are entered here

Filtrate pump appears only if enabled

Alarms set-points will stop pumps

Notification points (create no action)

Ability to save/recall frequently used recipes

Once a data file is started this button becomes enabled and if selected it activates the queued recipe tab feature

Configure notification email or text message alerts

Setup View | System View | Trends View | Maintenance View | Condition Excursion | Condition Excursion Plots | Queued Recipe

Experiment Name   Demo
Filter Name   Company ABC
Filter Area (m^2)   0.1000
Starting Volume (L)   2.000   Starting Concentration (mg/mL)   1.00
File name and location:
C:\TFF\demo22.csv

Conductivity Measure Location: filtrate
Other Details: Batch XYZ
Total Grams   2.000

Start Process Data Collection
End Process Data collection
File Update Rate (min)   .1
Save Process Info
Recall Process Info

Recipe Selection: Diafiltration 1, Concentration 1, Diafiltration 2, Concentration 2   Auto Run Recovery
Diafiltration 1   Concentration 1   Diafiltration 2   Concentration 2

	Diafiltration 1	Concentration 1	Diafiltration 2	Concentration 2

Diafiltration End Point   Air in Line
Diafiltration Weight   2000
Main Scale End Point   200
Diafiltration End Point   Weight Filtrate Scale
Diafiltration Weight   200
Main Scale End Point   100

Pump Flow Rates (LPM) Circulation: 0.6
Diafeed Pump   0.2

Pump Flow Rates (LPM) Circulation: 0.55
Pump Flow Rates (LPM) Circulation: 0.55
Diafeed Pump   0.2
Filtrate Scale Weight End Point   4800
Pump Flow Rates (LPM) Circulation: 0.54

Pumps programmed for different steps

6 Diafiltration endpoint options listed:

Diafiltration End Point
- Weight Filtrate Scale
- Total Flow (Liters)
- Air in Line
- Conductivity
- pH
- Conductivity and pH

Run Queued Recipes

Critical Alarm Set Points:	P in	P ret	P fil	TMP	pH	Conductivity	External 1	External 2
Maximum	50.0	45.0	33.0	55.0	25.00	100	100	100
Minimum	-7.0	-7.0	-7.0	-7.0	0.00	0	-99	-99

Notification Points:	P in	P ret	P fil	TMP	pH	Conductivity
Maximum	38.0	38.0	22.0	29.0	14.00	22
Minimum	-3.0	-3.0	-3.0	-3.0	0.00	0

Critical Alarm:
Notifications:

Configure Email   Stop   Run
Current Run Mode   Stop

Trends

Utility to trend process variables with features to view the data of interest, auto or manual scale the axes, & export a trend as a data or graphics file

Slide to change cursor value

Options to select Auto-scale or Manual scale on all axes

Powerful tools to zoom, export an image of the current trend and much more

Quickly compare current values to cursor value

Ability to change plot update rate

Export the current trend only to open in software such as Excel

Trend Select	Y-axis units	Current Value	Cursor Value
Pressure In	PSI	11.75	14.16
Pressure Ret.	PSI	7.43	9.4
TMP	PSI	9.63	11.83
Circ. Pump	L/min	0.075	0.075
pH	pH/Analog	7.04	7.05
Conductivity	(mS)	0.03	0.03
None		0	0
None		0	0

Update Rate (min) .1
Plot Area Day(s) 0.25
Export
Current Run Mode Stop

Maintenance

Use to set up pumps based on tubing size, calibrate pH & conductivity via wizards, select units of measure, configure flow meter & more

Functions Include:

- Zero pressure sensors
- Enable/disable filtrate pump
- Select conductivity input type/enter predetermined cell constant (K)
- Calibrate pH
- Set units of measure
- Set-up pumps
- Select graphic display for filter
- Configure the flow meter
- Zero flow meter total
- Set range of external signals
- Enable/disable Diafiltration Valves
- Exit program

pH wizard zoom

Filtrate Flow Meter that is also used to determine flux, has a choice of flow meters that set the K-factor for the flow meter or the K-factor may be entered manually or determined by a user calibration wizard.

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Condition Excursion

Condition excursion function where up to 40 different conditions can be programmed and saved - designed for DOE

Reset timer back to 0 seconds

For Stage 2, 3 & 4 the weight is entered to start a stage. Could be the same or lower weight (higher concentration)

Start Excursion

Stop (or pause) Excursion

Indicates time spent in each step

Pause excursion timer during a step. Used if more time is needed in a specific step - excursion continues to run

Enter electronic notes to data file

Pressure and flowrate setpoints for each step

Save excursion setup

Recall saved excursion setups

Restore tab back to default values
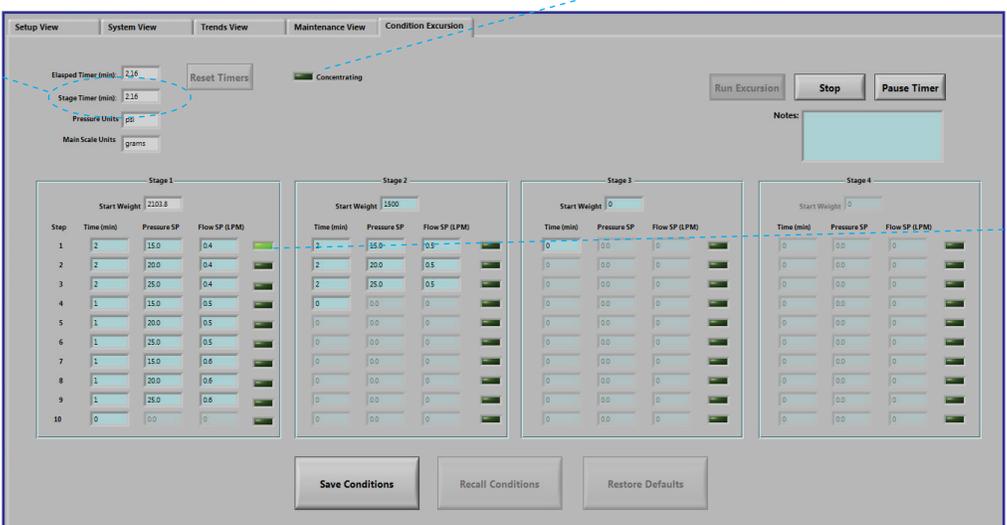
Indicates concentration occurring between stages

Stage timer is automatically reset to zero when a new stage begins

LED indicator turns on when stage is complete

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Process excursion plots tab- creates real-time graphs to view flux vs TMP plots at different flow rates

Condition Excursion Plots

All 40 conditions can be used to create a complex process optimization experimental design
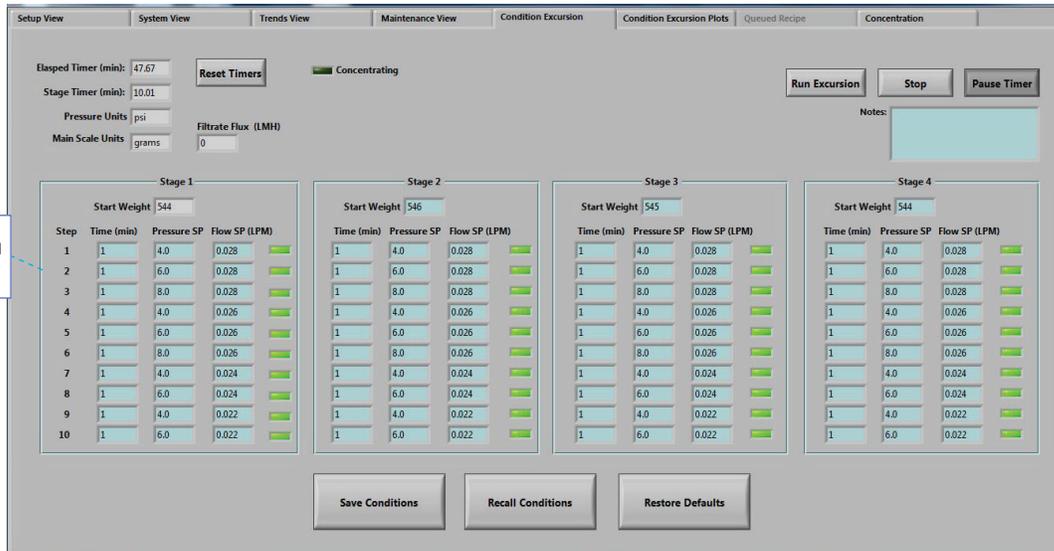
Shown is a completed run of all 40 conditions

Each stage in the excursion has its own plot

The current flux value is shown. The value plotted is the average of the last 6 values before the step is finished.

The flow rates are plotted with different color lines
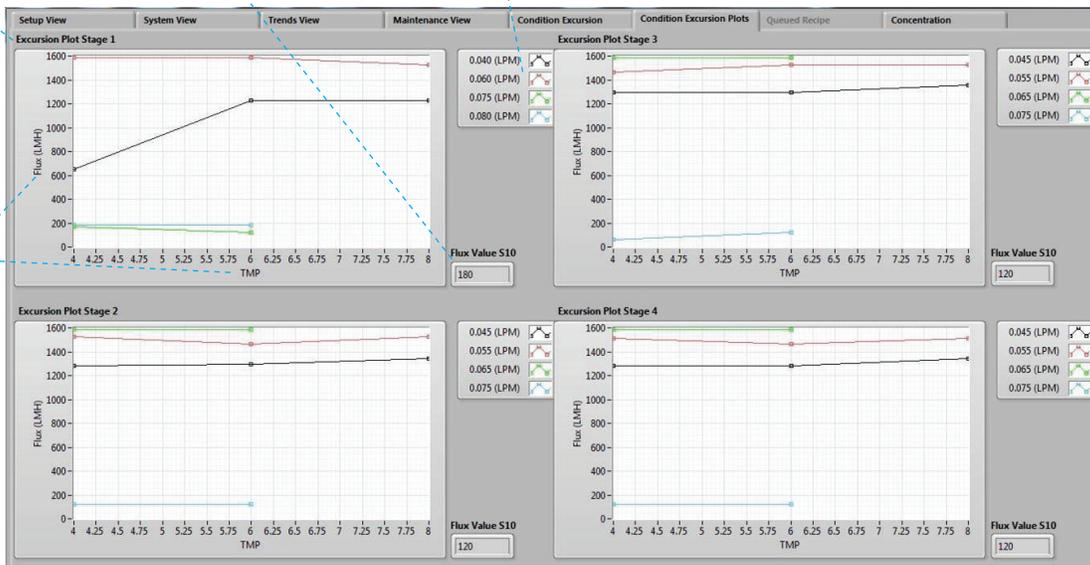
On each plot there is flux on the Y-axis; there is TMP on the X-axis

Queued Recipe

Allows some more customized recipes to be created with the ability to program up to 4 in a queue that will run consecutively

Recipe options available

If no selection is made the process will end after the previous recipe is completed

The diafil valve indicator appears and the selection can be made to which one is open during that recipe. This allows for additional flexibility to customize a process.

Shown below is a sample of 4 queued recipes that will run consecutively for a total of 8 steps

Concentration

Based on user entered data of batch volume & starting concentration, the concentration is calculated and plotted with flux data

On the setup view the starting volume and the starting concentration are entered

Setup View	System View	Trends View	Maintenance View	Condition Excursion	Condition Excu

Experiment Name demo

Filter Name Company XYZ

Filter Area (m^2) 0.0050

Starting Volume (L) 0.100   **Starting Concentration (mg/mL)** 5.00

File name and location:

Conductivity Measure Location: filtrate

Other Details: Batch ABC

Total Grams 0.500

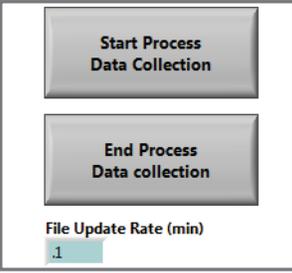| Setup View	System View	Trends View	Maintenance View	Condition Excursion	Condition Excursion Plots	Queued Recipe	Concentration

Flux vs Concentration
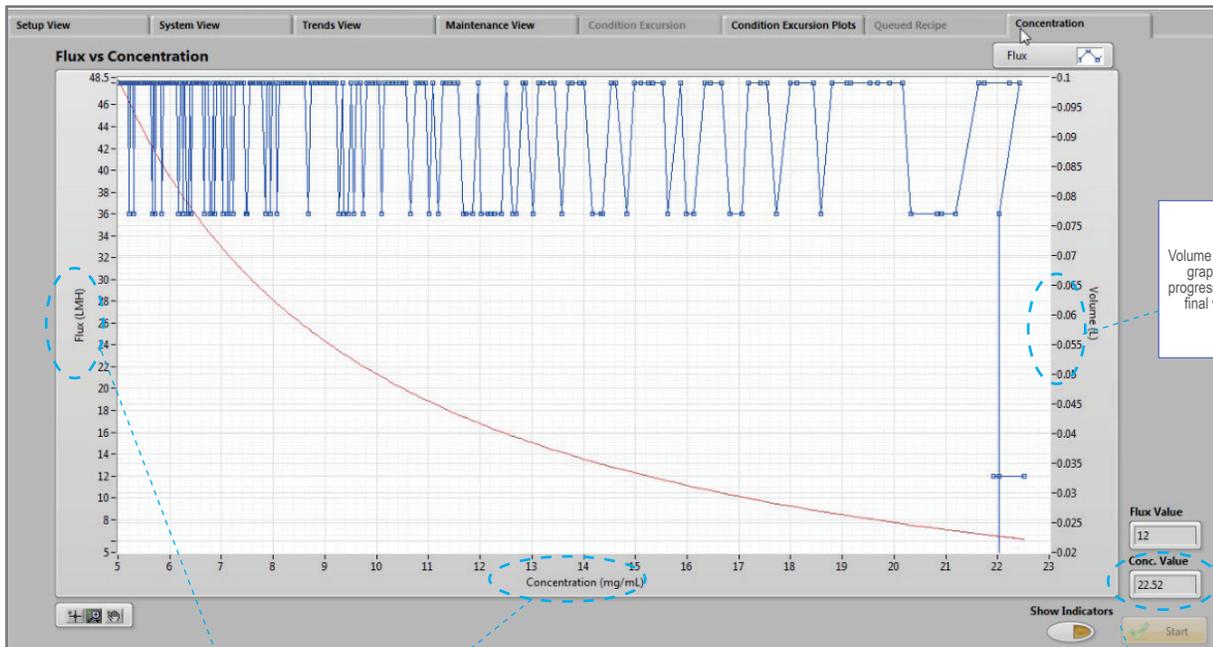
Flux

Volume is plotted on the graph to visualize progression towards the final volume target

Flux Value
12

The initial concentration is based upon the data entered on the setup view

Conc. Value
22.52

Show Indicators

Start

The flux is plotted on the Y axis and the concentration on the X axis. This plot visualizes the relationship of the flux through the filter as the product is concentrated. Monitoring these parameters provides key information to help determine optimal process conditions.

When the concentration process is started, the start button is pressed and the calculations will begin. This is typically done when the experiment has been setup and the RUN button is pressed to execute the process

Separately from the trending function, data is written to the file created when data collection is started on the setup tab and the frequency is set on the same tab which can be different than the trending frequency. The data is written to a locked file until the user "ends data collection," and the file is then released. All data and notes are logged. A example of the header and the columns included in the data file is shown below. Data is logged real-time and if a power failure or PC problem occurs, all data is captured to the file until that point in time.


Buttons from Setup Tab

Data File Example

Automatic Creation of a Locked, Uneditable PDF Data File

When End Experiment is selected to end logging to the file, a PDF file that is locked and password protected is automatically created. The Excel file is locked while data is being logged but will not be locked after End Data Collection is selected. So this automatic creation of a PDF file, provides the user with a locked, un-editable copy of their data. The PDF will have the same name as the CSV as shown below:

Integration Options
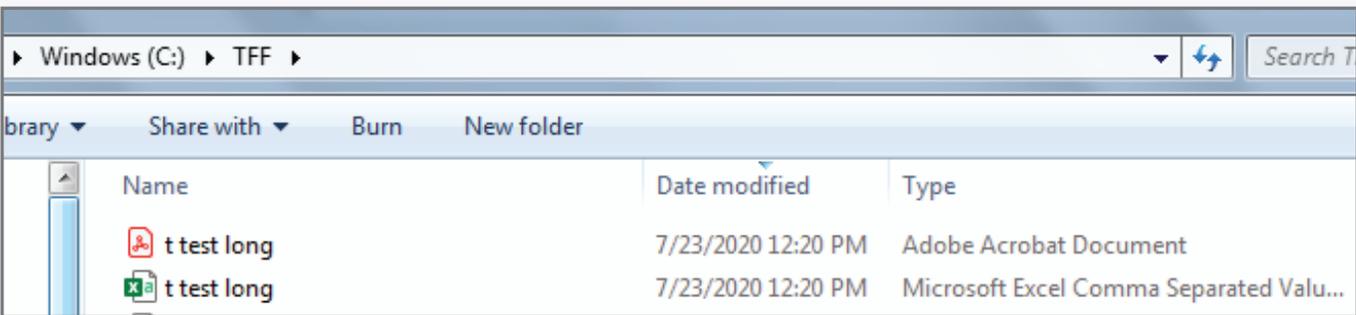
Control System Back Panel Input/Output Connections
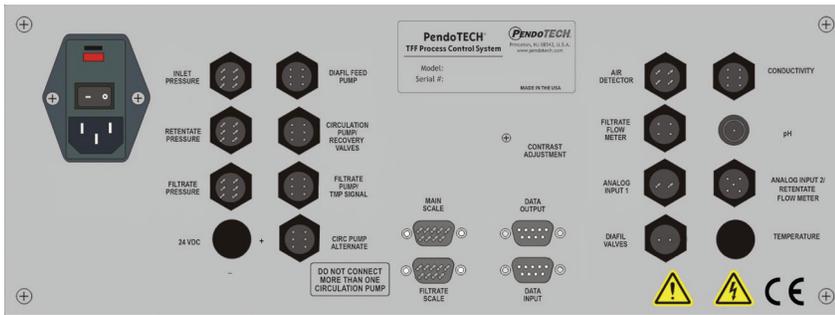
The system comes with the required cables to enable the sytem to be quickly up and running. All connections are keyed to prevent connection of a cable to the wrong connector. Pumps and scales may be delivered with the system or existing equipment or self-procured equipment may be used.

Conductivity Sensors

The system measures conductivity via the PendoTECH Single Use Conductivity Sensor which is also robust enough for cleaning and extensive reuse. The sensors are available in a range of sizes. All sensors have a pre-determined cell constant that is printed on their tag which is entered into the software. Temperature compensation performs normalization to 25°C and have a measurement range of 0 to 100mS.

Pressure Sensors

Pressure sensor cables provided with the system accept the PendoTECH Pressure Sensors (below). Even though these are called single use, they are robust enough to be re-used for process development work where cross-contamination is not a concern. Sizes available luer, 1/8inch,1/4inch, 1/2inch, 3/8inch, 1/2inch, 3/4inch and 1inch hosebarb, also in sanitary flange. Ultra secure tubing retainers are available for higher pressure operations.

Other sensors such as Stainless Steel transducers with full bridge - 4 wire output may be used.

pH

Single Use Probe inserted into the 2 flow cells

pH measurement is integrated to the system. The probe can be removed from the cell for calibration with buffers using the software's pH calibration wizard. The PendoTECH Single Use pH Probe may be re-used, however, in applications where cross contamination is desired to be avoided, it can be easily replaced with a new one. The probe must be calibrated before use, then inserted into the flow cell and hand tightened. The flow cell is available in two sizes: 1/4inch hose barb and 3/4inch sanitary flange.

WARNING: Maximum pressure of 15psi/1 bar

Temperature

Temperature is displayed in the software system view and recorded in the data file.There are several options to measure temperature - either a luer fitting for small scale, and in-line hose barb sensors, and a dip probe.

Hose Barb

Luer Sensor   *Dip Probe*

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Pump Options

• Any pump with a remote speed control input can be used- no process scale limitations!
• Peristaltic, rotary lobe, diaphragm pump, and other
• Pump Setup function used to quickly enter the pump parameters
• Masterflex pump selection guide available from PendoTECH
• The pump cables are supplied to interface to the remote control connector on the user selected pumps as shown in the example to the right.

Interface Connector

Pump Cable (Masterflex Pump Cable Shown)
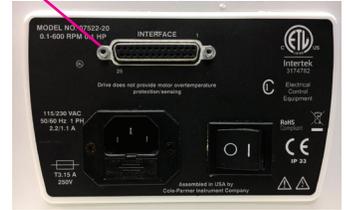
Example of Pump Back Panel with remote interface connector

Peristaltic Pump Features

A peristaltic pump allows for quick changeout of the tubing to prevent cross-contamination and tubing is available in a wide range of materials for different applications. Peristaltic pumps are self-priming and can run dry to drain the tubing. They are positive displacement pumps so based on the different options of tubing inner diameter, one pump model can cover a wide range of flow rates. For many applications they can generate adequate pressure based on the pump design and tubing used.

Quattroflow™ Diaphragm Pump Features

The method of operation of Quattroflow pumps allows them to gently, safely and securely convey aqueous solutions and biological products that are sensitive to shear force. The design does not feature a mechanical shaft seal or wetted rotating parts, ensuring total product containment without abrasion. Additionally, the pumping principle enables risk-free dry-running, low pulsation, self priming, and minimal particle generation.

The QF30SU pump offers the following features:

• A wide range of flow and pressure up to 4bar (58psi) which is generally not achievable with peristaltic technology

• The pressure capability enables concentration to high concentration factors as the product becomes viscous

• The pump design is for low shear operation that can reduce pump damage to fragile biomolecules and shear-sensitive viruses

• A pump chamber that can be reused extensively or can be swapped quickly without the use of tools in situations where cross-contamination wants to be avoided

Scale Options

• Most scales with RS232 communication can be used
• Control system has customized software interface for optimal integration of scales to enhance performance

• A scale selection menu on the process control system is used to quickly configure the RS232 parameters for the different scale brands.

PendoTECH Throttle Valve™ Option

The valve receives the pressure signal from the control system and controls back pressure by varying the flow path area by only contacting the outside of the tubing without the valve contacting the fluid. It includes one-touch real-time adjustment of the proportional setting for the PID control to account for different pumps and system setups.

Air Detector Option

The non-invasive ultrasonic air detector detects air in a tube placed into the detector. There is an integral LED that indicates liquid presence. The tube can be opaque because the sensing mechanism is sound waves. The software has a user entered detection delay to prevent false endpoints.

The Air Detector which detects the difference between air and liquid in a tube, is integrated into the software as a Diafiltration Endpoint. This can be used primarily in one of two ways. One is to run a fed-batch process where liquid is continuously fed to allow a batch to be continuously added to the vessel which simultaneously concentrates. This gives more flexibility to a defined setup and can assist in minimization of the overall system hold-up by minimizing the vessel size. Secondly, it can be used with a pre-measured buffer volume for a diafiltration step.

Diafiltration Valves

Pneumatic valves for 3/8inch ID tubing

*Electric valves for 1/8inch & 1/4inch ID tubing*

Diafiltration valves work with the air detector end-point and can be used for "Fed-batch" process where product is fed to the main vessel and dynamically concentrated via diafiltration mode. After the concentration step the valves switch to buffer and the diafiltration pump will then draw in buffer for that step.

Filtrate Flow Meter Options

For filtrate flow measurement, flux calculation, and total flow measurement, there is a Filtrate Flow Meter input on the back panel. This reads a digital pulse/frequency input signal that is an available output on many flow meters. Basic flow meter measurement technology can be used to measure clean, filtered material with relatively consistent viscosity. Ultrasonic flow measurement is available with the Leviflow Sensor with five models available covering the range from 10mL/min to 80L/min. These can be used on a single use mode or re-used and have high accuracy of +/- 1%. There is also a Low Flow Ultrasonic Flow Meter capable of measuring flows in a range of 5 to 100 mL/minute. This model has a low hold-up volume and a 1/16inch ID x 1/8inch OD and a luer fitting inlet fitting for easy connection. The rotary flow meters have a 1/4inch hose barb and can measure flows from about 0.1 to 2L/min or a 1/2inch barb that can measure flows from 1.0 to 20L/min. These rotary flow meters can be used in a single use mode or re-used.

Leviflow Sensor Monitor with Sensor Stand Click here for data sheet
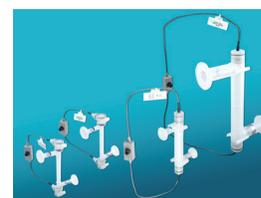
A selection of sensors to cover a wide range of flow rates

Rotary Flow meter

Low Flow Ultrasonic

Retentate Flow Meter Options

For retentate flow where there may be a shift in viscosity flow must be measured by other types of flow meters such as a Coriolis Flow Meter or magnetic flow measurement technology. There are 2 models of the PendoTECH Coriolis Flow Meter covering the range from 5 to 4,000g/min and a range of models of the BH-Coriolis available for up to 1 to 5,000g/min. For higher flow rates there are two mag flow meters available. The Krohne FLEXMAG 4050 offers a single use option and a wide range of flow rates that can be measured. Click here for product data sheet. The E+H Promag can measure from 2 to 45L/minute. These flow meters connect into the Analog Input 2 connector on the back panel which is a 4-20mA analog input signal. The 4mA and 20mA output range of the flow meter in L/minute is entered into the software. Connecting to this input, integrates the reading into the option Retentate Flow Control algorithm.

PendoTECH Coriolis

BH Coriolis

Krohne FLEXMAG 4050

E+H Mag Flow Meter

Lab Scale Process Vessels

Three different size vessels with Low Holdup Volume - the key to minimizing overall system holdup. All have a conical bottom with mixing and a low point drain.

Small Scale Vessels

- Design with conical base with low-point drain minimizes liquid hold-up
- Luer outlet at base that facilitates easy integration to any process flow path
- Lid with 3 holes easily inserts into vessel -   2 holes for placement of dip tubes and one for venting
- Locator at bottom for stir bar for process mixing
- Transparent with graduation marks for accurate process volume measurement
- Made of polysulfone which is compatible with many chemicals including sodium hydroxide
- Available in 2 different sizes of 600mL and 140mL

Contact Materials
Vessel: Polysulfone
Dip Tubes: Nylon

*Stir plate not included

Luer Outlet

600mL with 40mL in conical section

140mL with 12mL in conical section

Pocket for the included magnetic stir bar*

2 Liter Vessel

Vessel Detail - *2 Liter Vessel shown*

Removable collars for tube adjustment/ removal

Buffer Feed & Retentate tubes can be positioned to deliver liquid to the bottom

Spare hole for venting or recycle

Top and base attached by sanitary clamps

Vessel made of polysulfone - easily removed for cleaning

Conical base with low point drain

Stand with adjustable legs for included stir plate

Stir bar locator in the center of the base

Lab Scale Flow Cell for a Variety of 12mm OD Probes

PendoTECH has available lab scale flow cell made of acrylic material. It could be used to make measurements from 12mm OD probes and features a low hold-up volume. It can be used with a pH probe that connects directly to the pH input on the rear panel of the system. And additionally it can be used for probes connected to 3rd party transmitters that are connected to one of the analog inputs. For example, this could be used to measure a second conductivity, dissolved oxygen or other. If only one probe is to be used there is a blank available to seal the second probe port. The probe port blank can also be used to seal the port during cleaning if the probe is removed.

Acrylic Flow Cell shown with 12mm OD epoxy conductivity probe & 12mm OD polysulfone pH probe.

Compression fitting to secure probe

Low hold-up volume fluid path

Available with different fitting options

1/2inch hole for mounting

WARNING: Maximum pressure of 15psi/1 bar

UV Absorbance & Turbidity

PendoTECH's Single-Use UV Absorbance and Turbidity measurement units can measure from the bioprocess fluid streams while it is processing, resulting in less disruption to bioprocessing operations compared to off-line measurements. PendoTECH's Single Use UV Flow Cells, coupled with a unit's compact photometer with fiber optic cables, can measure the UV absorbance at 280nm without product contact. Additionally, the single wavelength LED light source in the unit is available in other popular wavelengths of 300nm and 260nm and most other wavelengths in the UV-VIS-NIR range. Our Turbidity Flow Cells and 880nm photometer can measure the turbidity of a liquid as it flows through a tube in a process. The single use cells are cost-effective for disposable applications, but also may be repeatedly cleaned and reused. The photometer has no display so via their transmitter feature they integrate to the analog input on the TFF System to display the measured value. On the Maintenance View of the software the range of measurements and units of measure are configured. The UV flow cell can be placed on the filtrate/permeate tubing to detect breakthrough of product through the filter membrane. An alarm can be set so when breakthrough is detected the process will stop. Concentration measurement may or may not be possible because saturation may occur quickly during the concentration process because the flow cell has a fixed path length.

UV Flow Cells

Photometer

Turbidity Flow Cell

UV Flow Cell Stand

PENDOTECH
Adding Value To Your Process

Small Scale Benchtop Setup

Diafiltration Feed Selection Pinch Valves

Diafiltration feed pump

Air Detector For Fed Batch End Point

Retentate Flow Meter

Vessel with stirrer

Control System

Filtrate Flow Monitor

Throttle Valve Controller

PC for Graphical User Interface

Filtrate Flow Cell

pH Probe in Flow Cell

Throttle Valve

Pressure Sensors

Circulation Pump
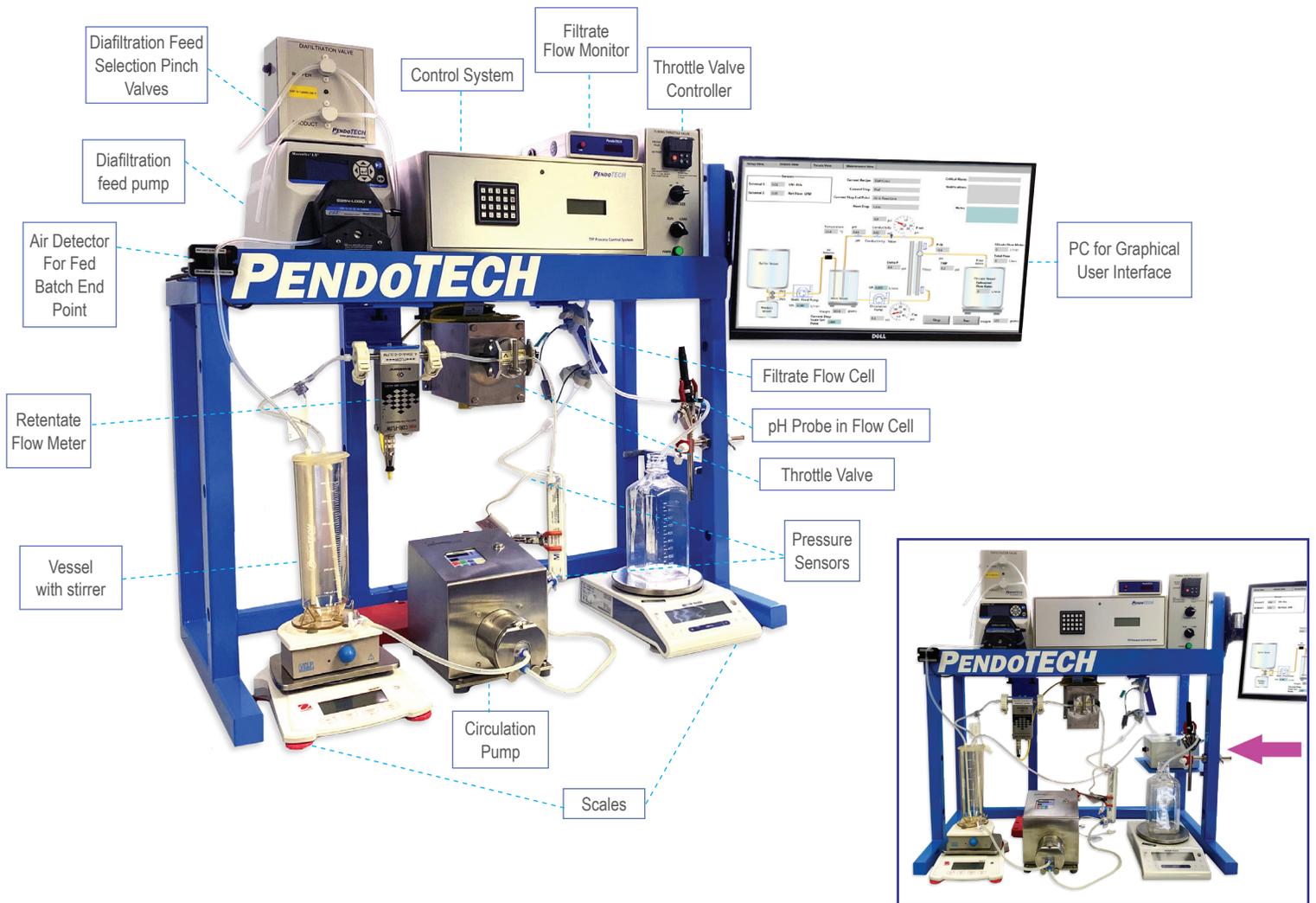
Scales

Stand shelf for valve box to automate excursions at different concentrations by diverting flow to permeate scale for automated stage to stage progression

Hold-up volume calculator - Small Scale Benchtop Setup

	If Tube, length (cm)	Select tube ID from pick list	Hold-up per cm (mL)	Volume (mL)	Total (mL)	% of total
Vessel				5	5.0	21.6%
Tube-Vessel to Pump	15	ID of 1/8inch	0.0792		1.2	5.1%
Pump				3	3.0	13.0%
Tube-Pump to Filter	20	ID of 1/8inch	0.0792		1.6	6.8%
Filter and Holder Path				10	10.0	43.2%
Tube-Filter to Vessel	30	ID of 1/8inch	0.0792		2.4	10.3%
Other 1				0	0.0	0.0%
Other 2				0	0.0	0.0%
				GRAND TOTAL:		23.1mL

Benchtop Systems

Pre-configured Small Scale Benchtop Setup		
Operating Scale	Small Scale with Diaphragm Pump	Small Scale with Peristaltic Pump
System Part #	PDKT-PCS-TFF-SD	PDKT-PCS-TFF-SP
System Part # With Fed-Batch Accessories*	PDKT-PCS-TFF-SD-F	PDKT-PCS-TFF-SP-F
Part #'s/Description — Circulation / Filter Feed Pump	PUMP-QF30D-SU	PUMP-MF-LS-TKW
Part #'s/Description — Diafiltration Pump	PUMP-WM-120TW or PUMP-MF-LS-TW	PUMP-MF-LS-TW
Part #'s/Description — Main / Retentate Vessel Scale	SCALE-OHAUS-8200-1	SCALE-OHAUS-8200-1
Part #'s/Description — Filtrate / Permeate Scale	SCALE-MT-35000-0	SCALE-MT-35000-0
Part #'s/Description — Throttle Valve	PDKT-PVT	PDKT-PVT
Part #'s/Description — Vessel	PDKT-TNK500M	PDKT-TNK500M
Fed-Bath Accessories — Air in Tube Detector	AD-16-P	AD-16-P
Fed-Bath Accessories — Diafiltration Selection Valves	PDKT-PVE2-TFF-S	PDKT-PVE2-TFF-S
Accessories — pH	PT-PH1-L	PT-PH1-L
Accessories — Conductivity	CONDS-N-012	CONDS-N-012
Accessories — Retentate Coriolis Flow Meter	FM-BC-14	FM-BC-14
Accessories — Filtrate / Permeate Flow Meter	FMT-LFS monitor with flow cell FM-LFS-03SU	FMT-LFS monitor with flow cell FM-LFS-03SU
Accessories — UV Detector for Permeate	SPEC-L-1-SU-280	SPEC-L-1-SU-280
Tank Options — Alternate Vessels	PDKT-TNK125M	PDKT-TNK125M
Feed Rate Range (mL/min) — Pump Flow Rate Range	2 to 100	1 to 480
Feed Volume (L) — Approximate Range*	0.1 - 2	0.1 - 2

* Feed volume increased with fed-batch functionality
^ Holds two probes

NOTES:

Development Scale Benchtop Setup

Hold-up volume calculator - Development Scale Benchtop Setup

	If Tube, length (cm)	Select tube ID from pick list	Hold-up per cm (mL)	Volume (mL)	Total (mL)	% of total
Vessel				10	10.0	18.0%
Tube - Vessel to Pump	15	ID of 1/4inch	0.3167		4.8	8.5%
Pump				15	15.0	27.0%
Tube - Pump to Filter	20	ID of 1/4inch	0.3167		6.3	11.4%
Filter and Holder Path				10	10.0	18.0%
Tube - Filter to Vessel	30	ID of 1/4inch	0.3167		9.5	17.1%
Other 1				0	0.0	0.0%
Other 2				0	0.0	0.0%
					GRAND TOTAL:	55.6mL

Pre-configured Development Scale Benchtop Setup

Operating Scale		Development Scale with Diaphragm Pump	Development Scale with Peristaltic Pump
System Part #		PDKT-PCS-TFF-BD	PDKT-PCS-TFF-BP
System Part # With Fed-Batch Accessories*		PDKT-PCS-TFF-BD-F	PDKT-PCS-TFF-BP-F
Part #'s/Description	Circulation / Filter Feed Pump	PUMP-Q150SS	PUMP-MF-LS-TW
	Diafiltration Pump	PUMP-MF-LS-TW	PUMP-MF-LS-TW
	Main / Retentate Vessel Scale	SCALE-MT-15000-1	SCALE-MT-15000-1
	Filtrate / Permeate Scale	SCALE-MT-35000-0	SCALE-MT-35000-0
	Throttle Valve	PDKT-PVT	PDKT-PVT
	Vessel	PDKT-TNK	PDKT-TNK
Fed-Bath Accessories	Air in Tube Detector	AD-17-P	AD-17-P
	Diafiltration Selection Valves	PDKT-PVE2-TFF-M	PDKT-PVE2-TFF-M
Accessories	pH	PT-PH1-L	PT-PH1-L
	Conductivity	CONDS-N-025	CONDS-N-025
	Retentate Coriolis Flow Meter	FM-BC-15	FM-BC-15
	Filtrate / Permeate Flow Meter	FMT-LFS monitor with flow cell FM-LFS-03SU	FMT-LFS monitor with flow cell FM-LFS-03SU
	UV Detector for Permeate	SPEC-L-1-SU-280	SPEC-L-1-SU-280
Tank Options	Alternate Vessels	PDKT-TNK500M	PDKT-TNK500M
Feed Rate Range (mL/min)	Pump Flow Rate Range	~100 - 3000	~100 - 1600
Feed Volume (L)	Approximate Range*	0.5 - 5	0.5 - 5

* Feed volume increased with fed-batch functionality
^ Holds two probes

NOTES:

Q150 Pump Setup

Diafiltration Feed Pump

Air Detector For Fed Batch End Point

Diafiltration Feed Selection Pinch Valves

Throttle Valve

Retentate Flow Meter

PC for Graphical User Interface with Touch-Screen

2 Liter Vessel with Stirrer Conical Bottom With Low Point Drain

Filtrate Flow Meter

Pressure Sensors

Scale

Circulation Pump

Throttle Valve Controller

Control System

Waterproof integral keyboard/ mouse on slideout tray

Filtrate Scale

Heavy Duty Locking Casters

Hold-up volume calculator - Q150 Pump Setup

	If Tube, length (cm)	Select tube ID from pick list	Hold-up per cm (mL)	Volume (mL)	Total (mL)	% of total
Vessel				10	10.0	14.7%
Tube - Vessel to Pump	15	ID of 1/4inch	0.3167		4.8	7.0%
Pump				15	15.0	22.0%
Tube - Pump to Filter	30	ID of 1/4inch	0.3167		9.5	13.9%
Filter and Holder Path				10	10.0	14.7%
Tube - Filter to Vessel	60	ID of 1/4inch	0.3167		19.0	27.8%
Other 1				0	0.0	0.0%
Other 2				0	0.0	0.0%
				GRAND TOTAL:		68.3mL

Process Development Carts

Pre-configured Q150 Pump Setup		
Operating Scale		Process Development Cart with Diaphragm Pump
System Part #*		PDKT-PCS-TFF-BDC-F
Part #'s/Description	Circulation / Filter Feed Pump	PUMP-Q150SS
	Diafiltration Pump	PUMP-MF-LS-TKW
	Main / Retentate Vessel Scale	SCALE-MT-15000-1
	Filtrate / Permeate Scale	SCALE-AND-32000-1D
	Throttle Valve	PDKT-PVT
	Vessel	PDKT-TNK
	Air in Tube Detector	AD-17-P
	Diafiltration Selection Valves	PDKT-PVE2-TFF-M
	Cart	CART-TFF-COMPACT-RFMS
Accessories	pH	PT-PH1-L
	Conductivity	CONDS-N-025
	Retentate Coriolis Flow Meter	FM-BC-15
	Filtrate / Permeate Flow Meter	FMT-LFS monitor with flow cell FM-LFS-03SU
	UV Detector for Permeate	SPEC-L-1-SU-280
Tank Options	Alternate Vessels	PDKT-TNK500M
Feed Rate Range (mL/min)	Pump Flow Rate Range	~100 - 3000
Feed Volume (L)	Approximate Range*	0.5 - 5

* Feed volume increased with fed-batch functionality
^ Holds two probes

NOTES:

Q1200 Pump Setup

Masterflex L/S Pump Setup

Hold-up volume calculator - Q1200 Pump Setup

	If Tube, length (cm)	Select tube ID from pick list	Hold-up per cm (mL)	Volume (mL)	Total (mL)	% of total
Vessel				10	10.0	5.4%
Tube-Vessel to Pump	15	ID of 3/8inch	0.7126		10.7	5.8%
Pump				75	75.0	40.6%
Tube-Pump to Filter	30	ID of 3/8inch	0.7126		21.4	11.6%
Filter and Holder Path				25	25.0	13.5%
Tube-Filter to Vessel	60	ID of 3/8inch	0.7126		42.8	23.1%
Other 1				0	0.0	0.0%
Other 2				0	0.0	0.0%
				GRAND TOTAL:		184.8mL

Hold-up volume calculator - Masterflex L/S Pump Setup

	If Tube, length (cm)	Select tube ID from pick list	Hold-up per cm (mL)	Volume (mL)	Total (mL)	% of total
Vessel				10	10.0	12.0%
Tube-Vessel to Pump	15	ID of 1/4inch	0.3167		4.8	5.7%
Pump				15	15.0	18.0%
Tube-Pump to Filter	30	ID of 1/4inch	0.3167		9.5	11.4%
Filter and Holder Path				25	25.0	30.0%
Tube-Filter to Vessel	60	ID of 1/4inch	0.3167		19.0	22.8%
Other 1				0	0.0	0.0%
Other 2				0	0.0	0.0%
				GRAND TOTAL:		83.3mL

Process Development Carts

Pre-configured Q1200 Pump & Masterflex L/S Setup		
Operating Scale	Process Development Cart with Peristaltic Pump	Process Development Cart with HI FLOW Diaphragm Pump
System Part #*	PDKT-PCS-TFF-BDC-F	PDKT-PCS-TFF-BHDC-F
Part #'s/Description — Circulation / Filter Feed Pump	PUMP-MF-LS-TW	PUMP-Q1200HTS
Diafiltration Pump	PUMP-MF-LS-TW	PUMP-MF-LS-TW
Main / Retentate Vessel Scale	SCALE-MT-15000-1	SCALE-MT-15000-1
Filtrate / Permeate Scale	SCALE-AND-32000-1D	SCALE-AND-61000-0
Throttle Valve	PDKT-PVT	PDKT-PVT
Vessel	PDKT-TNK	N/A
Air in Tube Detector	AD-17-P	AD-36-P
Diafiltration Selection Valves	PDKT-PVE2-TFF-M	PDKT-PVE2-TFF-M
Cart	CART-TFF-COMPACT-RFMS	CART-TFF-COMPACT-RFMS
Accessories — pH	PT-PH1-L	PT-PH1-P
Conductivity	CONDS-N-025	CONDS-N-050
Retentate Coriolis Flow Meter	FM-BC-15	Contact PendoTECH for options
Filtrate / Permeate Flow Meter	FMT-LFS monitor with flow cell FM-LFS-03SU	FMT-LFS monitor with flow cell FM-LFS-06SU
UV Detector for Permeate	SPEC-L-1-SU-280	SPEC-L-1-SU-280
Tank Options — Alternate Vessels	PDKT-TNK500M	N/A
Feed Rate Range (mL/min) — Pump Flow Rate Range	~100 - 1600	~660 - 22000
Feed Volume (L) — Approximate Range*	0.5 - 5	1 - 30

* Feed volume increased with fed-batch functionality
^ Holds two probes

NOTES:

Pilot System

Throttle Valve Controller

Water Resistant PC for Graphical User Interface with Touch-Screen and Wireless Networking

Retentate Flow Meter (optional-not shown)

Throttle Valve

Pressure Sensors

Control System

Surface for Filter

Filtrate Flow Meter

30 Liter Vessel with Stirrer with Bottom Drain

Conductivity Flow Cell

Diafiltration Feed Selection Pinch Valves

Pinch Valves For Automated Recovery

Diafiltration Feed Pump

Air Detector For Fed Batch End Point

Heavy Duty Locking Casters for Moving

Scales

Circulation Pump

Hold-up volume calculator - Q1200 Pump Setup

	If Tube, length (cm)	Select tube ID from pick list	Hold-up per cm (mL)	Volume (mL)	Total (mL)	% of total
Vessel				50	50.0	17.5%
Tube - Vessel to Pump	20	ID of 3/8inch	0.7126		14.3	5.0%
Pump				75	75.0	26.3%
Tube - Pump to Filter	45	ID of 3/8inch	0.7126		32.1	11.2%
Filter and Holder Path				50	50.0	17.5%
Tube - Filter to Vessel	90	ID of 3/8inch	0.7126		64.1	22.5%
Other 1				0	0.0	0.0%
Other 2				0	0.0	0.0%
			GRAND TOTAL:		285.4mL	

Integrated Cart Systems

Cart shown with I/P Diafiltration Pump and Mag Retentate Flow Meter mounted in-line

Pilot cart shown with push-up cart with larger pump demonstrates system flexibility that is required in Pilot environments.

Hold-up volume calculator - Pilot Cart System with Q4400

	If Tube, length (cm)	Select tube ID from pick list	Hold-up per cm (mL)	Volume (mL)	Total (mL)	% of total
Vessel				1000	1000.0	32.2%
Tube-Vessel to Pump	20	ID of 1inch	5.0671		101.3	3.3%
Pump				820	820.0	26.4%
Tube-Pump to Filter	45	ID of 1inch	5.0671		228.0	7.3%
Filter and Holder Path				500	500.0	16.1%
Tube-Filter to Vessel	90	ID of 1inch	5.0671		456.0	14.7%
Other 1				0	0.0	0.0%
Other 2				0	0.0	0.0%
				GRAND TOTAL:		3105.4mL

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Pre-configured Pilot Cart Setup			
Operating Scale		Pilot Cart with Q1200 Diaphragm Pump	Pilot Cart with Q4400 Diaphragm Pump
System Part #*		PDKT-PCS-TFF-PIL	PDKT-PCS-TFF-PIL-HF
Part #'s/Description	Circulation / Filter Feed Pump	PUMP-Q1200HTSS	PUMP-Q4400SS
	Diafiltration Pump	PUMP-MF-IP-TW	PUMP-MF-IP-TW
	Main / Retentate Vessel Scale	SCALE-MT-150000-0	SCALE-MT-150000-0
	Filtrate / Permeate Scale	SCALE-MT-150000-0	N/A ^
	Throttle Valve	PDKT-PVT	PDKT-PVT
	Vessel	N/A	N/A
	Air in Tube Detector	AD-73-P	AD-82-P
	Diafiltration Selection Valves	Integral to cart	Integral to cart
	Cart	CART-TFF-CART1	CART-TFF-CART1
Accessories	pH	PT-PH1-P	PT-PH1-P
	Conductivity	CONDS-N-050	CONDS-N-050
	Retentate Coriolis Flow Meter	FM-EH-MAG-53H15 or Krohne FLEXMAG 4050	FM-EH-MAG-53H15 or Krohne FLEXMAG 4050
	Filtrate / Permeate Flow Meter	FMT-LFS monitor with flow cell FM-LFS-10SU	FMT-LFS monitor with flow cell FM-LFS-10SU
	UV Detector for Permeate	SPEC-L-1-SU-280	SPEC-L-1-SU-280
Tank Options	Alternate Vessels	N/A	N/A
Feed Rate Range (mL/min)	Pump Flow Rate Range	~660 - 22000	~4000 - 90,000
Feed Volume (L)	Approximate Range*	5 - 100	10 - 500

* Feed volume increased with fed-batch functionality which is included
^ Floor scale typically provided by the customer that can be connected to the system

NOTES:

Remote Access

• Easy ability to operate system remotely from another PC using software such as Real VNC, Remote Desktop, Timbuktu, GoToMyPC, LogMeIn and others or smart devices such as the iPhone/iPad

Circulation Pump Control

• Options for Retentate Flow Control which adjusts the flow rate of the circulation pump:

> • A Retentate flow set point can be controlled by enabling this feature and installing a retentate flow meter such as the PendoTECH Coriolis Flow Meter

> • DeltaP can be controlled by the GUI software "FlowAdjust" algorithm by entering the DeltaP setpoint

These modes are activated on the Maintenance Tab. Additional control settings are added to the other tabs to optimize these features. Some filter manufacturers recommend operation in these modes. These modes works independent of automated TMP control.
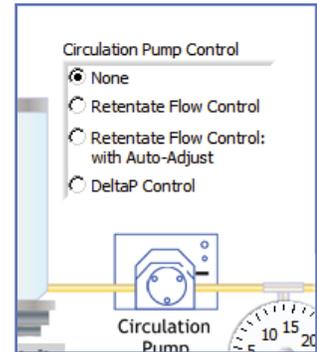
Email & Text Message Notification

The pre-alarm notification points can be used to send email alerts and text messages. The system is given a name and the email addresses to send the alerts are entered. There is a built-in mail program to send these notifications with a default mailbox which may be replaced by a user configured mailbox.
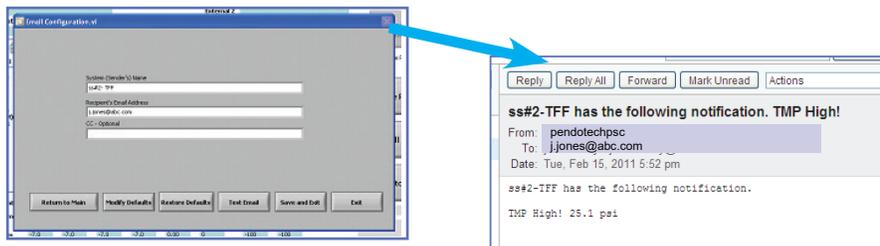
External Input

The two external inputs can be used to collect data from a wide variety of sensors not built into the system. The input signals are configured in the software and alarm points on these values may be entered also. These inputs give the ability to instantly integrate the PendoTECH UV sensors, 3rd party concentration monitors, or other desired measurements via a 3rd party transmitter.

UV Sensor with Transmitter

Expand System Capability for Normal Flow Process Development

VF-DF GUI works with TFF System!
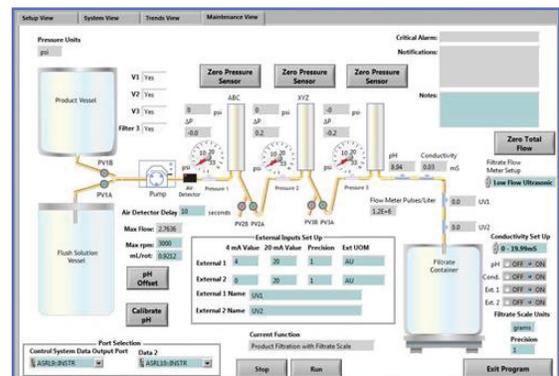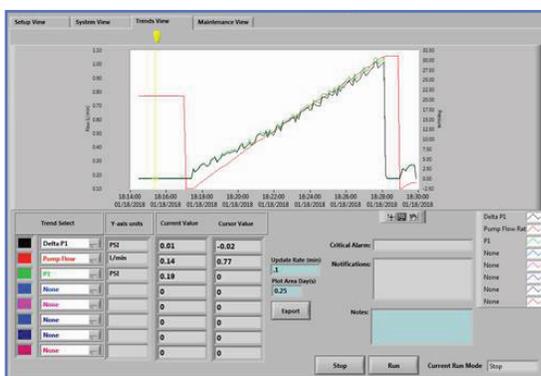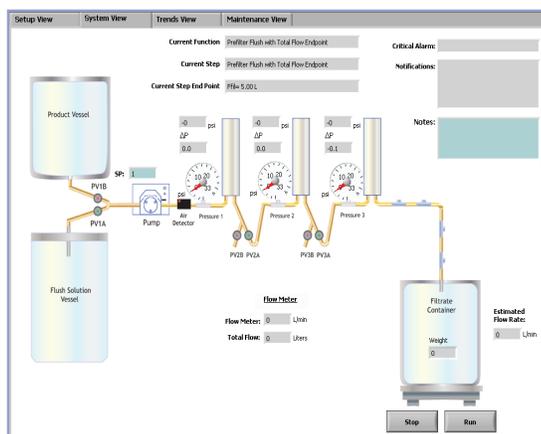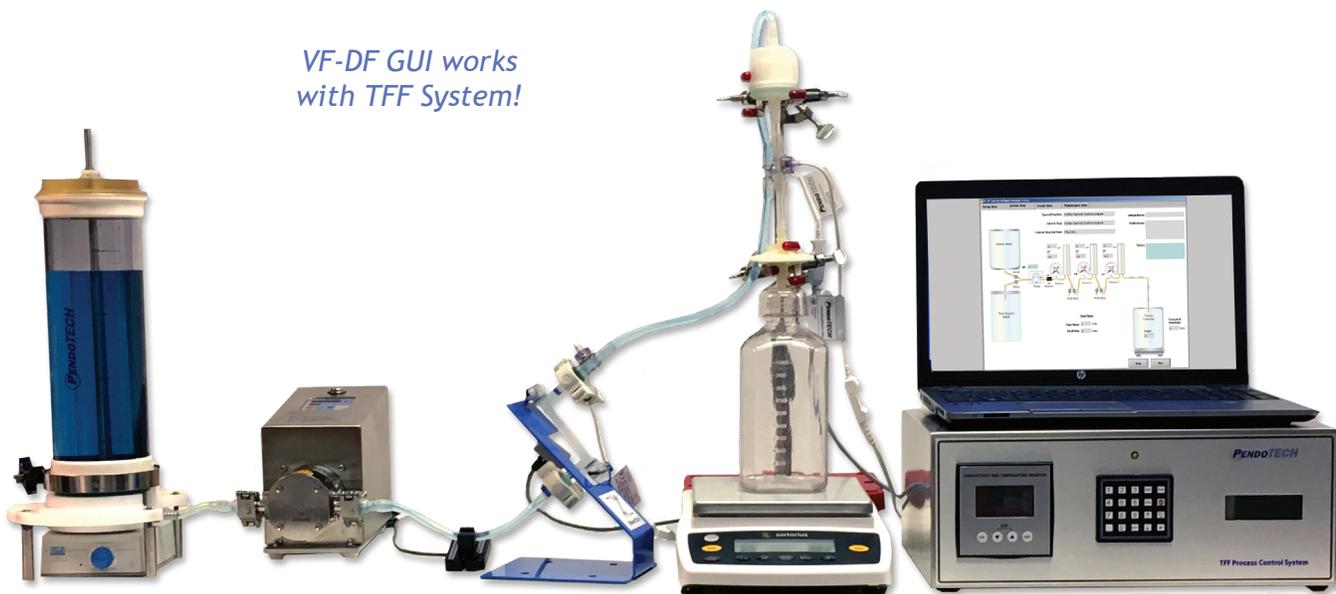
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PC Requirements:

Windows 7 or 10, 2 GHz or faster, 4GB of RAM with at least 2 available USB ports

Windows 10

Graphical User Interface (GUI) Software has resolution of 1366x768 pixels so this resolution on the PC is preferred, at higher resolution the unused area will be grey or the display settings can be adjusted to match.

Detail	Specifications
Dimensions (HxWxD)	6.125inch x 16inch x 11.5inch (15.5575cm x 40.64cm x 29.21cm)
Weight	20 lbs. (9.1 kgs.)
Enclosure Material	304 Stainless Steel
Power Requirements	100 - 240 Volts, 50 - 60 Hertz, 2 amp max
Pressure Sensor Inputs	PendoTECH Pressure Sensors default configuration- other full-bridge type sensors optional
Pump Control	Speed Control: 4 - 20mA; Circ Pump Alternate: Scalable voltage signal within 0-10 volts Start/Stop: Relay 3 - 48VDC, up to 3A continuous
AIr Detector Input	Digital input with 24VDC supply
Flow Meter Input	5V Digital pulse input with 5VDC or 24VDC supply
External Inputs	Analog Signal - both 4-20mA
pH Input	Standard probe input via BNC connector
Conductivity Input	Specifically designed to read the PendoTECH Single Use Conductivity Sensor with the K input via the software
Scale Inputs	RS232 Communication
Temperature Inputs	2-wire 2252ohm thermistor input designed for use the PendoTECH temperature sensors available in a luer design, in-line with a hose barb and a dip probe.
PC Requirements	Windows 7 or 10, 2 GHz or faster, 4GB of RAM

CE

Ordering Information

SYSTEM	
PDKT-PCS-TFF	TFF Process Control System with Graphical User Interface Software and interface cables

PUMPS *(Others Available)*	
PUMP-MF-LS-TW	Masterflex General Purpose Digital, with RPM display only, 600RPM with EasyLoad II pump head for thin wall L/S tubings
PUMP-MF-LS-TKW	Masterflex General Purpose Digital, with RPM display only, 600RPM with EasyLoad II pump head for thick wall L/S tubings
PUMP-MFD-LS-TKW	Masterflex Peristaltic Digital Pump w/DB25 remote control port for control from system. 600RPM drive w/ EasyLoad II for precision thick wall L/S tubing
PUMP-MFD-LS-TW	Masterflex Peristaltic Digital Pump w/DB25 remote control port for control from system. 600RPM drive w/ EasyLoad II for precision thin wall L/S tubing
PUMP-WM-120-TW	Watson-Marlow 120U/DV 200RPM Pump Fitted with 114DV flip-top four roller pumphead for thin tubing
PUMP-WM-620	Watson Marlow Model 630UN/R with 4-20mA control and NEMA 4X ingress protection 265 RPM Pump with Flow to 15L/min
PUMP-QF30D-SU	Quattro Pump QF30 pump with one SU chamber (up to 500mL/min)
PUMP-Q150SU	Quattro Pump Q150 Single Use chamber (up to 3L/min) and includes 3 disposable chambers (QTY 3 of part # QUA-QF15DISPP-3)
PUMP-Q150SS	Quattro Pump Q150 Stainless steel chamber (up to 3L/min)
PUMP-Q1200HSU	Quattroflow 1200 (up to 20 LPM) Compact Version with 3 disposable pump chambers (QTY 3 of part # QUA-PQ12DISPP) and a stainless steel pressure plate, 4-20mA analog input for speed control, 120VAC
PUMP-Q1200HSS	Quattroflow 1200 (up to 20 LPM) Compact Version with Stainless Steel Pump Head, 4-20mA analog input for speed control, 120VAC
PUMP-Q4400HSS	Quattroflow 4400 (up to 83.3 LPM) Compact Version with Stainless Steel Pump Head, 4-20mA analog input for speed control, 200-240VAC
PUMP-Q4400HSU	Quattroflow 4400 (up to 83.3 LPM) Compact Version for use with single use chamber (incl. QTY 1: QF44D) and pressure plate, 4-20mA analog input for speed control, 200-240VAC
PUMP-KN-LS	Mini Diaphragm Pump with KNF FEM Pump Head w/M12 remote control port for control from system, 2 to 90mL/min

SCALES
Contact PendoTECH for Scale Selection Guide

FLOW METERS

FILTRATE FLOW METERS

FM-22WV	Rotor for Disposable PVDF Turbine Flowmeter 1/4inch, 0.1-1.0 LPM, clip mount. With individual calibrations.
FM-22WV-E	Electronic Assembly for one PVDF rotor with 1/4inch hose barb (includes one rotor), 0.1-1.0 LPM clip mount. With individual calibrations.
FM-23WV	Single Use Rotary Flow Meter, non-sterile, PVDF, 1/2inch hose barb, 0.3-20.0 LPM, clip mount. With individual calibrations.
FM-23WV-E	Electronic Assembly for one PVDF rotor with 1/2inch hose barb (includes one rotor), 0.3-20.0 LPM, clip mount. With individual calibrations.
FM-US-LF-C	Low Flow Ultrasonic Benchtop Flow Meter (1/16inch ID), flow range 2-200mL/min (with 24 VDC power supply & output signal connector)
FM-LFS-03SU	Leviflow single use flow sensor to 0.8LPM
FM-LFS-06SU	Leviflow single use flow sensor to 8LPM
FM-LFS-10SU	Leviflow single use flow sensor to 20LPM
FM-LFS-15SU	Leviflow single use flow sensor to 50LPM
FM-LFS-20SU	Leviflow single use flow sensor to 80LPM
FMT-LFS	PendoTECH Leviflow Sensor Monitor

RETENTATE FLOW METERS

PCFM-31	PendoTECH Coriolis Mass Flowmeter with 0.125inch /3.15mm ID (range 5 - 1,500 grams/min)
PCFM-32	PendoTECH Coriolis Mass Flowmeter with 0.25inch /6.35mm ID (range 5 - 4,000 grams/min)
FM-EH-MAG-53H15	E + H Promag 53H15, DN15 1/2inch Electromagnetic Flowmeter, 2-50LPM, 120V plug installed, 4-20mA output for integration, 1/2inch ID, 316L TC inlet/outlet, integral display with touch control - includes bracket & mount
FM-BC-14-100	Bronkhorst M14 Coriolis Mass Flowmeter with 1/2inch SF connections; flow rate range 1 - 100 grams/min
FM-BC-14	Bronkhorst M14 Coriolis Mass Flowmeter with 1/4inch SF connections; flow rate range 15 - 500 grams/min
FM-BC-15	Bronkhorst M15 Coriolis Mass Flowmeter with 1/2inch SF connections; flow rate range 80 - 5,000 grams/min
FM-KRNESU-S	Krohne FLEXMAG 4050C Single Use Magnetic Flowmeter Small base unit, for 1/4inch flow tube
FM-KRNESU-M	Krohne FLEXMAG 4050C Single Use Magnetic Flowmeter Medium base unit, for 3/8inch and 1/2inch flow tubes
FM-KRNESU-L	Krohne FLEXMAG 4050C Single Use Magnetic Flowmeter Large base unit, for 3/4inch and 1inch flow tubes
FM-KRNESU-SU025	Single Use Flow Tube for Krohne FLEXMAG 4050C, 1/4inch hosebarbs, polysulfone for small base
FM-KRNESU-SU038	Single Use Flow Tube for Krohne FLEXMAG 4050C, 3/8"inch hosebarbs, polysulfone for medium base
FM-KRNESU-SU050	Single Use Flow Tube for Krohne FLEXMAG 4050C, 1/2inch hosebarbs, polysulfone for medium base
FM-KRNESU-SU075	Single Use Flow Tube for Krohne FLEXMAG 4050C, 3/4inch hosebarbs, polysulfone for large base
FM-KRNESU-SU100	Single Use Flow Tube for Krohne FLEXMAG 4050C, 1inch hosebarbs, polysulfone for large base

CONDUCTIVITY

COND2-TFF	Conductivity Probe K=1 with 100ohm Pt RTD for temperature measurement for TFF Process Control System, epoxy
CONDS-N-025	Single Use Conductivity Sensor, non-sterile, polysulfone 1/4inch hose barb
CONDS-N-050	Single Use Conductivity Sensor, non-sterile, polysulfone 1/2inch hose barb

AIR DETECTOR

Part Number	AD-16-P	AD-17-P	AD-73-P
Tubing OD	1/4inch	3/8inch	5/8inch

DIAFILTRATION VALVE

PDKT-PVE2-TFF-S	TFF Control System Electric Diafiltration Pinch Valve Pair - Small for 1/8inch ID
PDKT-PVE2-TFF-M	TFF Control System Electric Diafiltration Pinch Valve Pair - Medium for 1/4inch ID
PDKT-PV2-TFF-L	TFF Control System Pneumatic Diafiltration Pinch Valve Pair - Large for 3/8inch ID, size 36 tubing
PDKT-PV2-TFF-LT	TFF Control System Pneumatic Diafiltration Pinch Valve Pair - Large for 3/8inch ID, size 73 tubing

pH	
PT-PH1	PendoTECH Single Use pH probe with BNC connector for Single Use Cell
PT-PH1-CELL	Flow Cell for PendoTECH Single Use pH Probe, 3/4inch SF inlet/outlet, PA12 Nylon
PT-PH1-CELL-025	Flow Cell for PendoTECH Single Use pH Probe, 1/4 inch hosebarb inlet/outlet, PA12 Nylon
PT-PH1-M	PendoTECH Single Use pH probe with Single Use Cell- sanitary flange
PH-PILOT-C	pH pilot scale flow cell with 3/4inch sanitary flange inlet/outlets for 12mm OD probe
PH-PILOT-CP	12mm OD pH probe for flow cell
PH-PILOT-CC	pH pilot scale flow cell with 3/4inch sanitary flange inlet/outlets with 12mm OD pH probe
PH-PILOT-C-1	pH pilot scale flow cell, polysulphone with 1inch sanitary flange inlet/outlets for 12mm OD probe
PH-PILOT-6MM-SS	316L Stainless steel pilot scale flow cell with 3/4inch sanitary flange inlet/outlets for 6mm OD probe

pH/Conductivity	
PFC-RUA-L	Lab Scale pH and conductivity flow cell for 12mm OD probes with compression fitting- luer
PFC-RUA-012	Lab Scale pH and conductivity flow cell for 12mm OD probes with compression fitting- 1/8inch
PFC-RUA-025	Lab Scale pH and conductivity flow cell for 12mm OD probes with compression fitting- 1/4inch barb
PFC-RUA-5	Lab Scale pH and conductivity flow cell for 12mm OD probes with compression fitting- sanitary flange
PFC-RUA-B	Blank for Lab Scale pH and conductivity flow cell for 12mm OD probes

FOR PENDOTECH PRESSURE SENSORS	See www.pendotech.com/pressure
FOR PENDOTECH TEMPERATURE SENSORS	See www.pendotech.com/temperature

VESSELS	
PDKT-TNK	Complete 2L tank setup with stir plate, 2 dip tubes, and stand
TNK-2L-STRPLATE	Stirrer plate for 2 liter vessel
PDKT-TNK500M	600mL - conical bottom vessel with low point drain, includes lid and 2 dip tubes, polysulfone - (DOES NOT INCLUDE STIR PLATE)
PDKT-TNK125M	140mL - conical bottom vessel with low point drain, includes lid and 2 dip tubes, polysulfone - (DOES NOT INCLUDE STIR PLATE)

CABLES	
PDKT-PV-CABLE2	Cable from Diafiltration Valve Control from TFF System to control of 2 sets of pinch valves (2 cables from connector- 8 feet each)
PDKT-PVT-PUMP	Interface Y cable to connect both filtrate pump and throttle valve

CARTS & STAND	
PDKT-TFF-LABSTND	TFF Process Control System Benchtop Stand with touch-screen monitor (PC Not Included)
CART-TFF-COMPACT-RFMS	TFF Control System compact cart with slide tray with touch-screen monitor and water-proof keyboard (PC not included)
CART-TFFCOMPACT-SURF	TFF Control System compact cart removable drop-in work surface piece
PDKT-TFF-CART1	UF/DF Pilot Cart System includes Panel Mount NEMA4X touch screen PC(Industrial Stainless Steel PC, IP-66 Rating, 24VDC, 15.6 inch TFT-Display 1366x768, Ethernet, Intel 82551 10/100 w/RJ45, USB, Windows 10 PRO, Wireless)
PDKT-TFF-CART1-SURF	Pilot Cart drop-in top shelf work surface
PDKT-TFF-CART-Q4400	Q4400 pump cart
PDKT-TFF-CART1-NV	UF/DF Complete Pilot Cart includes Panel Mount NEMA4X touch screen PC(Teguar Industrial Stainless Steel PC, IP-66 Rating, 24VDC, 15.6" inch TFT-Display 1366X768)- WITHOUT PINCH VALVES
PDKT-TFF-CART1-NVP	UF/DF Pilot Cart System - WITHOUT PINCH VALVES AND PC

Warranty/Disclaimer

For warranty information see our website at http://www.pendotech.com/warranty