PendoTECH Virus Filtration-Depth Filtration Process Control System & Data Acquisition System

- Process automation with pre-programmed functions for different process steps including filter flush and automated process endpoints
- Real-time trending and data collection to a file that can be opened with Excel
- System interaction via a PC-based Graphical User Interface
- Features use of PendoTECH Pressure Sensors that are available from a luer size to 1 inch inner diameter
- Flexibility for bench-top setup or Pilot Cart with automated inlet valve selection and filter flush valves
- Integrates with different types of pumps and different brands of scales
- Delta pressure control option that regulates pump automatically
- Graphical user interface software will operate with TFF Process Control System Box or VFDF Control Box
- Option to use PendoTECH Single Use Temperature Sensor
- Built-in data server to exchange data with OPC client software such as PI from OSIsoft®

- Create an automated benchtop system using built-in functions with end-points
- Alarms with automatic pump shut off
- GUI PC software will operate on TFF Control System

- Pilot cart with automated inlet selection and flush valves
- Streamlined design for use in clean environment
• Completely and efficiently automates your Virus Filtration-Depth (VF-DF) Filtration Process
• 3 pressure measurements with PendoTECH Pressure Sensors which can be re-used extensively or other pressure sensors
• Functions that automate all process steps include:
  1. Manual- control valves and pump manually by clicking on the GUI graphic
  2. Run Pump (pump runs but no endpoint with valves in default positions)
  3. Prefilter Flush with Total Flow Endpoint
  4. Second Filter (Virus Filter) Timed Flush
  5. Product Filtration with Air Detector Endpoint
  6. Product Filtration with Filtrate Scale Endpoint
  7. Recovery with Filtrate Scale Endpoint
• Interact with the system via an easy to use graphical user interface (GUI) that includes a trending module with many advanced features
• Alarms for process parameters that shuts-down the pump
• 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
• Pre alarm setpoints for notifications and email alerts

• Automation and alarm features allow the system to be operated with minimal user interaction
• Process control via integration of industry standard scales and pumps
• Can be used at different process scales by entering the pump set-up in the software
• pH probe input via a BNC connector that can accommodate standard pH probes and the GUI includes an easy to use probe calibration wizard
• Conductivity probe/flow cell input to embedded conductivity transmitter with temperature display and compensation
• Non-invasive Air detector with delay time programmable, can be used as a product filtration end-point
• Filtrate flow meter input for optional rotary flow meter, ultrasonic flow meter, or other that includes the ability to totalize flow
• Option to use PendoTECH Single Use Temperature Sensor
• Two inputs available for other sensors with 4 - 20 milliamp outputs to enable collection of additional process data that can be configured for decimal places and alarms points
• CE tested for EMC and LVD
• Built-in data server to exchange data with OPC client software such as PI from OSIsoft®
Pilot Cart

In the Pilot Cart, additional system functions are controlled by the tubing pinch valves. There are 3 pairs of valves in which one valve is normally closed and the other is normally open. The pair is always actuated in sync so the open valve closes and the closed valve opens which serves to re-direct flow. The available functions are:

1. Manual - control valves and pump manually by clicking on the GUI graphic
2. Run Pump (pump runs but no endpoint with valves in default positions)
3. Prefilter Flush with Total Flow Endpoint (valve pair 2 switches)
4. Second Filter (Virus Filter) Timed Flush (valve pair 3 switches)
5. Product Filtration with Air Detector Endpoint (inlet valve pair 1 switch)
6. Product Filtration with Filtrate Scale Endpoint (inlet valve pair 1 switch)
7. Recovery with Filtrate Scale Endpoint (valves in default position)

There is a delta-P control function available that allows the pump to slow to a delta-P setpoint.

Selectively, the system can be custom-configured in the software to remove Filter 3 or any pair of valves if not required for a specific process. The pH, conductivity and external sensors can also be optionally selected for display on the system view.

- Engineered system uses an optionally interchangeable fluid path that may be project/product dedicated to prevent cross contamination
- Completely sealed front panel for use in clean environments where frequent wipe-down is required.

The process is represented in the following schematic:
Normal Flow Filtration Systems for All Stages of Process Development

**Screening**

(~1L or less)

Screening System

- Studies with constant flow or constant pressure
- Four parallel filtration optimization studies possible with scale-down filter disks

For more information on this Normal Flow Filtration Screening Product
www.pendotech.com/nffss

**Process Development / Scale-up**

(~1 to 5L)

VF-DF System

- Ability to run constant flow or constant pressure
- Automates a normal flow process with a range of process functions with automated endpoints

**Pilot**

(~>5L)

VF-DF Pilot Cart

- Automated fluid path selection valves
- A range of process functions with automated endpoints
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 keypad for data entry. Values entered that are out of range are rejected with a message. There are four tabs for easy navigation:

1. Setup View - used to enter experiment information, function selection, 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 rate.

3. Trends View - ability to trend process variables that is loaded with features to dynamically view the data of interest, ability to quickly auto-scale or manually scale the axes, and ability to export a trend of interest either as data or a graphics file.

4. Maintenance View - used to set up pump, calibrate pH and conductivity via easy to use wizards, select units of measure, configure flow meter and more. The system can be customized to remove Filter 3 or any pair of valves if not required for a specific process. The pH, conductivity and external sensors can also be optionally selected for display on the system view.
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.

Ability to save/recall frequently used functions

Ability to enter filter names and areas

Configure email client for Notification alerts and function completion

7 functions available

Settings for selected function are entered here

Delta-P control by pump speed control

Notification points: Show warnings in Notifications box and email alerts (if configured) (create no action)

Alarms set-points: Will stop pumps
Used to trend process variables with features to dynamically view the data of interest, ability to quickly auto-scale or manually scale the axes, and ability to export a trend of interest either as data or a graphics file. Using the features on the Trends View, the trends to be plotted can be selected and the yellow cursor tab at the top of the plot area can be dragged across the plot area to display desired cursor values that appear in the table for the respective trend as shown along with the current values.
Maintenance View includes the ability to:

- Zero pressure sensors
- Select conductivity range
- Calibrate pH
- Set units of measure
- Set-up pump
- Customize system view for specific processes
- Configure the flow meter
- Zero flow meter total
- Set range of external signals & name them
- Exit program
The system comes with the required cables to enable the system 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.

**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.

**Flowmeter 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. The filtrate flow meter can be a basic flow measurement technology because the fluid being measured is clean, filtered material with relatively consistent viscosity. The Low Flow Ultrasonic Flowmeter is capable of measuring flows in a difficult to measure flow range of 2 to 100 mL/minute. It has a 1/16 inch ID x 1/8 inch OD and a luer fitting inlet fitting for easy connection. The rotary flow meters have a ¼ inch hose barb and can measure flows from about 0.1 to 1 Liter /minute or a ½ inch barb that can measure flows from 0.3 to 20 Liter/min.
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 an Endpoint.

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, 1/8 inch, 1/4 inch, 1/2 inch, 3/8 inch, 1/2 inch, 3/4 inch and 1 inch 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.

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 below.

Following is a selection of just some of the pumps that can be integrated to the system
**PendoTECH Vessel Options**

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

**pH**

pH measurement is integrated to the system. Any standard pH probe that has a BNC circular connector can be used. PendoTECH offers 2 inline options: one for Lab/Development with either a luer or 1/4 inch hose barb and one for Pilot scale with a 1/4 inch sanitary flange. In both designs, the probe can be removed from the cell for calibration with buffers using the software’s pH calibration wizard. The lab scale probe slides past a o-ring seal to give the probe tip access to the fluid path and the hold-up volume is less than 1mL. The Pilot scale probe has a 12mm OD and is secured in the custom designed flow cell via a compression fitting. The compression ferrules are made from PTFE so they can slide up the probe or removed from the probe.

**Conductivity**

Built-in conductivity monitor also measures temperature and performs temperature compensation. There is a simple one-step calibration procedure and probes with constants of K=1 or K=10 may be used. The range is selectable from either 0-19.99 mS or 0-199.9 mS. Different flow cell or dip probe options are available.

**Conductivity Probe Options:**

- **Epoxy dip probe**
- **Flange probe**
- **Small scale with luer or barb inlet/outlet**
- **Stainless probe in flow cell with either barb or flange inlet/outlet**

**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.

**Conductivity Probe Options:**

- **Epoxy dip probe**
- **Flange probe**
- **Small scale with luer or barb inlet/outlet**
- **Stainless probe in flow cell with either barb or flange inlet/outlet**

**Vessel Detail - 2 Liter Vessel shown**

- **Buffer Feed & Retentate tubes can be positioned to deliver liquid to the bottom**
- **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 different stir plates**
- **Spare hole for venting or recycle**
- **Removable collars for tube adjustment/ removal**
- **Stir bar locator in the center of the base**

Copyright © 2018 PendoTECH
Advanced Features

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

OPC Server Option Available

• Serve data to OPC - clients such as facility historian like OPC client software such as PI from OSI soft®
• Enable the data generated by the system to be stored in a central repository with other process data

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 Temperature Sensors and UV Sensors.
**Detail** | **Specifications**
---|---
Dimensions (HxWxD) | 6.125” x 16” x 11.5” (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 | 4 wire input (2 wires for 100 ohm Pt RTD) K=1 or K=10 with range selectable for either 0-19.99mS or 0-199.9mS
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, at least 2 USB ports

### Ordering Information

**SYSTEM**

| PDKT-PCS-VFDF | PendoTECH Virus Filtration-Depth Filtration Process Control and Monitoring System w/ pressure sensor and pump 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-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-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-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 620U/R 265 RPM Pump with Flow to 12.7 l/min |
| PUMP-Q150SU | Quattro Pump Q150 Single Use chamber (up to 3L/min) and includes 3 chambers |
| PUMP-Q150SS | Quattro Pump Q150 Stainless steel chamber (up to 3L/min) |
| PUMP-Q1200HSU | Quattro Pump Q1200 5° Pump Single Use chamber (up to 18.3 L/min) and includes 3 chambers |
| PUMP-Q1200HSS | Quattro Pump Q1200 5° Pump Stainless steel chamber (up to 18.3L/min) |
| PUMP-KN-LS | Mini Diaphragm Pump with KNF FEM Pump Head w/M12 remote control port for control from system, 2 to 90mL/min |

**FOR PENDOTECH PRESSURE SENSORS**

See www.pendotech.com/pressure

**FOR PENDOTECH TEMPERATURE SENSORS**

See www.pendotech.com/temperature
**Ordering Information**

**FLOWMETERS**

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FM-22WV</td>
<td>Rotor for Disposable PVDF Turbine Flowmeter 1/4 inch, 0.1-1.0 LPM, clip mount. With individual calibrations.</td>
</tr>
<tr>
<td>FM-22WV-E</td>
<td>Electronic Assembly for one PVDF rotor with 1/4 inch hose barb (includes one rotor), 0.1-1.0 LPM clip mount. With individual calibrations.</td>
</tr>
<tr>
<td>FM-23WV</td>
<td>Single Use Rotary Flowmeter, non-sterile, PVDF, 1/2 inch hose barb, 0.3-20.0 LPM, clip mount. With individual calibrations.</td>
</tr>
<tr>
<td>FM-23WV-E</td>
<td>Electronic Assembly for one PVDF rotor with 1/2 inch hose barb (includes one rotor), 0.3-20.0 LPM, clip mount. With individual calibrations.</td>
</tr>
<tr>
<td>FM-US-LF-I</td>
<td>Low Flow Ultrasonic Flow Meter (1/16in ID), flow range 2-400mL/min, console unit with 24VDC power supply and Freq and mA output</td>
</tr>
<tr>
<td>FMT-LFS</td>
<td>PendoTECH Leviflow Sensor Monitor</td>
</tr>
<tr>
<td>FM-LFS-03SU</td>
<td>Leviflow single use flow sensor to 0.8LPM</td>
</tr>
<tr>
<td>FM-LFS-06SU</td>
<td>Leviflow single use flow sensor to 8LPM</td>
</tr>
<tr>
<td>FM-LFS-10SU</td>
<td>Leviflow single use flow sensor to 20LPM</td>
</tr>
<tr>
<td>FM-LFS-20SU</td>
<td>Leviflow single use flow sensor to 80LPM</td>
</tr>
</tbody>
</table>

**CONDUCTIVITY**

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>COND1-TFF</td>
<td>Conductivity Probe K=1 with 100ohm Pt RTD for temperature measurement for TFF Process Control System, stainless steel with flow cell</td>
</tr>
<tr>
<td>COND2-TFF</td>
<td>Conductivity Probe K=1 with 100ohm Pt RTD for temperature measurement for TFF Process Control System, epoxy</td>
</tr>
<tr>
<td>COND3-TFF</td>
<td>Conductivity Glass flow cell K=1 for 1/4” ID tubing w/100ohm Pt RTD for temperature measurement for TFF Process Control System</td>
</tr>
<tr>
<td>COND4-TFF</td>
<td>Conductivity Probe K=1 with 100ohm Pt RTD for temperature measurement for TFF Process Control System, stainless steel with sanitary flange</td>
</tr>
</tbody>
</table>

**AIR DETECTOR**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>AD-16</th>
<th>AD-17</th>
<th>AD-73</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tubing OD</td>
<td>1/4”</td>
<td>3/8”</td>
<td>5/8”</td>
</tr>
</tbody>
</table>

**DIAFILTRATION VALVE**

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PDKT-PVE2-TFF-S</td>
<td>TFF Control System Electric Diafiltration Pinch Valve Pair - Small for 1/8 inch ID</td>
</tr>
<tr>
<td>PDKT-PVE2-TFF-M</td>
<td>TFF Control System Electric Diafiltration Pinch Valve Pair - Medium for 1/4 inch ID</td>
</tr>
</tbody>
</table>

**pH**

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PH-GFCP</td>
<td>pH probe for flow cell</td>
</tr>
<tr>
<td>PH-GFCC</td>
<td>pH probe &amp; flow cell with 1/4 inch barb or luer for lab scale</td>
</tr>
<tr>
<td>PH-PILOT-C</td>
<td>pH pilot scale flow cell with 3/4inch sanitary flange inlet/outlets for 12mm OD probe</td>
</tr>
<tr>
<td>PH-PILOT-CP</td>
<td>12mm OD pH probe for flow cell</td>
</tr>
<tr>
<td>PH-PILOT-CC</td>
<td>pH pilot scale flow cell with 3/4inch sanitary flange inlet/outlets with 12mm OD pH probe</td>
</tr>
</tbody>
</table>

**VESSELS**

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PDKT-TNK</td>
<td>Complete 2L tank setup with stir plate, 2 dip tubes, and stand</td>
</tr>
<tr>
<td>TNK-2L-STRPLATE</td>
<td>Stirrer plate for 2 liter vessel</td>
</tr>
<tr>
<td>PDKT-TNK500M</td>
<td>500mL - 2.5 inch diameter (base with outlet, vessel, lid with 2 tube holders and dip tubes)-(DOES NOT INCLUDE STIR PLATE)</td>
</tr>
<tr>
<td>PDKT-TNK125M</td>
<td>125mL - 1.5 inch diameter (base with outlet, vessel, lid with 2 tube holders and dip tubes)-(DOES NOT INCLUDE STIR PLATE)</td>
</tr>
</tbody>
</table>

**Warranty/Disclaimer**

All descriptions, representations and/or other information concerning Product on the PendoTECH website and/or contained in PendoTECH's advertisements, brochures, promotional material, or statements made by employees or sales representatives of PendoTECH are solely for general informational purposes only and are not binding upon PendoTECH. No employee or sales representative of PendoTECH shall have any authority to establish, expand or otherwise modify PendoTECH's warranty associated with the sale of Product. PendoTECH, LLC makes no warranty or representation regarding whether or not a customer's end use of any PendoTECH product or system infringes the valid intellectual property rights of others. PendoTECH does not direct or instruct customers to use any PendoTECH product or system in combination with particular commercially available pre-sterilized manifolds, remotely operated pinch valves, as such use could possibly be covered by the claims of one or more patents. PendoTECH shall not be liable to BUYER in any manner with respect to Product sold. SELLER, PendoTECH MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY TYPE, EXPRESS OR IMPLIED, AND EXPRESSLY DISCLAIMS AND EXCLUDES ANY REPRESENTATION OR WARRANTY OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR USE, NON-INFRINGEMENT OR WARRANTY ARISING FROM USAGE OF TRADE, COURSE OF DEALING OR PERFORMANCE.

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

Copyright © 2018 PendoTECH VFDF-REV3-DRAFT