

PendoTECH® Perfusion Controller

**a new control system designed
for upstream processing...**

PRODUCT
PREVIEW

Product Overview

For a continuous bioreactor perfusion process the PendoTECH Perfusion Controller has the ability to monitor and control the perfusion process separate from the bioreactor. The controller can monitor three PendoTECH Single Use Pressure Sensors that are integrated to alarms to monitor the performance of an external perfusion device such as a hollow fiber filter. These three pressures (Pin, Pret, and Pfil) are used to calculate delta-P and TMP which are required to measure filter performance. The Bioreactor Vessel weight control feature is used to replenish fresh media as spent media is removed by the filtrate pump in a constant flow set to a certain vessel volumes per day. The temperature can also be logged external to the vessel with a PendoTECH Single User Temperature Sensor. The filtrate scale can also be used to confirm amount of spent media removed. All data is logged to the file and can be trended to measure performance over a lengthy run.



Perfusion
Controller

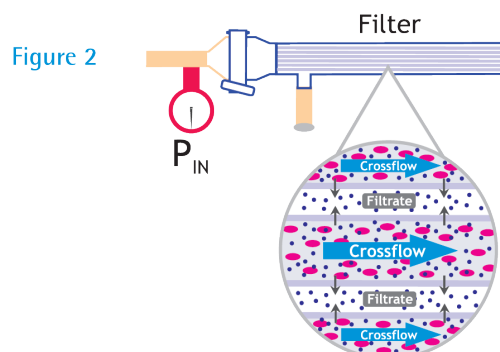
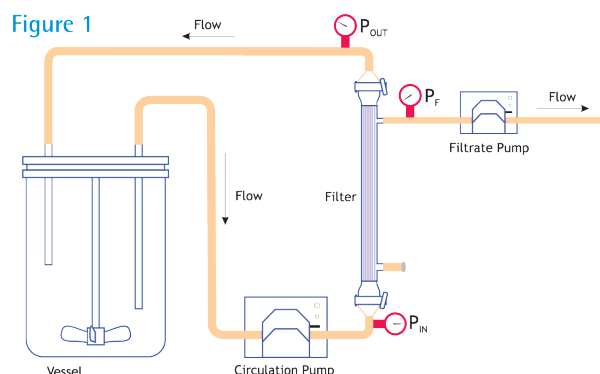


Features Include:

- Compact footprint to minimize bench space and designed to support a peristaltic pump
- Integral ring stand post to hold a filter module
- Vessel weight control by use of a vessel scale and a vessel media feed pump
- Perfusion pump control
- Filter feed pump control
- Pressure monitoring of external perfusion device, such as a hollow fiber filter (including filtrate pressure monitoring to indicate filter clogging) with PendoTECH Single Use Pressure Sensors™
- Optional monitoring of temperature in perfusion loop with PendoTECH Single Use Temperature Sensor
- Graphical User Interface with trending of process data and logging of data to a file
- Built-in data server to exchange data with OPC client software such as PI from OSIsoft®
- Filtrate scale to measure perfusion weight per day
- Additional inputs to log data from optional sensors
- Both minimum and maximum pressure alarms that will stop the pumps

Operating a perfusion bioreactor with a cross flow filtration process

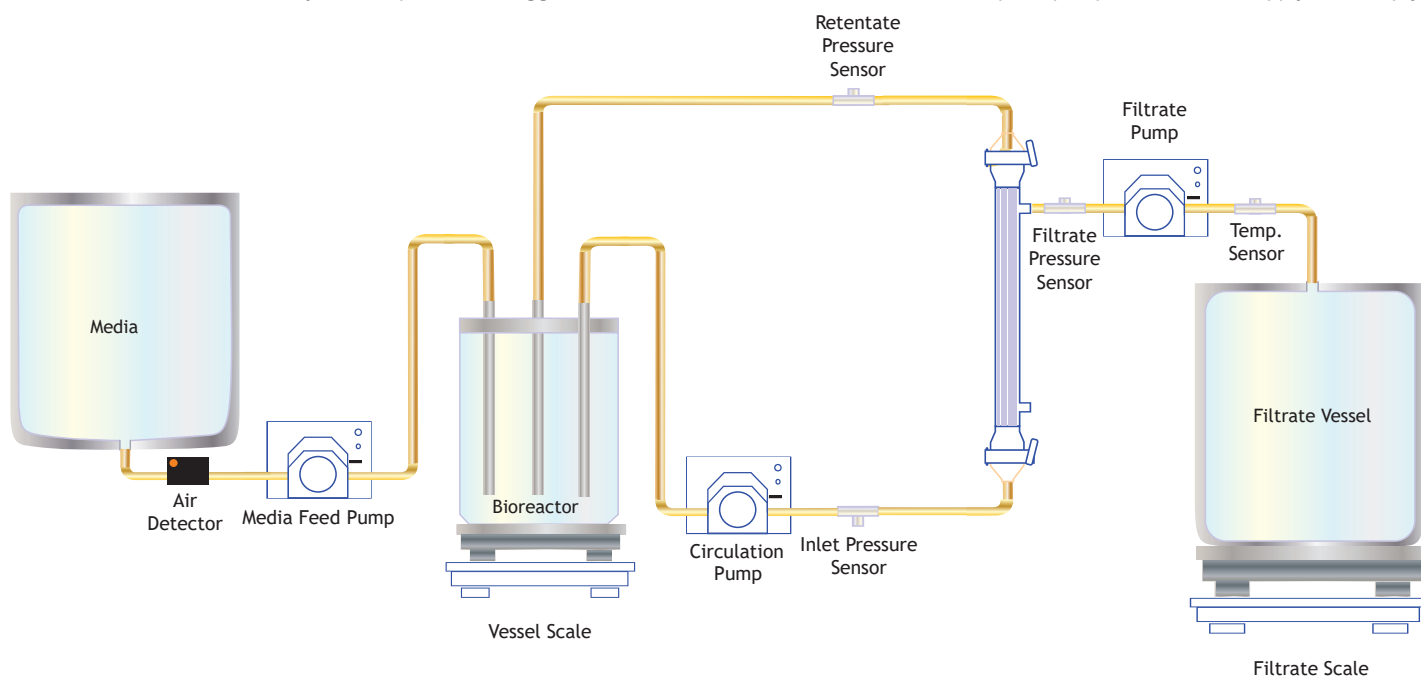
A traditional cross flow filtration process using a hollow fiber filter module (versus a plate and frame flat sheet device) is shown in Figure 1. Liquid is fed from a product vessel (or bioreactor) by a circulation pump (frequently a peristaltic pump) to a filter module containing numerous hollow fibers 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 in return pressure (P_{ret}) because of the pressure drop as liquid flows out 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_{fil} . 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. Cross flow filtration is very effective process for perfusion to retain the cells in the bioreactor.



In a perfusion process, the filtrate pump withdrawals spent media from the vessel at a constant flow rate typically corresponding to 0.5 to multiple vessel volumes per day. Fresh media is added to the vessel to replace the volume being removed. It's very important to measure all pressures to monitor the filter performance. The filtrate pressure is very important to measure because if the filter clogs and spent media can no longer be removed the filtrate pressure will start to drop to an increasing negative value. At this point the filter can no longer perform and would need to be replaced.

Automating a perfusion process with the PendoTECH Perfusion Controller

The PendoTECH Perfusion Controller measures all pressures in the perfusion process to monitor filter performance continuously. The values can be trended and alarms can be set to prevent out of range values. The filtrate pump is set via the control system to the required vessel volume per day flow rate. The filtrate scale is used to verify the amount of spent media removed from the bioreactor. The media feed pump automatically maintains the vessel scale setpoint to ensure the required amount of media is fed to the bioreactor. The in-line temperature sensor can be used to monitor temperature external to the bioreactor and additionally this temperature is logged. The Air Detector shown can be used to stop the pumps if the media supply runs empty.





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.

Single Use 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.

Single Use Temperature Sensors



Temperature is displayed in the software system view and recorded in the data file. They are available in a range of hose barb sizes from 1/8inch to 3/4inch and also a 1inch flange.

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.

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.

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. It can be used to stop the process when the media supply is empty.

Filtrate Flow Meter Options



Rotary
Flow Meter



Leviflow Sensor
Monitor with Sensor

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%. The rotary flow meters have a 1/4 inch hose barb and can measure flows from about 0.1 to 2 L/min or a 1/2 inch barb that can measure flows from 1.0 to 20 L/min. These rotary flow meters can be used in a single use mode or re-used.

Detail	Specifications
Dimensions (HxWxD)	8.5inch x 10inch x 8.5inch (21.59cm x 25.4cm x 21.59cm)
Weight	13.5 lbs. (6.12kgs.)
Enclosure Material	304 Stainless Steel
Power Requirements	24 VDC, 2.1 amp max (comes with 100 - 240 Volts, 50 - 60 Hertz wall plug transformer to 24 VDC with plug for country supplied)
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
Scale Inputs	RS232 Communication
Temperature Inputs	2-wire 2252ohm thermistor input designed for use the PendoTECH temperature sensors
PC Requirements	Windows 7 or 10, 2 GHz or faster, 4GB of RAM

Ordering Information

PDKT-PCS-PERFUSION	PendoTECH Bioreactor Perfusion Controller with PC software and interface cables (PC not included)
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Interface cables included:

- 1) PDKT-650-298-PCS (QTY 3)
- 2) Pump interface cables (QTY 3) vary depending on pump model
- 3) PDKT-TEMPB-PNL (QTY 1)
- 4) USB cable for PC connection
- 5) PDKTP-RS232 - RS232 cable for scales (6ft/2m)