MICRODYN® Module
Modules for Microfiltration

Principle flow diagrams for Crossflow-Microfiltration
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1. Introduction
This brochure is to give you fundamental information, suggestions and definitions. But product specific details are not included. Please contact your Microdyn sales person for these details and other information.

1.1. Crossflow-Filtration (CF)
In the case of a tubular membrane, the feed flows through the membrane lumen (inside). There are a bundle of tubes in each filter device or module. A part of this feed exits the module as filtrate or clean water due to a pressure difference across the membrane. The remaining liquid is called the concentrate.

Fig. 1: Principles of Crossflow-Filtration

1.2. Back Pulsing
During the filtration some particles will settle down on the surface of the membrane. This decreases the performance of the membrane. In order to clean the membrane of these particles, you can clean the membrane by pushing some of the filtrate back through the wall of the membrane by a change in the direction of filtration.

Fig. 2 und 3: Principle and operation of the Back Pulse
1.3. Basic flow diagram and control devices

The feed will be pumped under pressure through the module. There will be a loss of pressure from the module’s inlet side to its outlet side due to the velocity of the liquid being forced down the lumen of the membrane tube (\( \Delta P \)). The value of this loss indicates the flow velocity. There are other factors involved (i.e. viscosity, fouling, etc.).

Additionally, the filtrate flow (flux), filtrate pressure and back pulse pressure need to be measured. In some cases a temperature reading must be recorded.

This is a sample flow diagram:

Fig. 4: Simplified basic flow diagram
2. Process possibilities

2.1. Open loop operation

In this process variety you put a receiving vessel in a loop with a pump and the module. This process possibility is used for batch operation. You can reach a high concentration in the concentrate, maybe with refilling the receiving vessel.

A continuous operation is possible, by continuous feeding of the vessel and concentrate bleeding. But the pump has to make the whole working pressure and the flow velocity. Because of that this type of operation mode is normally only used for smaller systems.

Fig. 5: Simplified flow diagram for open loop operation
2.2. Closed loop operation

In this process variety you build up a loop only with a circulation pump and the module. The advantage is that the pumping pressure is lower. It is only the pressure loss of the module ($P = (P_1 - P_2)$) and of the pipes. The smaller feeding pump makes the system pressure. The pumping volume is only the flow rate of the filtrate and the bled concentrate. The concentration of the concentrate is founded on the relation of feeding and bleeding. It is important to keep the PBP-valve wide open to bleed the high amount of back pulsing water and to protect the feed side for a pressure increase.

Fig. 6: Simplified flow diagram for closed loop operation
2.2.1. Multistage operation

Fig. 7: Simplified flow diagram (without control devices and back pulsing system) for multistage operation

If there is a decreasing filtrate rate by an increasing feed concentration, it is possible to make the concentration in multistage operation. In this case feeds a part of the concentrate from the loop of the first stage the second stage. So the flow rate is higher in the first stages and only in the last smaller stages lower. The result is a smaller Membrane requirement for the whole plant.

The sense of the PBP-System is to remove the solid fouling and scaling material from the surface of the membrane (see 1.2). The result is a high performance of the filtration also when the feed flow velocity is low. Also the energy consumption decreases because of that.

While the feed pump is running you press every few minutes a little bit of the filtrate opposed to the normal filtration direction through the membrane. In this moment the filtration pressure must be higher then the feed pressure (max. PF = P2 + 1,5 bar). The fouling and scaling material lifts up from the membrane, because of the backflow and leaves the module, because of the feed flow. It is recommended to install a PBP overflow for the concentrate, because of the high back flow volume (nearly 1 l per m2 of installed membrane area in approximately 2 s). To find out how often a back pulse is needed, trials are necessary. Normally it is used every 5 – 30 minutes.

3.1. PBP with compressed air

The compressed air (or other compressed gases like N2 or CO2) is not used as cleaning substance. The air only press the liquid through the membrane:

![Fig. 8: Simplified flow diagram PBP with compressed air](image-url)
Valve PV4 is only used in closed loop operation systems (see also 2.2).
3.2. Periodic Back Pulsing with pump pressure

In large systems it is possible to back pulse the modules individually or in groups. In this case it is best to use a pressure controlled pump. To keep the pump small and to get the necessary flow volume, it is possible to use a pressure vessel with a rubber membrane for the storage of pressurized filtrate. The pump will pressurize the filtrate in this vessel up to a regulated pressure. The vessel has to be big enough to store the back pulsing volume of 1 Liter per installed square meter of membrane area.

Example:

**Fig. 10: Simplified flow diagram PBP with pump pressure**
Usually the outlet on the upper, downstream side is used for the filtrate, due to the automatic ventilation of the module. It is also possible to use the outlet on the other side of the module for back pulsing, especially when it is used for chemical cleaning with automatic valving.

Fig. 11: Flow diagram PBP with the second filtrate socket
3.3. Backwashing with special pump and disconnected feed pump

Backwashing is better to use in some cases instead of back pulsing. It is not used as often (e.g. 1 h), but for a longer time (10 s – 1 min.) and with the feed pump disconnected. For this procedure you need a bigger filtrate storage vessel and maybe a sterile air vent filter.

Fig. 12: Simplified flow diagram for back washing
4. Adjustment of filtrate flow

The performance of a new or cleaned membrane is very high. But with a very high flow rate, there is also a large fouling potential for the membrane. To maintain good performance of the membrane it is better to limit the filtrate flow with the filtrate pressure. In the beginning the filtrate pressure will be high. While the filtration is going on, fouling formation and discharge get into balance. Now the filtrate pressure decreases and the differential pressure across the membrane increases. But the filtrate flow rate remains the same.

Example:

![Flow diagram adjustment of filtrate flow](image)

**Fig. 13:** Flow diagram adjustment of filtrate flow
5. Chemical Cleaning (CIP)

The chemical cleaning of the membrane is best effected from the filtrate side. The procedure is the following:

a) Uncouple the filtration system from other systems;
b) Empty the system on both sides of the membrane (feed and filtrate);
c) Fill the system completely with cleaning solution (e.g. Sodium Hydroxide) from the filtrate side;
d) Wait for the reaction time of the cleaning solution;
e) Empty the whole system;
f) Rinse the System with water (best is demi water)
g) A second cleaning procedure with other cleaning solution (e.g. citric acid) maybe necessary. Repeat steps d) to f).
h) Connect the filtration to the other systems

Fig. 14: Flow diagram CIP
Notice:
The particulars given in this data sheet reflect the latest published information of Microdyn as at the date of the same. The drawings are simplified and made only to give help to make a flow sheet for a real system. They are not a basis for plant building. Liability of any kind, which is not covered by the warranty as specified in Microdyn’s Conditions of Sale, cannot be accepted.
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