

## A MEMBRANE FILTER ELEMENT

**SUBSTANTIATION ON PRIOR ART AND LIMITATIONS:****Membrane filtration device.**

Ultrafiltration and microfiltration are in general use for the separation of suspended materials. The applications are wide and cover the recovery of materials which have economic value as in the food industry to the removal of suspended matters ( silt, bacteria, viruses) in the drinking water industry.

For the filtration use is made of two filtration principles. The first being a cross-flow system, in which the liquid to be filtered is transported at a relatively high velocity along the surface of the membrane under pressure. A part of the liquid is passing the membrane and is called filtrate. Because of the turbulence generated by the velocity the deposition of particulates on the membrane surface is controlled. In more advanced systems the cleaning can also be assisted by periodic backwashing, where the filtrate is brought under a higher pressure causing the flow through the



membrane to be reversed. Systems using cross-flow filtration need large pumps and related equipment and therefore tend to be expensive and complex and use more energy.

In recent years the "dead-end system" has won in popularity. Instead of continuously discharging the suspended materials these materials are collected on the surface of the membranes in the filter element. Since in this type of filtration all the liquid is passing through the membranes the energy efficiency is very high. The collected material accumulated on the membrane surface is periodically removed by backwash, sometimes in combination with a forward flush. The forward flush can be regarded as a cross-flow mode, where most of the times one ensures that there is no filtrate production during the operation.

This type of system is particularly suited for treatment of liquids which are not heavily contaminated.

Recently virtually all systems for the treatment of water to make it potable using ultrafiltration and microfiltration are using a type of dead-end technology.

One example of dead end filtration combined with backflushing and forward flush is described in WO 97/47375 assigned to USF Rossmark which describes an ultrafiltration system of elements in a pressure vessel. The elements consist of hollow fiber elements of the inside-out configuration, which means that the contaminated liquid is flowing through the bore of the hollow fiber.

In contrast to the inside-out mode the outside-in mode takes advantage of the fact that it uses the outer surface of a hollow fiber and therefore a larger filtration surface can be obtained with the same number of hollow fibers in a similar element.

A configuration which uses the outside-in mode for the filtration is described in WO 98/16297 assigned to USF Limited. Here the fibers are in an enclosure. The collected suspended solids are removed by backwash combined by a forward flush. Here it is also described that some types of membrane using backwash are very hard to clean because "dead spaces" can occur which lead to either inefficient cleaning or to great backwash losses and therefore loss of efficiency of the element.

In patent US 4767539 assigned to Memtec an element is described where the feed is from the outside of the fibers and where the element is backwashed with air to remove the collected suspended solids. This process has the disadvantage that one has to use hydrophobic membranes and that because of the nature of the backwash only microfiltration is possible.

In patent US 5248424 assigned to Zenon Environmental a process is described where hollow fibers are immersed in a bath and the filtrate is obtained by having a vacuum on the filtrate side of the membranes. The cleaning is performed by bubbling air through the feed side which causes the fibers to move ( vibrating) and the fluid to move upwards causing the suspended solids to be taken along with the feed. This procedure can be enhanced by a backwash. This method has proved to be most efficient when the fibers are in a vertical position, which is the case in the commercially available microfiltration elements from Zenon Environmental.

The fibers are placed loosely in a big container which means that it is difficult to remove contamination completely without loss of feed water.

**STATEMENT OF INVENTION AND EMBODIMENTS:**

The present invention concerns a filtration device for ultrafiltration or microfiltration comprising hollow fiber or tubular microfiltration or ultrafiltration membranes with the active filtration layer on the outer surface of the fiber or tube, enclosed in an element, preferably of tubular shape which allows the suspended solids collected after some time of dead-end operation to be removed completely without a forward flush and the connected loss of water.

**DESCRIPTION:**

A detailed description of an element according to the present invention and the use of it is given below:

In fig. 1 an element is depicted which consists of an outer tube A, typically between 50 mm and 600 mm of diameter and between 400 mm and 2000 mm long in which hollow fibers are potted at one(B) side to transport the filtrate from the bores of the fibers. On the lower side of the element a feed entry / exit C is provided and on the top side an air entry/exit D is provided. The latter connect to the inside of the element and are inside the element of open or porous nature for distribution of air and water.

At the start of the filtration cycle the element is filled with air. Water is fed through port C and the replaced air is removed through port D until the element is full of water. Then port D is closed and a pressure is build up causing water to permeate the membranes and

filtrate to leave via exit B. When the collected suspended solids have to be removed a backwash can be performed by putting pressure on port B and opening port C. Then or at the same time air can be introduced via port D or alternatively port C. After the removal of all fluid the element is again ready for use. The ports C and D could also be provided through the wall of the tube.

In fig 2 an alternative element is depicted which can be coupled to another element. The difference from the element in fig 1 is that here the potting is on both sides of the tube A and the connections C and D are also on both sides of the tube. This allows the elements to be connected in series within a pressure vessel.

An extra in this element is a filtrate transport tube which protudes through the pottings and connects the filtrate sides B.

In fig 3 a vertical possibility of an element according to the invention is given. The port numbering and use is according to the first example.

### **ADVANTAGES:**

1. The element of the present invention use the dead-end filtration cycle for the filtration. After the suspended solids have been collected a backwash is performed and the water containing the suspended solids is removed from the enclosure of the fibers by replacing all the fluid on the feed side with air.
2. The cleaning of the element improved when the backwashing continued during the replacement of the water in the element with air.

3. Another great advantage of the present invention is the fact that it solves the problem of deaeration which is often found in elements which are placed horizontally. In those type of elements often air pockets can occur which reduce the efficiency of the elements. By having an air connection in the top side of the element their problem is non existent in the elements according to the present invention.

4. This procedure has the advantage that one does not have to use a forward flush with feed water to remove the suspended solids from the membrane element and is therefore increasing the efficiency of the filtration process.

5. The elements according to the present invention have the advantage that they can be placed horizontal and can be coupled into a pressure vessel so that the length of the pressure vessel is not limited as it is with vertical placement.

The examples are given as examples only and do not intend to limit the invention in any way.



## CLAIMS

1. A filter element comprising open-ended tubular or hollow fiber membranes, housed within and extending axially along the length of a horizontal tube with pottings arranged at at least one end of the tube such that the membranes extend therethrough, the potting preventing axial flow of fluid through the ends of the tube except through internal conduit of the membranes, and at least two conduits communicating with the interior of the tube between the pottings. Besides feeding the raw water to the outside of the membrane and removing backwash water, the conduits can be used to feed air to the filter element and to remove air from it. Air is added periodically to dislodge filtered material from the membranes and / or to remove the water containing the filtered material from the filterelement.
2. A filter element according to claim 1 where the hollow fibers have a dimension of 0,2 to 3 mm, preferably 0,5 - 1 mm.



3. A filter element according to claim 1 where the membranes are of the ultrafiltration type with a cut-off of 2000 to 500000 Dalten, preferably between 20000 and 100000 Dalton.
4. A filter element according to claim 1 where the membranes are of the microfiltration type with a pore size of 0,05 – 5 micro, preferably between 0,1 and 1 micron.
5. A filter element according to claim 1 where the conduits communicating with the interior of the tube extend through the potting on one side of the filter element.
6. A filter element according to claim 1 where the conduits communicating with the interior of the tube extend through the potting on two sides of the filter element enabling series connection of filter elements.



7. A filter element according to claim 1 and 6 where a conduit is present for transport of permeate from the potting on one side of the tube to the potting on the other side of the tube.
8. A filter element according to claim 1 where the conduits communicating with the interior of the tube extend through the wall of the tube.
9. A filter element according to claim 1 where the membranes can be backwashed with fluid.
10. A filter element according to claim 1 and 4 with hydrophobic membranes enabling air-backwash.