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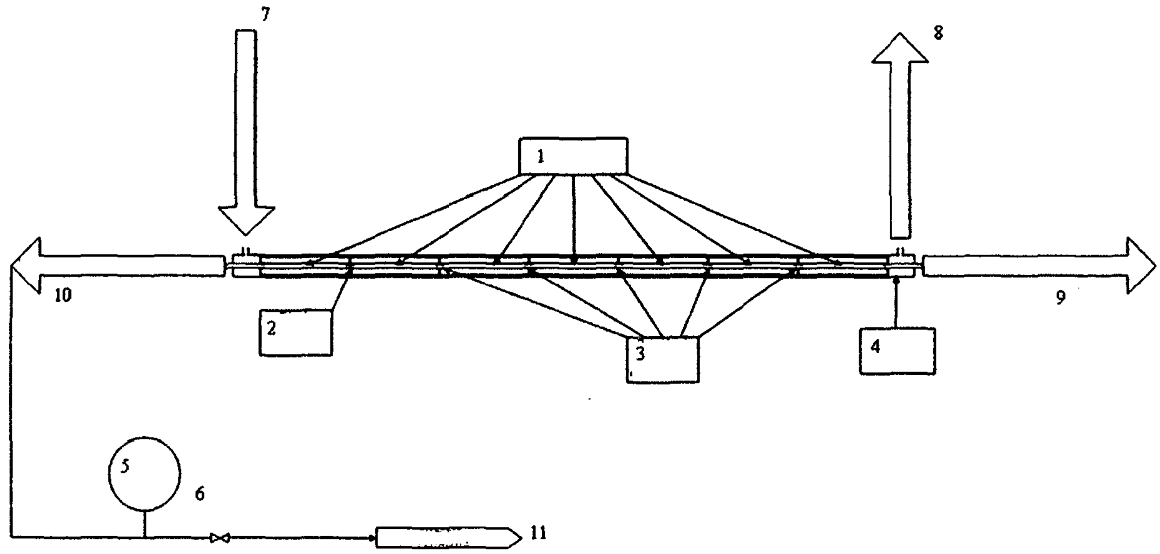
Drawings

Figure 1



LEAD ELEMENT FLUX CONTROL IN THE PURIFICATION OF WATER BY REVERSE OSMOSIS

Background of the Invention

Technical Field:
The invention concerns a method of independently controlling the production rate of the lead element of a series of reverse osmosis elements used for the removal of dissolved solids from water. As a consequence of this independent control of lead element flux, it is possible to increase the overall production efficiency of a reverse osmosis system.

Description of Related Art:
Reverse osmosis is an established process for removing dissolved solids from water, and is the subject of a number of existing patents, including:

- US 3,608,730 Blaha, Desalination apparatus, 1971
- US 3,637,081 Bradley Liquid treatment system, 1972
- US 4,169,789 Lerat, Process and apparatus for purifying sea water by reverse osmosis, 1979

A number of established vendors, including Dow FilmTec, Hydranautics, Koch and Toray supply reverse osmosis membranes commercially for the purposes of producing potable water from seawater. All of these vendors provide proprietary software to predict the performance of a membrane system design for a given set of seawater and operating conditions. This software is used to check that all of the membranes meet with design guidelines, which are intended to ensure reliable and efficient operation of the system.

One of the critical design guidelines is the lead element flux.

Object of the invention

The object of the invention is to control the flux rate of the lead element of a series of reverse osmosis membranes independently from the remaining membrane elements in series. As a direct result of this, a number of advantages are realised including:

1. Lead element flux can be removed as the dictating design constraint for a reverse osmosis system for water purification.
2. A system can be operated with full knowledge and control over the lead element of a series of reverse osmosis membranes, thereby reducing the risk of membrane fouling.
3. The overall number of membranes required to purify a given quantity of water containing dissolved solids can be reduced, thereby reducing the overall capital cost of the system.

These advantages and other objects of the invention are achieved by the method for controlling lead element flux in a series of reverse osmosis membranes as described below. This invention is further described and characterised by the enclosed patent claims.

Essential features

The invention concerns a method of independently controlling the production rate of the lead element of a series of reverse osmosis elements used for the removal of dissolved solids from water. Water containing dissolved solids is purified by a number of reverse osmosis membranes arranged in series. The first membrane in the series of elements purifies a proportion of the feed water by producing a permeate stream containing a reduced concentration of dissolved solids, and a brine stream containing a more concentrated solution of dissolved solids. This brine stream is then passed directly onto the second membrane element in the series, where a further proportion of purified permeate is removed, and a reduced quantity of further concentrated brine is passed onto the third element. All of the membrane elements in series are housed within a common pressure vessel.

It is essential that the permeate from the lead element in the series be hydraulically isolated from the permeate of the remaining elements in the series.

It is essential that the flowrate of permeate from the first element be monitored independently from the permeate of the remaining elements in the series.

It is essential that the flowrate of permeate from the first element be controlled independently from the permeate of the remaining elements in the series.

Important but non essential features

Preferably the pressure vessels containing the reverse osmosis membrane elements will contain between four and eight spirally wound reverse osmosis membrane elements.

Preferably there will be a large number of pressure vessels acting in parallel to provide the required production of purified water.

Preferably, a manifold system will collect the permeate from all of the lead elements in each pressure vessel of a group of pressure vessels

Preferably, the manifolded lead element permeate flowrate will be continuously monitored by an in line flowmeter, used to automatically regulate that flowrate of water by use of an in line control valve.

Detailed Description

The invention will be further described with reference to the drawings. The items on the drawings have all been labelled with numbers. These numbers are used in the detailed description. The key to these items is as follows

Item 1 - Reverse osmosis membrane elements
Item 2 - Blanked off permeate connector
Item 3 - Standard, flow through permeate connector
Item 4 - Pressure Vessel
Item 5 - Flow measurement
Item 6 - Flow control device
Item 7 - Feedwater inlet
Item 8 - Brine outlet
Item 9 - End element permeate outlet
Item 10 - Lead element permeate outlet
Item 11 - Controlled lead element permeate
Figure 1 – Reverse osmosis elements employing lead element flux control

A schematic representation of a single pressure vessel containing a number of reverse osmosis membranes in series, employing lead element flux control is provided in figure 1.

A number of reverse osmosis membranes (1) are housed in series in a pressure vessel (4). Feedwater is introduced into the pressure vessel at the inlet (7) and flows down the feed side of the first reverse osmosis membrane element. A small proportion of the feedwater passes through the reverse osmosis membrane, to form the first, or lead, element permeate. The permeate from the first element collects in the central, permeate tube of the first element, which is hydraulically isolated from the permeate of all of the other reverse osmosis membrane elements by a blanked off permeate connector (2). The permeate collected from the first element flows out of the lead element permeate outlet (10), from where its flowrate is measured (5) and regulated by a flow control device (6) to provide the controlled lead element permeate (11).

The remaining portion of feedwater which does not permeate through the first reverse osmosis membrane forms the first element reject water, which is fed to the feed side of the second reverse osmosis membrane element. A proportion of the second element feedwater permeates through the second element, into the second element permeate tube, and the remaining reject water makes the feed to the third element. This process continues until the final element, from where the reject water leaves the pressure vessel through the brine outlet (8). The permeate water from the second element is hydraulically connected to the permeate from all of the elements in the pressure vessel except for the lead element by standard, flow through permeate connectors (3). This combined permeate water flows out of the pressure vessel through the end element permeate outlet (9).

Claims :

1. Method for controlling the production rate of the lead element of a series of reverse osmosis elements used for the removal of dissolved solids from water independently of the elements downstream of the lead element, where the permeate flow from the lead element of a series of reverse osmosis membranes is segregated from the remaining elements by a blanked off permeate collector, its flowrate monitored by an on-line flowmeter, and the output from that flowmeter used to control the position of an automatic control valve positioned in the lead element permeate line.

2. A method substantially as herein described above and illustrated in the accompanying drawing.