



## Rotating Reverse-Osmosis for Water Purification

This device would resist fouling.

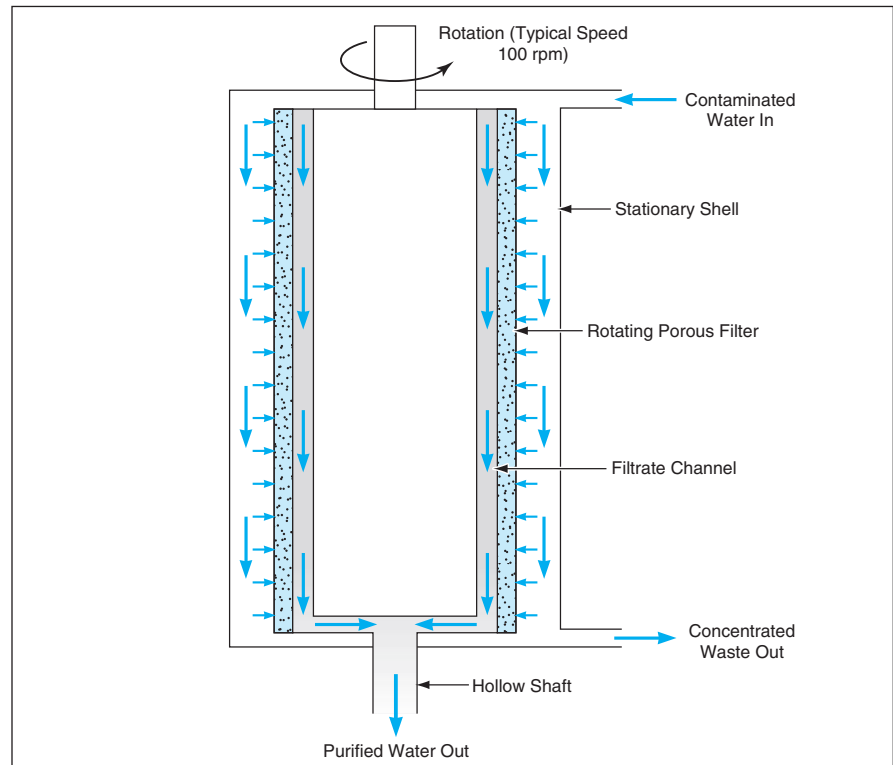
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A new design for a water-filtering device combines rotating filtration with reverse osmosis to create a rotating reverse-osmosis system. Rotating filtration has been used for separating plasma from whole blood, while reverse osmosis has been used in purification of water and in some chemical processes. Reverse-osmosis membranes are vulnerable to concentration polarization — a type of fouling in which the chemicals meant not to pass through the reverse-osmosis membranes accumulate very near the surfaces of the membranes. The combination of rotating filtration and reverse osmosis is intended to prevent concentration polarization and thereby increase the desired flux of filtered water while decreasing the likelihood of passage of undesired chemical species through the filter. Devices based on this concept could be useful in a variety of commercial applications, including purification and desalination of drinking water, purification of pharmaceutical process water, treatment of household and industrial wastewater, and treatment of industrial process water.

A rotating filter consists of a cylindrical porous microfilter rotating within a stationary concentric cylindrical outer shell (see figure). The aqueous suspension enters one end of the annulus between the inner and outer cylinders. Filtrate passes through the rotating cylindrical microfilter and is removed via a hollow shaft. The concentrated suspension is removed at the end of the annulus opposite the end where the suspension entered.

The effectiveness of a rotating filter in preventing fouling comes from high fluid shear caused by the rotation and from the appearance of a vortical flow structure known as Taylor vortices: the resultant flow field tends to wash particles off the rotating filter.

In reverse osmosis, water is forced at high pressure through a membrane made of a material through which contaminants in aqueous solution pass much more slowly than does water. Hence, the concentration of undesired dissolved compounds is decreased by



The Flow Through a Rotating Osmosis Device is shown. Shear and vortices that arise in the liquid flowing between the rotating filter and the stationary outer shell wash away material that would otherwise accumulate on or near the filter surface and thereby cause fouling.

forcing the water through the membrane, creating purified water. In conventional practice, concentration polarization of reverse-osmosis membranes is often reduced by using cross-flows (flows parallel to the membrane surfaces) to wash away the concentrated chemicals, but this is not always effective without cleaning or back washing.

The rotating reverse-osmosis device resembles a conventional rotating filter, except that the cylindrical porous microfilter is replaced with a cylindrical reverse-osmosis membrane. The shear and the Taylor vortices generated by the rotation of the cylindrical reverse-osmosis membrane wash away the concentration-polarization layer. The latest prototype of a rotating reverse-osmosis module incorporates special rotating seals to solve one of the most difficult problems in the system, enabling the device to withstand the differential pressures needed for

operation period: Whereas microfiltration systems operate at differential pressures of the order of 1 atmosphere ( $\approx 0.1$  MPa), reverse-osmosis systems operate at differential pressures as high as 30 to 50 atmospheres ( $\approx 3$  to 5 MPa).

This work was done by Richard M. Lueptow of Northwestern University for Johnson Space Center.

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

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