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Stabilization of Porous Glass Reverse-Osmosis Membranes

Porous glass in the form of capillary tubes has been found to function as a low-capacity ion exchange membrane in hyperfiltration experiments. Thus, when dilute salt solutions (<0.2 molar) are kept in contact with the external walls of a closed-end porous glass capillary at 4 to 12 MN/m^2 (40 to 120 atmospheres), the liquid which penetrates the porous glass has less salt than the solution supplied to the capillary.

The efficiency of desalination by a reverse-osmosis system is defined as "percent rejection," that is, the percent reduction of the salt concentration in the solution fed to the system. Another parameter of interest is "flux," or the rate at which fluid flows through a unit area of membrane per unit pressure difference across the membrane. An annoying characteristic of porous glass membranes is that the high initial rejection of salts (such as sodium chloride) rapidly declines and the flux increases. Since considerable silica is leached from the porous membrane during hyperfiltration, it is probable that the molecular structures responsible for salt rejection are deteriorated; leaching of silica presumably leads to increases in pore size and corresponding increases in flux.

By treating porous glass membranes initially and then periodically with a 0.12 molar solution of aluminum chloride, deterioration of porous glass membranes with respect to salt rejection is sharply curtailed, and in some instances there even may be an improvement for a period of time. Moreover, if aluminum chloride is added to the solution fed to a hyperfiltration cell, periodic pretreatment is not necessary; it appears that the porous glass membrane is stabilized by the presence of aluminum chloride.

An initial decrease of water flux through a membrane may be observed after pretreatment with aluminum chloride, but the rate of decrease appears to level off after subsequent treatments. In experiments at 8.3 MN/m^2 (1200 psig), the loss of silica from membranes treated with aluminum chloride was about seven times less than from membranes which had not been treated; aluminum chloride appears to form an insoluble aluminosilicate on the surface of the porous glass.

References:

1. Ballou, E. V.; Leban, M. I.; and Wydeven, T.: Stabilization of Porous Glass Hyperfiltration Membranes by Aluminum Chloride Solution. Nature Physical Science, vol. 229, no. 4, p. 123, 1971.
2. Ballou, E. V.; Wydeven, T.; and Leban, M. I.: Solute Rejection by Porous Glass Membranes. I. Hyperfiltration of Sodium Chloride and Urea Feed Solutions. Environmental Science & Technology, vol. 5, p. 1032, 1971.

Notes:

1. The porous glass is manufactured by leaching a solid phase; there remains a fine-pored structure with a narrow pore-size distribution (Corning Glass Works, Vycor No. 7930).
2. No additional documentation is available. Specific questions, however, may be directed to:

   Technology Utilization Officer
   Ames Research Center
   Moffett Field, California 94035
   Reference: B72-10309

(continued overleaf)

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No patent action is contemplated by NASA.

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