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Improved Ion Exchange Membrane

The problem:

Existing ion exchange membranes have low exchange capacities, are not homogeneous, and have relatively-small surface areas.

The solution:

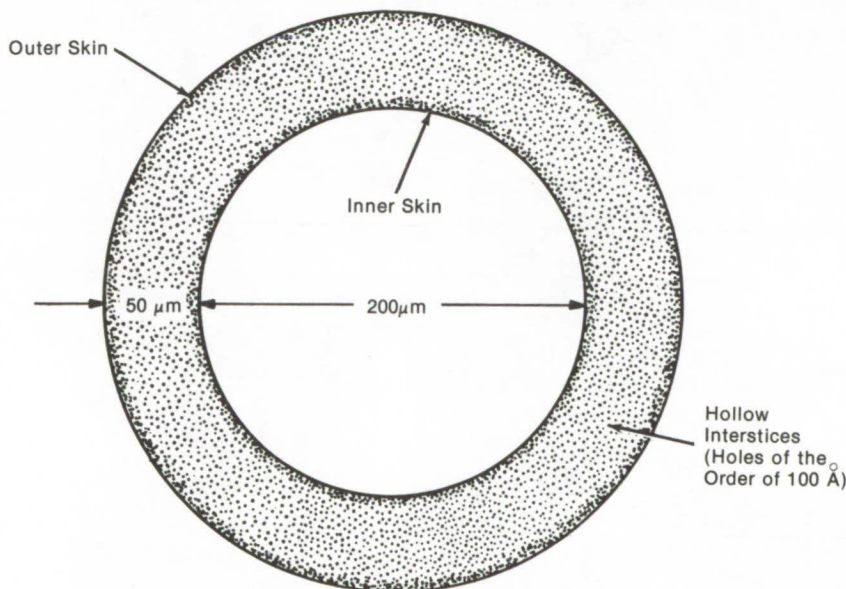
An improved ion exchange membrane has been made from ion exchange fibers. The new membrane is homogeneous and presents a relatively-large surface area.

How it's done:

The membrane is made from commercially-available hollow fibers which are used in reverse osmosis, or dialysis. A cross section of this fiber is shown in the illustration. The fiber has outside and inside skin layers which pass only small molecules. Macromolecules cannot penetrate the skin.

The fibers are simply impregnated with two monomers. The process consists of the spontaneous polymerization of 4-vinyl pyridine and similar monomers with dihalides. The polymerization proceeds without the aid of a catalyst or initiator, and the resulting polymer is therefore unusually pure. At the end of the polymerization, an insoluble cross-linked ion exchange resin exists in the walls of the fibers. The finished fibers have a high ion exchange capacity, a practical wall permeability, and good mechanical strength. This principle of polymerization inside of small pores can be extended to other materials, such as porous ceramic tubes and many types of porous membranes.

The ion exchange capability of the new membranes has been demonstrated by utilizing fibers with a 300- μm outside diameter and a 200- μm inside diameter. A bundle of 150 fibers 8 in. (20 cm) long



Ion Exchange Hollow Fiber

(continued overleaf)

was assembled. When a K_2CrO_4 solution of 10 ppm was fed through the core of the above fibers (at the rate of $16\text{ cm}^3/\text{min}$) and when the outside of the fiber bundle was bathed with a 2 N NaCl solution, the exit concentration of dichromate ion was found to be as low as 0.7 ppm. In another test with the same solutions, 15 liters of a solution containing 10 ppm of potassium chromate were passed through the fibers at a rate of $3\text{ cm}^3/\text{min}$. The existing solution contained 0.02 ppm of the chromate.

The fibers can also be used to remove other undesirable anions, such as phosphate, sulfate, carbonate, and uranium in the form of a uranium-sulfate complex. In addition, by the application of suitable monomers (e.g., acrylic acid, salts of acrylic acid, or monomers containing sulfonic groups), cation hollow fibers can also be produced.

Note:

Requests for further information may be directed to:

Technology Utilization Officer
NASA Pasadena Office
4800 Oak Grove Drive
Pasadena, California 91103
Reference: TSP75-10117

Patent status:

Title to this invention has been waived under the provisions of the National Aeronautics and Space Act [42 U.S.C. 2457(f)], to the California Institute of Technology, Pasadena, California 91109.

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