Determination of Stainless Steel Membrane Characteristics Using Radionuclide Tracer Materials under Dilute Aqueous Conditions

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ABSTRACT

The purpose of this study was to initiate investigations into the feasibility of using porous stainless steel membranes to selectively remove actinide and non-actinide cation constituents from waste solutions. The membrane material used for initial testing was purchased from Mott® Metal Corporation is a sintered 316L stainless steel membrane having a nominal filtration rating of 0.5 µm the and thickness of approximately 0.123 cm. Experimentation was conducted in two phases beginning with physical characterization of the membrane material and then measurement of the transport through the membrane material with non-actinide (Eu^{3+}, Cs^{+}, Ca^{2+}) and actinide (Am^{3+}, and Pu^{4+}) radiotracer cations under dilute conditions. Tests confirmed that diffusion was the rate controlling mechanism for transport through the membrane. Characterization experimentation was conducted at the Colorado School of Mines in the Chemical Engineering Department (CEPR) whereas, radiotracer transport experimentation was conducted at the Radiochemistry Facility, Los Alamos National Laboratory.

Characterization tests were conducted to determined the pore size distribution, porosity, and tortuosity of the stainless steel membrane material. The average pore size was approximately 2.2 µm and the average the porosity was 24.9 %. The tortuosity, determined by conducting transport studies of ^{14}C-labeled sucrose through the stainless steel membrane, was estimated to be 2.1.

Results from transport experimentation confirmed diffusion as the rate controlling mechanism for the transport of cation solutes through the stainless steel membrane as experimentally determined infinite-dilution diffusion coefficients compared well with those found in referenced literature (Table 1).

Table 1 - Comparison of Experimental and Referenced Infinite-Dilution Diffusion Coefficients

Cation	D_0 From Literature ($cm^2/s\ 10^6$)	Experimental D_0 ($cm^2/s\ 10^6$)
Cs^{+},	10.0	7.0 ± 3.0[a]
Ca^{2+}	7.9	4.8 ± 2.2
Eu^{3+}	5.18	3.7 ± 3.0
Am^{3+}	6.25	4.4 ± 2.0

In addition, the infinite-dilution diffusion coefficient for plutonium (which was not available in reference literature) was determined to be $3.2x10^{-6} \pm 1.5x10^{-6}$ cm^2/s.