A NEW METHOD FOR GENERATION OF TRACK ETCHED MEMBRANES FOR MICROFILTRATION AND ULTRAFILTRATION

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ABSTRACT

A new experimental apparatus for porous track etched membrane production has been designed, tested and installed near the core of the IEA-R1 nuclear reactor at IPEN-Sao Paulo. The thermal neutron flux close to the centre of the reactor core has been used to produce fission fragments from uranium sample which was deposited on a rod located at the centre of an evacuated aluminium chamber.

These nuclear fragments impinge on a polycarbonate film mounted on the inner cylindrical wall of the irradiation chamber. Under conditions of uniform neutron flux large areas of track etched membranes, with high level of pore uniformity, have been produced in the micro and ultrafiltration range. Membranes with pore diameters ranging from 15 to 100 nm. have been prepared reproducibly, based upon a calibration curve of track diameter versus etching time.

OBJECTIVES

The main objectives of the present work were:

1) To design, construct, install and test a new irradiation device, near the IEA-R1 reactor core, for controlled production of porous membranes with high level of pore uniformity.
2) To study the axial profile of the thermal neutron flux at the irradiation position of the U-235 fissile sample.
3) To obtain a calibration curve track diameter versus etching time in the ultrafiltration region.
4) To produce large areas of etched track membranes with pore sizes ranging from 10 000 nm down to 15 nm and pore density in the interval from 1.0×10^5 to 1.5×10^9 cm^{-2}, respectively.

RESULTS AND DISCUSSION

Irradiation times from 3 to 6 minutes were adequate to obtain membranes of 8.0×10^8 to 1.5×10^9 pores/cm^2, using the new equipment.

To produce TEM from the irradiated films of Makrofol in the ultrafiltration range (pore diameter < 100 nm), the best results were obtained with 5 M NaOH solutions at 35° C. Pore diameters in the etched Makrofol foils were measured using a SEM. The calibration curve of pore diameter versus etching time, for track diameter ranging from 15 to 120 nm and average pore density of 8.0×10^8 pores/cm^2 was obtained.

CONCLUSION

The new irradiation device is well suited for controlled production of microfiltration and ultrafiltration TEMs when irradiated by thermal neutrons in a nuclear reactor. Membranes are obtained with precisely defined pore sizes and pore densities and with pores normal or close to normal to the membrane surface. Large areas (~ 600 cm^2) of track etched membranes with a high level of pore uniformity can be prepared using this new configuration, and periods of irradiations as short as few minutes. The methodology for producing ultrafiltration membranes has been developed down to pore size of 15 nm employing a pore density around 8.0×10^8 pores cm^{-2}. However, the lower limit for the present technique should be, in principle, the hole size produced by the fission fragment without the chemical etching, which is approximately 8 nm according to Durrani and Bull.