THE EFFECT OF RADIATION AND DOSE ON DIFFUSION PUMP OIL

Jonas Smith [1]

[1] Department of Environmental Engineering and Sciences, Clemson University

jonass@g.clemson.edu

George Larsen[2] , Tyler Guin[2] , Valery N. Bliznyuk[1†] , Timothy A. DeVol[1†]

[2] Savannah River National Laboratory, Aiken, SC

[†] Center for Nuclear Environmental Engineering Sciences and Radioactive Waste Management, Clemson University

This research quantifies some of the chemical and physical changes that occur to commercially-available diffusion pump oils irradiated with gamma-ray and neutron radiation up to 10 MGy. One aliphatic, one silicone, and two polyphenyl ether diffusion pump oils were each irradiated up to 7.5 MGy at a dose rate of 20 kGy/hr using a Co-60 source at Savannah River National Laboratory (SRNL). Neutron irradiation up to 10 MGy was conducted incore at the Rhode Island Nuclear Science Center (RINSC) TRIGA reactor at a thermal flux on the order of 10^{13} n/cm^2*s. Neutron irradiation led to some activation of the oil which was characterized using gas flow proportional counting, liquid scintillation (LSC), and gamma spectroscopy with a High Purity Germanium detector (HPGe). Fourier transform infrared spectroscopy (FTIR) and measurements of interfacial tension (IFT) were used to identify damages in the chemical structure of the oils. Initial inspection after irradiation showed that the viscosity of the oils increased, and the color was noticeably darker. Activation analysis of the oils determined contamination by ^{65}Zn due to the vial that the oil was irradiated in. The gross-beta activity far exceeded that associated with the ^{65}Zn. FTIR was unable to discern any difference between irradiated and unirradiated oil aside from one sample. The change in IFT was within 7% of the control value for every sample. These experiments are being conducted as part of an investigation into cost-efficient alternatives to the turbo cryopumps for fusion power plants. Critical to the application of diffusion pumps in a radiation environment is to assure that the physical and chemical properties of the oil be maintained for a reasonable lifetime.

This work is being funded under ARPA-E grant #DE-AR0001376.