Application of nanofiltration to the treatment of radioactive waste

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Keywords: waste radioactive; nanofiltration membranes, uranium.

The present study investigated the potential of the nanofiltration membrane for the treatment of radioactive waste with the aim of reducing the volume of stored nuclear waste from research activities at IEN. Radioactive wastes are generated in the nuclear fuel cycle, during the production and application of radioisotopes, as well as during the processing of materials containing naturally occurring radioactive isotopes. Many consolidated traditional methods, such as chemical precipitation, evaporation and ion exchange, are used to treat radioactive waste of medium and low intensity. Membrane separation processes (MSP) have recently been adopted by the nuclear industry as an alternative method for the treatment of low and intermediate level liquid radioactive wastes, commonly used in some nuclear power stations around the world [1,2]. One of these processes is the nanofiltration (NF) – an intermediate process between reverse osmosis and ultrafiltration membranes. The NF membranes have the property of separating molecules of low molecular weight and multivalent ions [3]. Different from reverse osmosis, nanofiltrarion is most frequently used in water treatment, due to its low power consumption. The separation process takes place through a combination of two mechanisms: ion size exclusion and ion charge [4]. The nanofiltration presents a negative electrical charge in an aqueous medium, facilitating the rejection of multivalent anions, such as SO_4^{2-} and PO_4^{3-} due to an increase in electrostatic repulsive forces. The aim of this test was to evaluate the performance of commercial membrane SR 90-440i of FilmTec/Dow as the uranium rejection, as well as waste volume reduction. This test was carried out without the return the permeate to the feed tank. Liquid reject produced at IEN (Table 1) was used in the experiment. The performance of the membrane was evaluated in a system with permeation cell with displacement flow tangential of the Osmonics (Figura 1). The permeation experiments was at a constant pressure of the 1.5 MPa. The initial volume of waste was 2000mL. The rejection values of uranium and other chemical species are shown in Table 1. The considered parameters were the volume reduction factor and the rejection of the uranium.

Figure 1 - Pictures of the permeation system with filtration cell with displacement type flow tangential.

Table 1- Concentration of uranium and chemical species in the original waste, permeated and uranium rejection (%).

	Chemical composition (mg L^{-1})			
Original Waste	**Si**	**Cu**	**Fe**	**U**
	61	21	18	289
Permeated	-	-	-	23
Rejection (%)	100	100	100	**92**

The NF membrane was satisfactory for the separation of the uranium from the waste as it showed 92% of the rejection and the recovery in the permeate stream was equivalent to 70% of the original waste. The concentrated uranium with 814 mg L^{-1}, in a volume of 560 mL, can be recovered or stored.
The divalent anions complex UO_2^{2+} were rejected, however, the CONAMA recommends that uranium concentration limit for disposal must be less than (0.02 mgL^{-1}) [5]. Further tests will be conducted to improve the performance of this process.

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