Composite and derivatized membranes for the extraction of gadolinium from moderator's virgin heavy water

Abstract

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The doctoral thesis entitled "Composite and derivatized membranes for the extraction of gadolinium from moderator's virgin heavy water" aimed to obtain composite and derivatized membranes for the extraction of gadolinium from the heavy water of the moderator, to evaluate the possibility of replacing ion exchange columns, used in CANDU Nuclear Power Plants, for the purification of heavy water from the Moderator System. Chapter I of this thesis includes a literature review on CANDU-type nuclear reactors, the use and applications of gadolinium and the different methods / techniques of gadolinium extraction used. Chapter II of the thesis corresponds to the first objective of the research, which is fulfilled by presenting a new method for evaluating the process of separation through a membrane. For this purpose, a cellulose acetate membrane was modified in several steps - the reaction with amino-propyl-triethoxysilane, the reaction with glutaraldehyde and the functionalization with calmagit – a dual-role indicator: to facilitate and indicate the Gd(III) separation process. Upon Gd(III) separation, the membrane changed color from blue to pink, the efficiency of the Gd(III) separation process being 86%. Chapter III of the doctoral thesis was developed to meet the second objective of the thesis, according to which the surface of a cellulose acetate membrane was modified in several stages: initially with amino-propyl-triethoxysilane, followed by the reaction with glutaraldehyde and immobilization of the crown ether. A separation efficiency of 91% has been demonstrated compared to the initial feed solution. Chapter IV of the thesis highlights the third objective of the thesis, which was achieved by obtaining composite membranes with silica nanowires for gadolinium retention. An efficiency of the Gd(III) separation process of 75% was demonstrated for the membrane with the highest content of silica nanowires, compared to 58% for the initial CA membrane.