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IMMOBILIZATION OF RADIOACTIVE EVAPORATOR CONCENTRATE IN MORTAR MATRIX

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Abstract - Traditional methods of processing evaporator concentrates from NPP are evaporation and cementation.These methods allow the transformation of a liquid radioactive waste into an inert form, suitable for a final disposal. To assess the safety for disposal of radioactive mortar-waste composition, the leaching of ^{137}Cs from immobilized radioactive evaporator concentrate into a surrounding fluid has been studied. Leaching tests were carried out in accordance with a method recommended by IAEA. Determination of retardation factors, K_F, and coefficients of distribution, k_d, using a simplified mathematical model for analyzing the migration of radionuclides, has been developed. In our experiment we have achieved the lowest leaching values after 60 days in samples. Results presented in this paper are examples of results obtained in a 20 year mortar and concrete testing project, which will influence the design of the engineered trenches system for a future central Serbian radioactive waste disposal center

Key words: Radioactive waste, cement, mortar, diffusion, leaching

1. INTRODUCTION

Nuclear Power Plants, (NPP), industrial enterprises, and research institutes can be sources of liquid radioactive waste. Liquid radioactive wastes from NPP are typically salt concentrates evaporated to 200g/l and even higher concentrations. In order to prevent widespread dispersion of radionuclides into the human environment, radioactive waste produced in nuclear facilities has been incorporated in several kinds of matrices. Cement and concrete are widely used in low-level waste management both as a means of solidifying waste and for containment of dry or liquid wastes. At present there is also widespread interest in the use of a near-surface concrete trench system for the disposal of radwaste materials. Typical mortar is a mixture of cement, sand and water in various proportions that together determine the structural properties and tightness of the poured material. Water content is one of the critical parameters and must be carefully controlled during puring and setting; to a large extent it will determine the porosity of the resulting material. Cement is a porous, continuously hydrating material whose actual surface area greatly exceeds its geometric surface area. In leaching, the rate of dissolution varies as a function of phase chemistry and this dissolution exposes or enlarges pores; thus the leaching behaviour must be related to pore structure and the composition of the pore solution [1,2,3,4]

2. RADIONUCLIDE MIGRATION THROUGH POROUS MATERIALS

The dispersion of radionuclides in porous materials, such as grout or concrete, is described using a one dimensional differential model [2,4,5,6,7]

$$D\frac{\partial^2 A}{\partial X^2} - V_V\frac{\partial A}{\partial X} - \left(1 + \frac{1-f}{f}\rho_T k_D\right)\frac{\partial A}{\partial t} = 0 \qquad (1)$$

or

$$D\frac{\partial^2 A}{\partial X^2} - V_V\frac{\partial A}{\partial X} - K_F\frac{\partial A}{\partial t} = 0 \qquad (1')$$

where:

K_F - retardation factor

D - diffusion coefficient (cm^2/d) or (cm^2/s)