LABORATORY EXPERIMENTS FOR SOLIDIFICATION OF ORGANIC SOLVENTS SOLUTIONS CONTAMINATED WITH TRITIUM

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ABSTRACT

This paper describes the mechanical resistance results of an organic solvents solutions conditioning method. This radioactive waste type is generated at a CANDU nuclear power plant.

These organic solvents solutions are used in degreasing and decontamination processes of surfaces and equipments. They are solvents mixture such as: acetone, ethylene alcohol, methanol, trichloromethane, toluene, and white spirit.

The waste is converted into a stable monolithic form, which minimizes the probability to release radionuclides in the environment during their interim storage, transportation and final disposal.

INTRODUCTION

Conditioning of organic solvents solutions is carried out by cementation using aluminium stearate additive. Portland cement is the most common type of hydraulic cement and it is the original agent utilized for the solidification of low-level radioactive waste [1].

EXPERIMENTAL PROCEDURE

Solvents mixture characterization

This solvents mixture contains: acetone, ethylene alcohol, methanol, trichloromethane, toluene, and white spirit.

This waste contains varying amounts of tritium with activity below 1.00E+08Bq/l .

Characterization of conditioning matrix components

Portland cement 42.5R

- chemical characteristics: SO_3 - 2.95%;
  Cl^- - 0.0071%;
- physical characteristics: setting of concrete time - 10800 s;
  stability - $5 \cdot 10^{-4}$ m;
- mechanical resistance: after 2 days - $25.5 \cdot 10^6$ N/m^2.

Aluminium stearate

- composition: stearic acid aluminium salt;
- physical and chemical properties: form - solid;
  colour - white;
  odour - odourless;
  melting temperature - $(120 \ldots 130)^0$C;
  solubility in ethanol at 20^0C - soluble.

Verification of conditioning matrix mechanical resistance

The verification is performed on the prism-test specimens, having $40 \cdot 10^{-3}$ m length, $40 \cdot 10^{-3}$ m width, $160 \cdot 10^{-3}$ m height, after 28 days from the preparing of the test specimens. During this period, the test specimens are preserved in plastic bags. A uniaxial compressive load is applied along the axis of the prism-test specimen until it is crushed. The maximum load is divided by the cross-sectional area of the specimen to determine its compressive strength.

Two prism-test specimens were tested with the composition and mechanical resistances shown in table I.

Table I Composition and Mechanical Resistance of the Samples

Code sample	Composition, wt.%				Mechanical resistance [N/m^2]
	Waste	Aluminium stearate	Cement 42.5R	Water	
A	9.77	0.89	67.94	21.40	$114 \cdot 10^3$
B	10.97	1.83	63.95	23.25	$97 \cdot 10^3$

The two values of mechanical resistance are higher than the required Waste Acceptance Criteria of disposal site (Baita Bihor National Repository), which is of $50 \cdot 10^3$ N/m^2 for the minimal disposal value.

The mechanical resistance high values offer security for the final disposal of conditioned waste.

The conditioning matrix of organic solvents solution contaminated with tritium expressed by incorporated ratio is shown in table II.

Table II Conditioning Matrix of Waste Expressed in Incorporated Ratio

Code sample	Water/cement	Waste/cement	Aluminium stearate/cement	Mechanical resistance [N/m^2]
A	0.31	0.14	0.01	$114 \cdot 10^3$
B	0.36	0.17	0.01	$97 \cdot 10^3$

The increase of mechanical resistance is obtained by reduction of ratio waste/cement and ratio water/cement until a homogeneous mixture is obtained.

The water/cement ratio is a very important factor that affects the porosity of the hardened cement paste and controls the leachability of tritium. The dissolution of the hardened cement composite, which contains organic solvents solution, plays an important role in the leaching process.

CONCLUSION

Conditioning of organic solvents solution contaminated with tritium into a cement and aluminium stearate matrix may be carried out using the follow conditioning matrix, wt%:

- waste 9.77 … 10.97;
- aluminium stearate 0.89 … 1.83;
- water 63.95 … 67.94;
- cement 21.40 … 23.25.

This method is simple, with low cost of working materials. The operator exposure is negligible because there is not any vapor problem. The high values of mechanical resistance offer security for transportation and final disposal.

REFERENCES

1. "Conditioning of low and intermediate level radioactive waste", Technical Reports Series no. 222, International Atomic Energy Agency, Vienna, 1994.