



IMMOBILIZATION OF RADIOACTIVE WASTE IN DIFFERENT FLY ASH- ZEOLITE CEMENT BLENDS

A thesis Submitted

By

Nesreen Mohamed Sami

M.Sc. (Chemistry)

**Hot Laboratories and Waste Management Center
Atomic Energy Authority**

To

**Chemistry Department, Faculty of Science
Ain Shams University**

For

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ABSTRACT

The problem of radioactive waste management has been raised from the beginning use of nuclear energy for different purposes. The radwaste streams produced were sufficient to cause dangerous effects to man and its environment.

The ordinary portland cement is the material more extensively used in the technologies of solidification and immobilization of the toxic wastes, low and medium level radioactive wastes.

The production of portland cement is one of the most energy-intensive and polluting. The use of high energy in the production causes high emission due to the nature and processes of raw materials. The cement industry is responsible for 7% of the total CO₂ emission. Thus, the cement industry has a crucial role in the global warming. The formation of alite (Ca₃SiO₅), which is the main component of the Portland cement clinker, produces a greater amount of CO₂ emission than the formation of belite (Ca₂SiO₄). The proportion of alite to belite is about 3 in ordinary Portland clinker. Therefore, by decreasing this proportion less CO₂ would be emitted. Furthermore, if industrial byproducts such as fly ash from thermal power station or from incineration of municipal solid wastes have the potential to reduce CO₂ used as raw materials and alternative hydrothermal–calcination-routes are employed for belite clinker production, CO₂ emission can be strongly reduced or even totally avoided. The availability of fly ash will help in reducing the CO₂ emissions and will also help in resolving, to a great extent, the fly ash disposal problem.

This thesis is based on focusing on the possibility of using fly ash as raw materials to prepare low cost innovation matrices for immobilization of radioactive wastes by synthesizing new kind of cement of low consuming

energy. The synthesis process is based on the hydrothermal-calcination-route of the fly ash without extra additions. The hydrothermal treatment was carried out in the presence of CaO and 1 M NaOH solution for 4 h at the temperature of 200 °C. The precursors obtained during the hydrothermal treatment were heated at temperatures of 700 °C, 800 °C, and 900 °C. Three types of new cements called fly ash-zeolite cement (FAZC) originates from dehydration by heating of the hydrated precursors formed at 700 °C, 800 °C, and 900 °C as a result of the pozzolanic reaction.

The changes of fly ash composition after different treatments and the microstructural changes produced in those precursors during heating were characterized by X-ray diffraction (XRD), FT infrared spectroscopy, surface area (BET-N₂), and thermal analyses (thermogravimetric analysis (TGA) and differential thermogravimetric analysis (DTG)). From the results obtained we concluded that the optimum temperature for obtaining the fly ash zeolite cement clinker is 800 °C.

The physical ,chemical and mechanical properties of fly ash zeolite cement (FAZC) including the setting time, bleeding rate and compressive strength were determined. Then, these investigations are compared with those of ordinary portland cement (OPC). The effect of water immersion in different leachants for long periods on the compressive strength was studied and also, radiation resistance. Leaching behaviour of Cs¹³⁷, Co⁶⁰ and Sr⁸⁵ from both immobilized FAZC and OPC have been investigated. Based on the results obtained it can be concluded that, fly ash zeolite cement can be used for radioactive waste solidification facilities in order to satisfy toward the safety requirements and reduce the radionuclides leach rates to the ground water in the disposal land facility.

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