ELABORATION OF GEOPOLYMER BINDERS FROM PHOSPHATE MINING WASTE ROCKS AND THEIR APPLICATION IN IMMOBILIZING SIMULATED RADIONUCLIDES Cs AND Sr

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This study investigates the development of alkali activated binders cured at ambient temperature using phosphate mining waste rocks (PMWRs) as aluminosilicate precursors. The impact of the silica modulus variation (SiO_2/Na_2O) in the activator solution on the structure, microstructure, and strength development of the binders is investigated. Considering the high silicon to aluminum (Si/Al) ratio of the waste rocks, metakaolin is added to adjust the Si/Al ratio. An optimized mix design is identified, consisting of 25% metakaolin by weight and Ms of 1.25 for alkaline solution. In the second step of the research, the physical barrier effect of developed geopolymer binders on the leaching behavior of cesium and strontium is investigated. Mechanical performance tests demonstrate that the geopolymer blocks exhibit highest compressive strength (62 MPa) after 28 days of curing, compared to only 45 MPa for the cement block. XRD and EDX analysis reveal that most of the strontium and cesium radionuclides in the geopolymer solidification blocks were incorporated in the gel structure as the charge balancing cation. The leaching behavior of simulated radioactive cesium and strontium from geopolymers was evaluated according to ANSI/ANS-16.1, which showed that the diffusivity of cesium and strontium in geopolymer specimens was significantly lower than in Portland cement by a factor of 10^3 and 10^6, respectively, demonstrating significantly improved immobilization performance. These findings suggest that the PMWRs/MK geopolymer is a promising matrix material for the solidification and stabilization of radioactive wastes compared to conventional Portland cement. Microstructure, structure analysis and thermal analysis were performed using Scanning Electron Microscopy (SEM), energy-dispersive X-ray spectroscopy (EDAX), X-ray Diffraction (XRD), Fourier Transform InfraRed (FTIR), (^{29}Si, ^{27}Al) Magic Angle Spinning Nuclear Magnetic Resonance (MAS NMR) and Thermogravimetric Analysis (TGA).

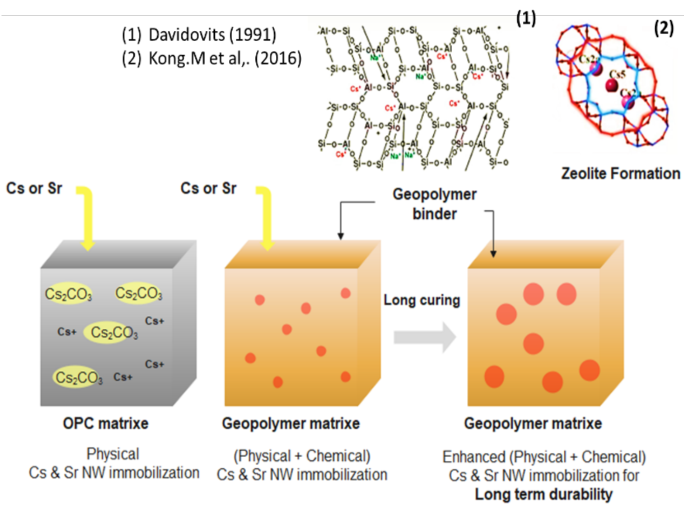

Figure 1 – Stabilization mechanism of Sr and Cs in geopolymer matrix compared to OPC.

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