

8-11 Stabilization of Low-Level Radioactive Waste Solutions

— Cement Solidification of Low-Level Radioactive Waste Solutions Containing Carbonates —

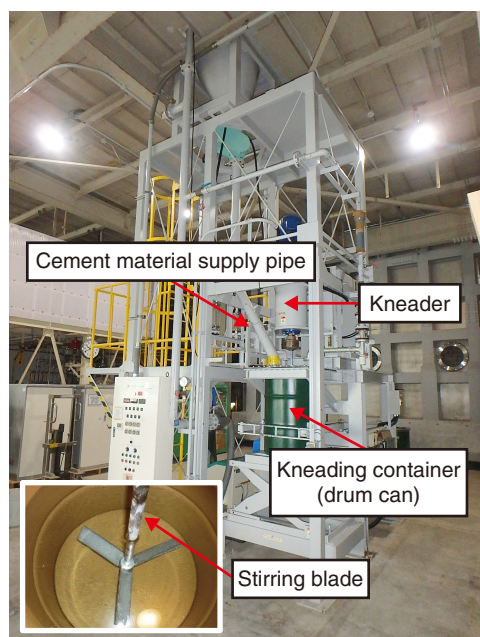


Fig.8-27 Real-scale kneading machine

As the drum-can-sized solidified cement product is kneaded, physical property data is acquired.

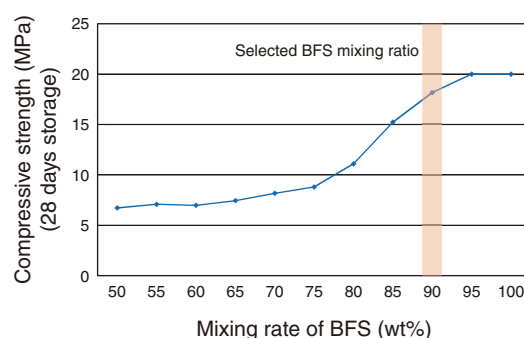


Fig.8-28 Changes in BFS mixing ratio and compressive strength for OPC

An increase in compressive strength was confirmed as the BFS mixing ratio increased. Solidification days are required when the BFS concentration is $\geq 95\%$, so mixed cement (BFS:OPC = 9:1) will be adopted at the LWTF to provide solidification days and fluidity suitable for operation.

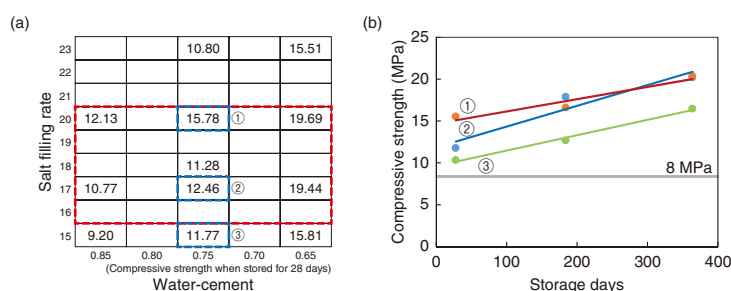


Fig.8-29 (a) Core compressive strength in mixed cement and (b) rate of change in compressive strength during long-term storage

(a) Compressive strength of 8 MPa or greater was obtained even over a wide range of water-cement mass ratios (0.65 to 0.85) and salt filling rate (15wt% to 23wt%). (b) A long-term increase in compressive strength was confirmed for the samples within the blue dotted line (① to ③).

At the Low-Level Radioactive Waste Treatment Technology Development Facility (LWTF), the low-level radioactive concentrated liquid waste and phosphoric acid liquid waste generated at the reprocessing facility is to be solidified. Of these, low-level radioactive concentrated liquid waste is subjected to nuclide separation (coprecipitation/ultrafiltration, Cs/Sr adsorption) and separated into slurry waste liquid and nitrate waste liquid. Nitrate waste liquid is converted to carbonate waste liquid by nitrate decomposition and it is planned to be cemented by using an in-drum mixing method. Carbonate waste liquid generated by nitrate decomposition treatment accelerates cement solidification, causing ordinary Portland cement (OPC), generally used for cement solidification, to cure too quickly. A new cement material must thus be selected and examined. Thus, the solidification range under various conditions such as water: cement ratio and salt filling rate (ratio of salt contained in solidified body when solidified), and the compressive strength during long-term storage was investigated using a real-scale kneading machine (Fig.8-27). The cement studied was a mixture of blast-furnace slag fine powder (BFS), which hardens slowly by reacting with alkali, and OPC. Increasing the ratio of BFS caused an increase of compressive strength and fluidity (Fig.8-28). Based on these results, real-scale kneading

was performed using mixed cement with a BFS:OPC ratio of 9:1. As the ratio of water and carbonate is expected to at the LWTF, the range of possible solidification was also investigated using the water: cement ratio and salt filling rate, which greatly affect the solidification properties, as parameters (Fig.8-29(a)). As a result, a the water-cement ratio of between 0.65 and 0.85 and salt filling rate between 15wt% and 23wt% satisfied the target compressive strength (≥ 8 MPa). From the red dotted line centered on ② (in the error range of LWTF operation), it was confirmed that solidification was possible even in consideration of fluctuations in the ratio of water and carbonate. Furthermore, the long-term change in compressive strength of the solidified material was found to increase over a long term (Fig.8-29(b)), likely because the BFS contained in the cement reacts slowly, slowly increasing the compressive strength. In addition, since no abnormalities such as cracks were observed after long-term storage, the solidified body was confirmed to be stable and did not expand or contract.

These results can be used to design a cement solidification facility for installation in the LWTF. In future work on cement solidification tests, a wider range of solidification condition will be studied to optimize LWTF operation.

Reference

Matsumura, R. et al., Development of Cement Based Encapsulation for Low Radioactive Liquid Waste in Tokai Reprocessing Plant, Proceedings of 3rd International Symposium on Cement-Based Materials for Nuclear Wastes (NUWCEM 2018), Avignon, France, 2018, 4p., in USB Flash Drive.