Japanese

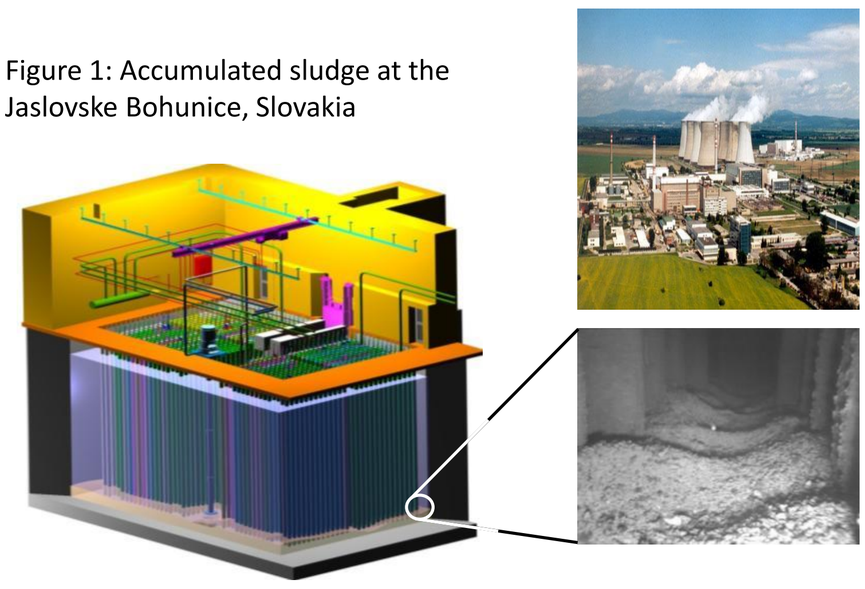
Geopolymer Waste Encapsulation

Japanese

Japanese application of SIAL® geopolymer, a licensed product with a track record

Geopolymers are a class of inorganic polymer formed by the reaction between an alkaline solution and an aluminosilicate source. First discovered in Ukraine in the 1950's, today, geopolymers and SIAL® in particular has been noted as an immobilization product which shows potential for the treatment of a number of waste stream scenarios present in the Japanese market today.

Figure 1: Accumulated sludge at the Jaslovske Bohunice, Slovakia



The need for Geopolymers

The Nuclear Power Plant A-1 located in Jaslovske Bohunice, completed in 1972 operated for 5 years until two accidents in 1976 and 1977. After the second accident in February 1977 (INES level 4) the Nuclear Power Plant was permanently shut down for decommissioning. Fuel assemblies and fuel cladding damaged in the accidents led to significant strontium-90, caesium-137 and transuranic contamination. As a consequence of the long-term corrosion of the barrier's material, highly contaminated sludge accumulated which could not be immobilized using conventional methods such as cementisation or bitumen treatment due to radionuclides such as caesium-137 being present.

This challenge led to Amec Foster Wheeler developing the **licensed** geopolymer, SIAL®. Today, SIAL® is the most proven widely used geopolymer at sites for on-site solidification of highly active materials such as sludge, resins, sorbents and organic liquids. It is licensed for use by both the Slovakian (ÚJD SR) and Czech Nuclear (SUJB) regulators.

The process

SIAL® can provide efficient and practical on-site treatment of radioactive waste streams at room temperature and can incorporate on average four times as much waste as a cement matrix equivalent. The equipment used to deploy SIAL® is also modular, flexible and versatile.

It can encapsulate waste quicker then cementisation and can even set under water. In addition, it is characterized by excellent mechanical and physical properties, compared with the earlier generation techniques. This includes higher mechanical strength, lower leachability, low volatility, posing a low fire risk and excellent physical stability in the presence of frost and water (no distortion or cracking).

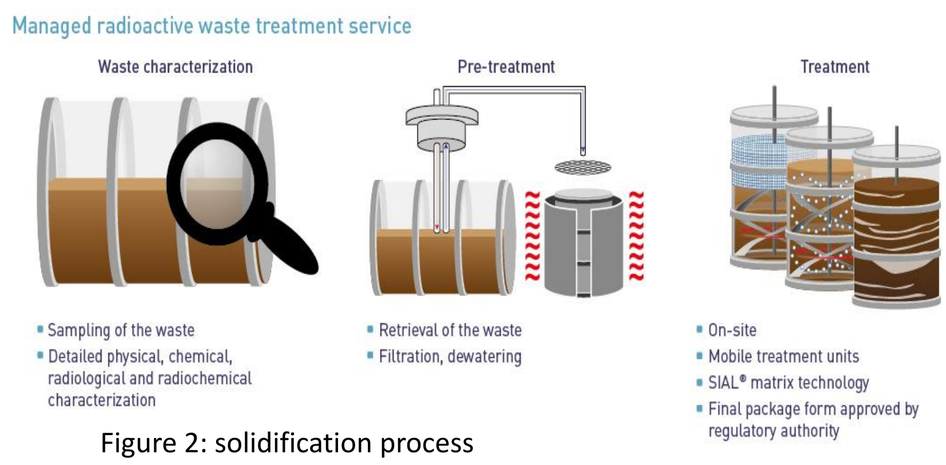


Figure 2: solidification process

Figure 3: condition of tanks

Case Study: Jaslovske Bohunice, Slovakia

About 650 m^3 of radioactive waste (spent resins, sludge and borates) stored in 14 tanks situated in auxiliary building of NPP V1. The waste was characterized into two types of waste, namely resins and crystalline sediment and sludge. This comprehensive scope of work started with the licensing process, solidification and then was followed by the decontamination and cleaning of the workplace post clean up and transport of all equipment off site.

Application to the Japanese Market

Through the lifetime of both Japanese PWR and BWR nuclear reactors, waste with high sodium sulphate content are produced which requires solidification before long term storage. Cementation is the usual solidification approach for this type of waste but this can lead to large expansion probably caused by the formation of ettringite. Ultimately the swelling and cracking of the solidified product could lead to the deformation of the waste container itself, influencing its integrity for long term storage.

In 2015, Amec Foster Wheeler in conjunction with Fuji Electric co. ltd tested Sodium Sulphate geopolymer encapsulation.

The study, which was reported in the 2015 AESJ fall meeting concluded that excellent performance was observed in terms of the required performance parameters (e.g. leachability, compressive strength etc.)

Currently, in conjunction with Fuji Electric co. ltd. we are assessing three Fukushima Daiichi waste streams for geopolymer solidification. These are:-

1. Sludge (barium sulphate, ferrocyanide nickel, iron hydroxide)
2. Slurry 1 (iron hydroxide slurry)
3. Slurry 2 (carbonate slurry)

Figure 4: representative sample of Sodium Suphate geopolymer encapsulation