Disposal of toxic waste by polymer encapsulation

Brookhaven National Laboratory (BNL), the United States, has developed a low-density polyethylene (PE) encapsulation process for safe disposal of low level radioactive, hazardous and mixed wastes. This method provides greater long-term stability compared with conventional solidification technologies. It employs a single screw extruder to mix, heat and extrude the material into appropriate containers where it cools and hardens into a solid waste form. A kinetic mixer, which uses frictional energy to melt the polymer, can also be used instead of the extruder.

PE is an inert, low permeability, thermoplastic material, which is highly resistant to chemical attack, microbial degradation and radiation damage. Some applications of polymer encapsulation include:

- Microencapsulation: PE is heated above its melting point and combined with dry waste to form a homogenous mixture. This mass is then allowed to cool into a monolithic solid waste form in which small waste particles are interspersed within the polymer matrix. Nitrate salts, sludge, incinerator ash, ion exchange resins and sodium sulphate/boric acids, etc. can be disposed in this manner.
- Macroencapsulation: Molten PE is poured into a waste container in which large pieces of waste matter have been suspended or supported. Upon cooling, PE forms a solid layer surrounding the waste. The method is ideal for radioactive lead solids and mixed waste debris.
- Sulphur polymer cement is a thermoplastic material that can be melted easily to obtain a low viscosity liquid at 120ºC. BNL's encapsulation technology can be used to solidify nearly 2.5 times more incinerator fly-ash in this material than in hydraulic cement, and with improved compressive and tensile strength properties.

BNL has also developed and characterized thermosetting resins/polymers for encapsulation of hazardous, mixed and radioactive waste, and for container materials. These materials have a broad range of chemical and physical durability, performance, viscosity and cost. They possess desirable properties in both fluid and solid forms. Also, new low-temperature glasses and glass-ceramics, based on advanced phosphate formulations, have been proposed by BNL to treat low level waste and mixed waste. A major disadvantage of using borosilicate glass is the high temperature range (1,200-1,500ºC) required for vitrification. The alternative glass compositions melt at temperatures between 450ºC to 900ºC.

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