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Radioactive waste vitrification

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As the world fossil fuel reserves diminish, alternate energy sources will become increasingly important. One of the most commonly discussed forms of alternative energy is nuclear power. Although there are a number of pros and cons to nuclear power generation, one aspect that has received some attention in the news over the past few years is the long-term storage solutions for nuclear waste from both past, current, and future productions.

Nuclear Waste

Nuclear waste currently in storage comes from three principal sources: spent fuel from commercial or research reactors, liquid waste from the reprocessing of spent fuel, and waste from the nuclear weapons and propulsions industry. Most of the storage concerns relate to so-called 'high level' nuclear waste, which are highly radioactive, require cooling and containment because their decay gives off heat and radiation, and have an extremely long half-life. In particular, some radioactive isotopes such as Tc-99, Se-79, and I-129 are mobile in water, requiring a storage solution that reduces their ability to move into the groundwater.

In the US, most nuclear waste storage is temporarily done on site. Spent nuclear fuel is kept in pools of recirculated water to keep it cool while the increased radioactivity dies down before it either reprocessed to recover the plutonium or kept in dry storage for eventual deposit into a geological repository. For the nuclear waste resulting from weapons development, the majority of the waste is stored at the Hanford site in southeastern Washington, where the plutonium for the US weapons was produced. Much of the waste there is stored in 177 buried tanks as a combination of both high-level and low-level liquid waste. These tanks were never intended for long-term waste storage and several are known to be leaking.

Vitrification

The desired long-term storage form for nuclear waste is a relatively insoluble, compact solid. As a solid, the waste becomes easier to store and handle; a small volume is desired because there are likely to be few candidates for long-term storage spaces and thus space will be at a premium. Keeping the solubility low reduces the chances of groundwater contamination. The resulting solid is then likely to be packaged, which provides additional barriers to contamination of the environment, but the effects of radiation on the surrounding matrix packaging are not negligible.

Amorphous borosilicate's have been identified as one option for nuclear waste storage forms. To produce the glass, the waste is dried, heated to convert the nitrates to oxides, and then mixed with glass-forming chemicals and heated again to very high temperatures (approximately 1000 °C) to produce the melt. This is then poured into a containment vessel where it cools to form a glass. The containment vessel can then be sealed, decontaminated, and placed into a long-term (or temporary) storage facility. Studies of archeological glasses have agreed with models showing the immobilization of the important mobile nuclides during the critical time period where they are highly radioactive, encouraging the continued study and use of this methodology. This process is used to prepare waste for storage at a number of nuclear power plants in Europe.

Growing Need

Although much of the work has focused on cleanup and storage of nuclear waste already present, it is clear that as more nuclear plants are added there is an increased need for waste storage capacity and eventually a long term storage location. Vitrification continues to be studied as a long term treatment plan, but the glass produced is still radioactive and needs to be stored somewhere.

For a 1000 MW plant, 30 tonnes of high level nuclear waste are produced a year. With 104 nuclear plants of roughly that size in the US, this produces 3120 tonnes of high level nuclear waste a year in the US alone. Multiple the number of nuclear plants by 5 to compensate for all the natural gas plants, for example, and the nuclear waste issue scales as well. In comparison, the abandoned Yucca Mountain Nuclear Waste Storage Repository was only planned to hold 77,000 tonnes of material, all of which is currently stored elsewhere. Even if the storage facility was not required for any of the currently existing waste, the current rate of high level nuclear waste production would fill the facility in 24.7 years, excluding any increases in capacity.

While nuclear power may prove to help alleviate the upcoming energy crisis, it becomes apparent that while some of the challenges relating to the storage of nuclear waste may have been solved, there are still major issues that remain before increased capacity becomes a viable solution over the long term.

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Das ataktische Polypropylen in der Energetik

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Das Wasser ist ein Hauptzerstörer der metallischen Konstruktionen. Besondere Gefahr stellt das Erfrieren des Wassers vor. Das Eis, das sich in den Kapillaren der Poren bildet, hat einen großen Umfang, deshalb im Material entstehen die starken mechanischen Anstrengungen.

Das ataktische Polypropylen ist ein wasserfestes Material. Das ataktische Polypropylen ist ein ganz einzigartiges wasserisolierendes Material. Es ist bei der Bearbeitung der Oberfläche des Betons, des Metalls zwecks der Verhinderung der Durchdringung der Feuchtigkeit in die Konstruktionen der Stromversorgungen, bei der Elektroisolierung der abgesonderten energetischen Knoten, bei der oberflächlichen Bearbeitung der elektrischen Leitungen zwecks der Verhinderung ihrer Vereisung (1, 2) effizient.

Die Zeichnung 1 zeigt die Erforschung des ataktischen Polypropylens mit Hilfe der Methode der Spektroskopie.