Nanoparticles, Super-Absorbent Gel Used to Clean Radioactivity from Porous Structures Nondestructively

M. D. Kaminski, M. R. Finck, C. J. Mertz, M. Kalensky, N. Kivenas, and J. L. Jerden
Chemical Engineering Division, Argonne National Laboratory

"Supergel"

Argonne researchers are designing a system to safely capture and dispose of radioactive elements in porous structures outdoors, such as buildings and monuments, using a spray-on, super-absorbent gel and engineered nanoparticles.

Such a system would help the nation be more prepared in the event of a terrorist attack with a "dirty bomb" or other radioactive dispersal device.

The polymer gel that is used to absorb the radioactivity is similar to the absorbent material found in disposable diapers. When exposed to a wetting agent, the polymers form something like a structural scaffold that allows the gel to absorb an incredible amount of liquid.

The gel adheres to vertical surfaces, as shown above, at right (gel sprayed from a water spray bottle onto a vertical concrete surface).

Argonne's Technique Leaves Structures Intact

Currently, it is common practice to demolish contaminated materials in hopes of getting rid of the radioactivity. Argonne's technique would allow surfaces to be preserved, which means that monuments or buildings would not have to be defaced to remove radiation.

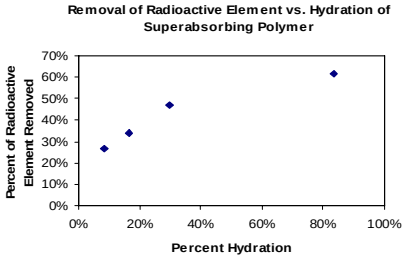
Using a simple, three-step procedure, the system operates much like an automated car wash.

- **Application:** Remote spray washers apply a wetting agent and a super-absorbent gel onto the contaminated surface.
- **Reaction:** The wetting agent causes the bound radioactivity to resuspend in the pores; the super-absorbent polymer gel then suctions the radioactivity out of the pores and it then becomes fixed in the engineered nanoparticles that sit in the gel.
- **Cleanup:** The gel is vacuumed and recycled, leaving behind only a small amount of radioactive waste for disposal.

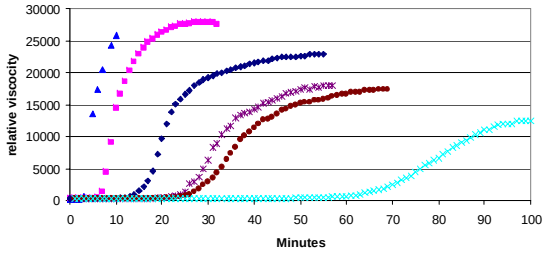
Results to Date

Our studies have involved removing a particular radioactive element from concrete, which is composed of cement and rock aggregate. A single application of the gel can remove up to >98% of the radioactive element from the cement component of the concrete, and >80% can be removed from concrete overall (some of the element remains attached to the outermost layer of aggregate).

Research currently is focusing on the variables involved in the removal of the element that remains attached to the aggregate. In addition, we are exploring superabsorbing polymer composition, controlled delayed superabsorbancy, wash chemicals (ionic, surfactant), concrete composition, polymer hydration, contact times, effect of contaminant aging, ambient temperature, spray applicators, vacuum technologies, waste management and volume.



The removal of the radioactive element is strongly dependent on hydration (wetness) of the superabsorbing polymer. These data are from an application scenario for removing a radioactive element from a concrete monolith.



A delay in absorbency would permit the combination of the wash solution and gel into a single step, simplifying the process to just application and cleanup. These data show the delay in absorbency (identified by an increase in viscosity) of a promising polymer under study (aqua).

Potential Other Uses for the Supergel

The polymer gel may also prove useful in maintenance at nuclear power stations and research institutions (for example, in hot cells or caves) and the decontamination of nuclear facilities prior to decommissioning.

Technology Transfer

Several industry partners are actively participating in the program including polymer suppliers, specialized spray technology suppliers, radionuclide absorber suppliers, system deployment and integration companies.

Research funded by U.S. Department of Homeland Security through the Technical Support Working Group

Argonne National Laboratory is operated by The University of Chicago for the U.S. Department of Energy Office of Science