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Researchers Develop Eco Friendly Way to Recycle Nuclear Waste

A new recycling plant will soon recover uranium from the ashes of radioactive garbage to be recycled back into nuclear fuel using an efficient, environmentally friendly technology inspired by decaffeinated coffee. The technique's future may even hold the key to recycling the most dangerous forms of radioactive waste.

Over the course of 20 years, Chien Wai, a University of Idaho chemistry professor, has developed a process that uses supercritical fluids to dissolve toxic metals.

When coupled with a purifying process developed in partnership with Sydney Koegler, an engineer with nuclear industry leader AREVA and University of Idaho alumnus, enriched uranium can be recovered from the ashes of contaminated materials.

On Wednesday, Aug. 20, representatives from the company and the university signed an agreement to share the technologies and pave the way for the recycling plant's construction.

"Radioactive waste is a big problem facing the United States and the entire world," said Wai. "We need new, innovative technology, and I think supercritical fluid is one such technology that will play an important role in the very near future."

A supercritical fluid-in this case carbon dioxide-is any substance raised to a temperature and pressure at which it exhibits properties of both a gas and a liquid. When supercritical, the substance can move directly into a solid like a gas and yet dissolve compounds like a liquid. For example, says Wai, supercritical carbon dioxide has directly dissolved and removed caffeine from whole coffee beans for decades.

When the carbon dioxide's pressure is returned to normal, it becomes a gas and evaporates, leaving behind only the extracted metals. No solvents required, no acids applied, and no organic waste left behind.

"That's why decaffeinated coffee tastes so good," said Wai, while chuckling at the beauty and simplicity of the process. "There is no solvent used, and so no solvent left behind."

Because the technology is so simple, cost-effective and environmentally friendly, AREVA is eager to test its first full-scale use on 32 tons of incinerator ash in Richland, Wash.

The existing plant in Richland fabricates fuel for commercial nuclear power plants from raw enriched uranium supplied by utility customers as uranium hexafluoride (UF6). During normal operation, common items including filters, rags, paper wipes, and gloves become contaminated with uranium. The waste is burned to reduce its volume and increase its uranium content, making it easier to recover the uranium.

Nearly 10 percent of the ash's weight is usable enriched uranium, worth about $900 dollars per pound on today's market.

This means about $5 million dollars is currently sitting in the garbage waiting to be recovered. The process may even become the basis of the next generation of plants designed to recover useful materials from spent fuel.

"This agreement and technology is something Idaho should be very proud of," said Wai of the supercritical fluid technology transfer. "We have developed something special. And to me, that something is important to Idaho and to the U.S., particularly as we look for alternate energy sources in the future."

The new recycling plant is expected to be operational in 2009 and will take about a year to process AREVA's ash inventory. When finished, much of its operating time can be devoted to ash received from other sites.

The key to Wai's research is to find a soluble chemical compound to bind with the uranium. Because carbon dioxide cannot directly dissolve metals such as uranium, a binding agent called a ligand is introduced to the equation.

Once the ligand is applied, the supercritical carbon dioxide flows through the waste, dissolving both the ligand and the metals bounded to it.

Dissolving and extracting any desired metal-possibly even radioactive material from high-level radioactive waste-simply requires finding a binding agent that works. Wai predicts supercritical fluids will be used in the not-too-distant-future to recycle even higher levels of radioactive waste.

"To me, accomplishing that is important to Idaho and to the United States, particularly as we look for alternate energy sources in the future." said Wai. "I believe nuclear energy will play a very large role, and that it can be done in a very environmentally safe and sustainable way."