Nuclear research could improve safety

Staff report

Clemson University researchers are working on questions in nuclear safety, including how to build next-generation reactors, where to store waste and how to test water for radioactivity, school officials said.

The research comes as nuclear power plants across the nation age and as the world's attention turns to Japan on the third anniversary of the Fukushima Daiichi reactor disaster.

Clemson's Rajendra "Raj" Bordia and John Ballato are looking at ways to make next-generation reactors safe, while Brian Powell is focusing on how radioactive material travels when released into the environment, school officials said.

Timothy DeVol and Scott Husson are working on new ways to test water that could provide early warning signs of contamination and make it easier for consumers to know whether it's safe to drink from home faucets.

An earthquake on March 11, 2011, triggered a tsunami that hit the Fukushima Daiichi nuclear power plant. Cooling systems failed, water levels dropped and fuel rods became exposed.

The fuel rods were covered by a cladding made of zircaloy, a metal alloy. When the cladding hit about 1,200 degrees Celsius, it reacted with steam and produced hydrogen gas, causing an explosion, officials said.

Bordia, chairman of the materials science and engineering department, is looking at whether silicon carbide could replace zircaloy as cladding. The advantage of silicon carbide is that it has a nominal melting temperature of 2,730 degrees Celsius. If there were another extreme event, plant operators would have more time to act before a meltdown, Bordia said.

A challenge in using silicon carbide is that it's a ceramic, which makes it hard to shape, Bordia said. His research is unique in how the team makes the silicon carbide, officials said.

They heat special silicon-based polymers to high temperatures, a "molecular precursor approach" that allows them to shape polymers before turning them into silicon carbide, Bordia said.

Silicon carbide could also be used to make fuel assemblies, sealant materials, fuel and waste-storage containers. Bordia's research group is collaborating with researchers at Purdue University and Pacific Northwest National Laboratory.

One of the ideas driving Ballato's research is that next-generation nuclear reactors will be small enough to transport by truck or rail. "Small modular reactors" would cost less than the massive nuclear-power plants that now predominate and could be used where large plants aren't needed.

The infrared fiber Ballato is starting to create would go into the small-modular reactors to help detect low-level gaseous compounds that are the first warning signs of reactor leaks, corrosion and radiolysis.

"If anything is wrong, you know about it ahead of time and can shut it down," Ballato said.

Ballato will take specially crafted glass from partners at Iowa State and use a two-story tower to draw it into fiber at Clemson's Center for Optical Materials Science and Engineering Technologies in Anderson County.

The fiber will be sent to Pacific Northwest National Laboratory for testing in temperature-harsh environments.

"It's a perfect marriage of three groups, each internationally respected for what they do," Ballato said.