Radiation studies key to nuclear reactor life, recycling spent fuel

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Two UW-Madison projects to study advanced materials and fuels for current and future nuclear reactors received roughly $1 million this month under the Department of Energy Nuclear Energy Research Initiative (NERI).

The NERI program supports research and development under three Department of Energy nuclear initiatives: Generation IV nuclear energy systems, advanced fuel cycles and nuclear hydrogen.

In one three-year project, UW-Madison nuclear engineers will study the resistance to radiation damage of oxide, carbide and nitride nuclear fuel "matrix" materials-the vessels that contain nuclear fuel. A second project will exploit recent advances in computational power and technique to develop computer models of how a reactor's structural materials behave as a result of long-term radiation exposure.

The projects were among 24 selected across the country; UW-Madison was among five universities to receive funding for multiple projects.

Matrix materials are a key element of future fast-spectrum reactors, which are capable of safely and efficiently recycling spent nuclear fuel. The nuclear fission process produces high-energy radioactive neutrons, called "fast" because of their great energy. Current thermal reactors use a moderator to reduce the neutrons' velocity, making them capable of sustaining the nuclear fission reaction using simpler fuel.

But to recycle and minimize the waste impact of the spent fuel, you need to keep those neutrons fast, says Todd Allen, an assistant professor of engineering physics. He and James Blanchard, a professor of engineering physics, are researching how proposed matrix materials hold up under a barrage of radiation.

"It's all in the context of devising new fuel forms that will allow you to efficiently recycle reactor fuel in a way that minimizes the net waste output from the entire fuel cycle," says Allen. "And the reason for looking at recycle is to limit the number of underground repositories you have to build."

Another project involves applying complex materials modeling to nuclear reactors. In it, Allen and Dane Morgan, an assistant professor of materials science and engineering, will incorporate the properties of iron, chromium and nickel into more complete computer models of radiation damage in steel, a common reactor structural material.

Previously, a lack of computing power limited such models to single pure materials like copper or iron. "People have learned a lot about radiation damage," says Allen. "But you never build anything out of just copper or just iron."

The effort may lead to structural materials that are better able to withstand long-term exposure to radiation-in some cases, nearly 60 years, says Allen.

Source: University of Wisconsin