Recycling fuel

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David Kramer; US takes another look at recycling nuclear fuel. Physics Today 1 February 2024; 77 (2): 22-25. https://doi /10.1063/pt.mrdf.volt

"With many advanced reactor designs that could use spent nuclear fuel coming closer to reality, DOE is assessing reprocessing and recycling technologies with more urgency," stated Kathryn Huff, DOE assistant secretary for nuclear energy. In written responses to questions, Huff said the agency will continue R& D on reprocessing approaches "to assess options as technologies and economics evolve."

A spokesperson for the National Nuclear Security Administration, the semiautonomous agency that monitors DOE"s nonproliferation policy, said it supports "limited, responsible" R& D on reprocessing to evaluate options. "We also recognize that US industry and other countries are pushing forward on nuclear fuel recycling concepts whether we like it or not, and not always with the same commitment to nonproliferation that we have." The spokesperson added that "the jury is still out" on whether reprocessing technologies can be developed that will adequately address proliferation concerns.

A 2023 report by the National Academies of Sciences, Engineering, and Medicine recommends that the once-through nuclear fuel cycle be continued "for the foreseeable future." It also calls for "fundamental studies" on reprocessing to be maintained.

La Hague, France, is the site of one of two operational commercial reprocessing plants in the world. Russia"s state-owned Rosatom also offers commercial reprocessing services. The UK"s Sellafield reprocessing plant closed in 2022.

The US and 21 other nations pledged to triple their nuclear energy outputs by 2050 during December"s United Nations Conference of the Parties climate change conference in Dubai. DOE is placing its bets on advanced nuclear technologies, which it says promise to be cheaper, quicker to build, and safer than today"s hulking light-water reactors (LWRs). Many of those advanced technologies would benefit from reprocessing, and several companies include reprocessing as integral to their business plans.

The International Atomic Energy Agency says that as little as 8 kg of plutonium could produce a crude explosive device; more sophisticated actors, it says, might require just 3.5 kg.

Reprocessing by other nations has produced commercial stockpiles of plutonium totaling 410 metric tons (t) in storage at locations in Russia, France, Japan, and the UK, most of which has no clear disposition path, according to the International Panel on Fissile Materials. The UK alone has accumulated 116 t of civilian plutonium. Russia and France continue commercial reprocessing today. In 1997 Japan began construction of a reprocessing plant that has yet to operate.

"Reprocessing as it exists today is certainly not competitive with a once-through cycle," says Ross Matzkin-Bridger, senior director for nuclear materials security at the Nuclear Threat Initiative. "I have not seen any kind of analysis that would indicate that reprocessing becomes cost-competitive or cost-advantageous for advanced reactor technologies."

Huff said reprocessing can conserve uranium, lessen the environmental impacts of mining, and lower US dependence on uranium imports. Reprocessing all the nation"s spent fuel could reduce the need for mined uranium by a factor of 100 or greater, she said.

Opponents of reprocessing say that uranium will remain plentiful for the foreseeable future. "Reprocessing started because of a belief that uranium was relatively scarce and expensive and that as nuclear power grew, uranium would become more expensive and it would pay to breed new fissile fuel," says Steve Fetter, dean of the graduate school at the University of Maryland, who is active in nonproliferation issues. "That hasn"t been the case." Even at today"s relatively high uranium price, he says, "we are far below the level that would make reprocessing economically attractive."

Driving DOE"s support for reprocessing R& D is the hope that many of the advanced reactor types, so-called fast reactors, will catch on commercially. Of the 60 or so advanced reactor designs under development globally, 25 are fast reactors, according to the International Atomic Energy Agency. The Bill Gates-backed Natrium reactor, which is to receive a $2 billion subsidy from DOE, is a liquid-sodium-cooled fast reactor. (See Physics Today, November 2021, page 25.)