Trying to Make Nuclear Power Less Risky

Backers of thorium say it is safer, and generates less waste, than uranium

By Kent Garber
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Thorium is a slightly radioactive element, a cousin of uranium. For the past four decades, in fits and starts, researchers have been testing it as a potentially attractive competitor to uranium as a source of nuclear fuel. Within the nuclear community, it's won a small, devoted following. Up to now, it's had little commercial impact.

Today, however, thorium is getting a serious second look from some powerful global players. With interest in nuclear power soaring, thorium is being re-examined as a potential solution to—or at least a palliative for—some of the industry's daunting problems, particularly the production of hazardous radioactive waste. Advocates say that adding thorium to a nuclear reaction would help reduce the volume of nuclear waste that is produced and help prevent civilian nuclear fuels from being converted into weapons-grade material.

With nearly three dozen nuclear reactors under construction worldwide and at least 50 more in the planning stages, world leaders are facing mounting pressure to ensure that any nuclear expansion occurs as safely and cleanly as possible.

So, could thorium, which is found in the sandy beaches of India, Australia, and the United States, be part of the answer? Some politicians certainly hope so. So do many foreign governments. In the United States last fall, Senate Majority Leader Harry Reid of Nevada and Utah Republican Sen. Orrin Hatch introduced a bill requesting $250 million for thorium research and development. Abroad, the Indian government is banking on thorium-run nuclear plants to meet its growing energy needs. Russia, France, the United Arab Emirates, and others also have expressed interest.

Of course, there's at least one big catch: At the moment, thorium isn't ready for wide commercial use. But on paper and in laboratory tests, it looks like a sleek upgrade from uranium. It's consumed much less quickly in a reaction, so it has the potential to slice in half the volume of waste that's produced. And unlike uranium, it doesn't produce plutonium that can be used in weapons. This could help allay fears, particularly in Washington, that developing countries might use civilian nuclear energy programs as a pretext for developing nuclear weapons.

Contaminated. Thorium's advantage comes partly from its atomic chemistry. In a typical reactor, the fuel is enriched uranium, which is a mixture of two types of uranium. One, U-235, can be ripped apart to release energy. The other, U-238, is heavier, more plentiful, and, in a nuclear reactor, yields a specific type of plutonium that can be isolated and used to make nuclear bombs. In advanced thorium-fuel reactions, however, something different happens. Plutonium is still produced, as is U-233, which can also be used for weapons. But so many other types of plutonium are formed, and so much toxic gamma radiation is released, that the final products are "contaminated," meaning that it's incredibly difficult—if not impossible—to isolate the plutonium or uranium and make a bomb out of them.

Then there's the waste advantage. A longtime political lightning rod, the issue of nuclear waste disposal is part of the reason that it has been three decades since a new nuclear plant received approval for construction in the United States. The federal government's decades-old plan to build a waste repository at Yucca Mountain in Nevada seems all but dead now, with the Obama administration recently saying that Yucca "is not an option." Thorium can't eliminate the problem, but it could help reduce the amount of waste that would need disposal. On average, experts say, a thorium fuel rod could stay in a reactor twice as long as a uranium one.

Blend. The most promising design being developed is a blend containing thorium and a small amount of uranium to help kick-start the reaction. Research is ongoing, and approval by the U.S. government remains at least several years off. But some surprising international partnerships are already yielding promising developments.

One leading company, Thorium Power, based in Virginia, has been working with Russian researchers since the early 1990s to commercialize thorium (with the blessing of the U.S. government, of course). For the past five years, Thorium Power has been testing its fuel design—a thorium-uranium blend designed to be more proliferation resistant—in a research reactor at Moscow's Kurchatov Institute. It's now examining the results, says Thorium Power's CEO, Seth Grae, and over the next few years plans to test the fuel in a commercial reactor. Eventually, it wants to seek approval from the Russian government to market the technology. "A few years ago, I would have ticked off several risk factors that are now behind us," Grae said. "This is now at a very advanced stage."

Yet even if the research is successfully completed, there's the question of who would want to use it. In India's case, thorium could be particularly attractive, because the country has some of the world's largest thorium reserves but limited access to uranium. Other countries that are working to build civilian nuclear programs, such as the United Arab Emirates, might also find thorium easier to obtain.

In the United States, there has been less enthusiasm for thorium. Experts say that U.S. uranium supplies are ample enough to last at least through the end of the century, and uranium is still relatively cheap, despite recent price jumps. "From the perspective of utilities, they like things that work the way they are," says Felix Killar, senior director at the Nuclear Energy Institute. "Unless somebody comes to them with a really good explanation for why they should go this way, they are not running and saying, 'Yeah, we will do this.' " On the other hand, if thorium does become viable, utilities wouldn't have to alter their operations much; it can be used in existing reactors without major changes.

For now, many in the industry are more focused on reprocessing unconsumed uranium and plutonium from used fuel and reusing it. "There is a lot of energy potential left in spent fuel, and that requires reprocessing," says Regis Matzie, chief technology officer at Westinghouse, one of the country's top nuclear reactor manufacturers. "The path we are going down is to put the waste in a repository, but the smartest technical solution would be to reprocess the fuel."

Reprocessing, of course, is linked to proliferation fears because it involves separating plutonium from the spent fuel, and the procedure has been banned in the United States

since the 1970s. The Bush administration made a serious attempt to reverse that policy, but Congress pushed back hard. With nuclear energy generating new interest in Washington these days, thorium's backers may find a more receptive audience.