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# Can Sodium Save Nuclear Power?

Behind thick glass in a laboratory nestled in French woodland, a silvery molten metal swirls like a liquid mirror.

REUTERS

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By Geert De Clercq



CADARACHE France (Reuters) - Behind thick glass in a laboratory nestled in French woodland, a silvery molten metal swirls like a liquid mirror. But the material is no mere novelty; as dangerous as it is captivating, it could offer a solution to the nuclear power debate.

For sodium, the sixth-most abundant element on the planet, is being held up as the key to one of several new types of nuclear reactor being developed as governments grapple with the problem of making atomic energy more environmentally friendly, safe and financially viable.

The 2011 Fukushima disaster in Japan effectively brought a global nuclear boom to a halt, but a decade-old research program into new reactors has regained relevance of late.

Quite apart from Germany's decision to phase out a large slice of its nuclear capacity in the wake of Fukushima, Britain and Belgium have recently switched off several aging reactors over safety concerns while a number of U.S. plants have closed because they can no longer compete with cheap shale gas.

Launched by the United States in 2000, the Generation IV International Forum (GIF) has 13 member countries including China, Russia, France, Japan and Britain, which have whittled down nearly 100 proffered concepts to focus research on six nuclear reactor models.

By far the most advanced of the six is the sodium-cooled fast reactor (SFR), developed by France, Russia and China from a concept pioneered in the United States in the 1950s.

The SFR's main advantage is that it can burn spent uranium and plutonium. These unwanted byproducts from water-cooled reactors have been piling up for years and the World Nuclear Association estimates stocks at about 1.5 million tonnes.

"We could produce power for several thousands of years with that without getting new natural uranium," said Christophe Behar, the vice-chairman of GIF.

Behar, also head of research at French nuclear agency CEA, points out that SFRs can also burn up uranium's most long-lived radioactive waste products, reducing the need for deep storage.

## EXPLOSIVE DRAWBACK

Liquid sodium is better than water at evacuating heat from the reactor core and its high boiling point of about 900 degrees Celsius allows SFRs to operate close to atmospheric pressure, negating the need for the thick, steel containment vessels at pressurized water reactors.

But sodium has significant disadvantages, too. On contact with air, it burns; plunged into water, it explodes.

Early SFRs built by France, Russia and Japan have suffered corrosion and sodium leaks. But these were not built to GIF standards and the CEA research facility amid the pine trees in Cadarache, southeast France, is working on how to tame sodium as the agency seeks to convince lawmakers to allow construction of its new Astrid reactor, a 600 megawatt SFR.

The Astrid project was granted a 652 million euro ($823 million) budget in 2010 and a decision on construction is expected around 2019.

The use of sodium, which occurs naturally only as a compound in other minerals, presents huge challenges, however.

Nitrogen-driven turbines are being designed to prevent sodium from mixing with water, while purpose-built electromagnetic pumps are seen as the solution to moving the superheated metal within reactors. Then there's the headache of not being able to see through the liquid metal should something go wrong in a reactor core.

The other five concepts - including lead and helium-cooled fast neutron reactors and three very-high-temperature reactors - are less mature than the SFR and face similar technological hurdles.

But technology is not the only obstacle. Cost is key, as ever, and abundant U.S. shale gas and a renewables energy boom in Europe have undermined the viability of the nuclear industry, leading some GIF member states, including Japan, Canada and Switzerland, to scale back funding.

## SCIENCE FRICTION

Regardless of which, if any, of the new concepts eventually holds sway, the inevitable political wrangling over commercial projects will almost inevitably bring further delays, as with Britain's 16 billion pound ($26 billion) Hinkley Point C plant to be operated by French utility EDF.

"Between the ambition in the beginning and today's status, the Generation IV research is not exactly on track," the OECD Nuclear Energy Agency's Thierry Dujardin said.

GIF's target of having the first prototypes in operation around 2020 has been pushed back to 2030, with the first commercial plants not expected before 2040-2050, but such are the timescales in the nuclear industry.

The group does have some wriggle room, as many of the second-generation reactors built in 1970s and 1980s are expected to run for another decade, while third-generation plants built today by firms such as Areva and Westinghouse are designed to operate for up to 60 years.

Critics of GIF say that France and other nations have been too quick to focus research on the SFR and should have made a more audacious bet on newer technologies, such as the pebble-bed high-temperature reactor or the molten-salt reactor.

"There is not a single really new idea among the 4G models," said Bernard Laponche, a retired CEA nuclear engineer.

Given sodium's explosive potential, Laponche argues that the molten-salt reactor, the least developed technology, is the safest of the six models.

"It's not a windmill, but it's better than the others," he said.

(Editing by David Goodman)

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