Reactor Prototypes

Sun research team ponders odds of accident caused by air ingress

Compared to its centuries-old fossil fuel counterparts, nuclear power is a young player in today's energy sources.

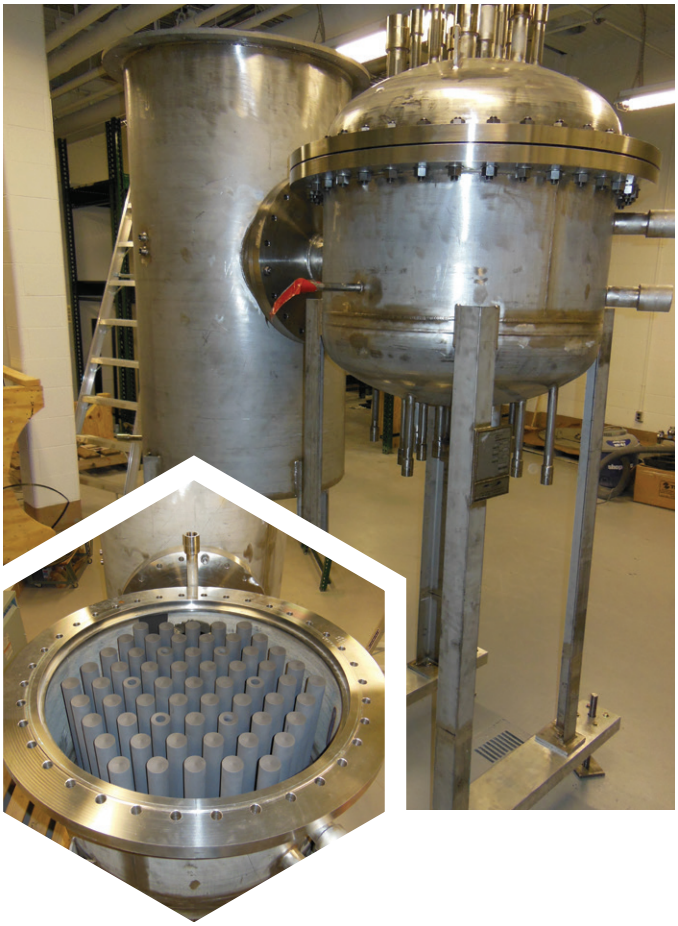
Still, since the world's first nuclear power plant became operational in 1954, there have been three marked generations of nuclear technology. With the fourth on the horizon, nuclear engineers are designing a suite of safe, efficient and innovative systems, which they estimate to be operational within 15 years. Xiaodong Sun, Ph.D., associate professor at The Ohio State University's Nuclear Engineering Program, is ensuring one of these new systems is as safe as possible, using high performance computing resources to test prototypes.

One of the most promising Generation IV power plant designs is the Very High Temperature Reactor. Nuclear designers favor the helium-cooled, graphite-moderated VHTR design because of its inherent safety characteristics: helium is inert and remains a gas while the graphite core maintains structural stability at high temperatures. Though touted as one of the safest nuclear reactor designs, one variable could compromise this: air ingress. Previous studies have shown the graphite structure could lose up to 25 percent of its strength and 4.5 percent of its density due to an air-ingress event. Sun's work focuses on the impacts of air ingress to determine if the issue can be mitigated.

"Computer models have been developed to analyze this type of accident scenario," Sun said. "There are, however, limited experimental data available to understand the phenomenology of the air-ingress accident and to validate these models."

To test the phenomenon, Sun and his team, Emeritus Professor Richard Christensen, Ph.D., Doctoral Candidate David Arcilesi and Tae Kyu Ham, Ph.D., constructed a one-eighth-scale test model of part of a VHTR reactor system. Using ANSYS FLUENT, a computational fluid dynamics software tool, Sun simulates the air-ingress phenomenon through Ohio Supercomputer Center resources. The model facility will duplicate these FLUENT runs and the data obtained should validate the computational calculations.

So far, Sun's team has found the model provides reliable data, closely resembling the air-ingress accident that might occur in a full-sized prototype VHTR. They are currently testing the two modes of air ingress to determine under which conditions each could dominate. This information will be used to improve VHTR prototype designs and accident mitigation. Generation IV designs will maintain today's high level of safety while shifting from the current paradigm of mastering accidents to excluding accidents entirely. •



(Above) A one-eighth-scale test model of part of a very high temperature reactor system, including graphite core structures. So far, the model provides reliable data resembling true-to-life air-ingress accident scenarios.

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