Westinghouse Global Technology Office

Westinghouse eVinci™ Micro Reactor

Introduction

Westinghouse Electric Company is a world leader in the development and commercialization of nuclear power plants. Westinghouse has established innovation programs aimed at supporting operating plants to reduce cost and improve efficiency, and is developing next-generation technologies to address global market needs. With this latter goal in mind, Westinghouse is developing the **eVinci™ micro reactor**, a next-generation, small nuclear energy generator for decentralized generation markets such as remote communities, arctic mines, etc.

Delivering affordable, reliable, resilient, secure, flexible and sustainable energy, with unparalleled safety and proliferation resistance, are Westinghouse's key goals for the eVinci micro reactor .

Background

Nuclear energy provides reliable, affordable and clean, carbon-free emission energy. However, the needs of a decentralized generation market are very different from those of centralized generation, thus Westinghouse has selected the heat pipe reactor as the ideal technology to meet the market's needs, as well as offer benefits beyond what is possible with incumbent technology.

The Technology

The Westinghouse eVinci micro reactor is an innovative design with many attractive safety features based on design simplicity. The unique core design is built around a solid steel monolith with channels for both heat pipes and fuel pellets. Each fuel pin in the core is adjacent to three heat pipes for efficiency and redundancy. Overall, there is a 1-to-2, heat-pipe-to-fuel ratio throughout the core. The large number of in-core heat pipes is intended to increase system reliability and safety. Decay heat also can be removed by the heat pipes with the decay heat exchanger.

The use of heat pipes in nuclear reactors is new and perhaps not as familiar to the commercial nuclear industry, but liquid metal heat pipe technology is mature and robust with a large experimental test database to support implementation of the technology into commercial nuclear applications. The marriage of these three components makes the eVinci micro reactor concept unique and simple.

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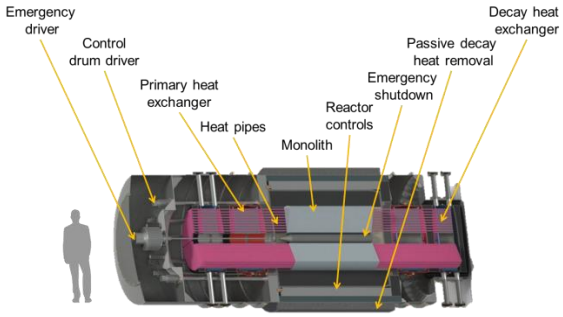
Use of the heat pipes in a reactor system addresses some of the most difficult reactor safety issues and reliability concerns present in current Generation II and III (and to some extent, Generation IV concepts) commercial nuclear reactors – in particular, loss of primary coolant. Heat pipes operate in a passive mode at relatively low pressures, less than an atmosphere. Each individual heat pipe contains only a small amount of working fluid, which is fully encapsulated in a sealed steel pipe. There is no primary cooling loop, hence no mechanical pumps, valves, or large-diameter primary loop piping typically found in all commercial reactors today. Heat pipes simply transport heat from the in-core evaporator section to the ex-core condenser in continuous isothermal vapor/liquid internal flow. Heat pipes offer a new and unique means to remove heat from a reactor core.



The primary purpose of the eVinci micro reactor system is to generate electricity and heat. The design uses a primary heat exchanger in the form of annular tubes around the ex-core condenser section of the heat pipes with inlet and outlet plenums at the condenser section ends. The reactor core can easily run for more than 10 years without the need for refueling.

The Westinghouse design goals and implementation of novel components have led to a reactor system that avoids some of the major conventional accident conditions in present-day commercial reactors. Accident conditions specifically avoided include:

- *Loss of primary coolant flow*
- *Loss-of-coolant accidents on the primary side*
- *Positive reactivity injection due to water ingress into the core*
- *High-pressure ruptures and ejections*
- *Positive reactivity injection due to control rod ejection*
- *Station blackout*

Roadmap

This program's technology development goal is to develop and demonstrate the eVinci micro reactor in less than six years. This is possible primarily due to small size and the high technology readiness level of the individual components. The first major milestone of this program is to develop a full-scale electrical demonstration unit to reduce technology gaps and demonstrate manufacturability by 2019. A system integral test with nuclear fuel will then be constructed and demonstrated to qualify the eVinci micro reactor for commercial deployment by 2024.

Benefits

Based upon the market needs and its extensive commercial nuclear experience, Westinghouse selected the heat pipe reactor technology as the ideal choice for decentralized energy generation. The key benefits of eVinci are attributed to its technology:

Solid Core:

- *Encapsulates fuel to significantly reduce proliferation risk*
- *Enables inherently safe core due to strong negative temperature feedback*

Heat Pipes:

- *Eliminates the need for reactor coolant pump and all associated auxiliary systems to enable compact packaging and simple design*
- *Can inherently adjust heat load, thus allowing easier autonomous load following*
- *Can operate at higher temperatures to enable higher efficient power conversion system and high-grade process heat*

Both heat pipes and the solid core together make the eVinci micro reactor a "solid state reactor" with minimal moving parts, which is key to the reliability and maintenance-free design of a long-life decentralized energy generator.

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