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Direct catalytic heating with Microreactors for hydrogen and fertilizer production

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Program: Microreactor cost reduction and end-user application integration

ABSTRACT:

Process heat is envisioned as an alternative application for nuclear reactors, but the supply of heat is always driven by the process coolant conditions and indirect heat transfer through a secondary or tertiary heat transfer fluid. This makes design and integration complex, and particularly uneconomical. Most of the thermally driven hydrogen generation processes or fertilizer production processes involve endothermic chemical reactions in a hot catalytic bed. This proposal presents a novel, integration approach to deliver process heat from microreactors by directly heating the catalyst particles from the primary heat transfer fluid in a moving packed bed heat exchanger (MPBHX). In this design, the tube side of the MPBHX can be a heat pipe or secondary molten salt coolant as in several microreactor designs. Whereas the final heat dispatch carriers will be moving catalyst particles in form of granular flows which upon heating will enter the chemical reactor for enabling the high temperature chemical reaction of interest. The proposed work will involve the design integration of this MPBHX with microreactors along with its safety and eco-nomic assessment. This design will be compared to the alternative or conventional methods to dispatch high temperature process heat from nuclear thermal systems.

The microreactors are uniquely suited for remote deployment to provide thermal or electrical energy needs. The proposed project will explore the technical and economic feasibility of these microreactors integrated with chemical processes for agricultural applications such as hydrogen to operate combines and other farm equipment, and ammonia for use as a fertilizer.