Composite Nuclear Fuel Pellet

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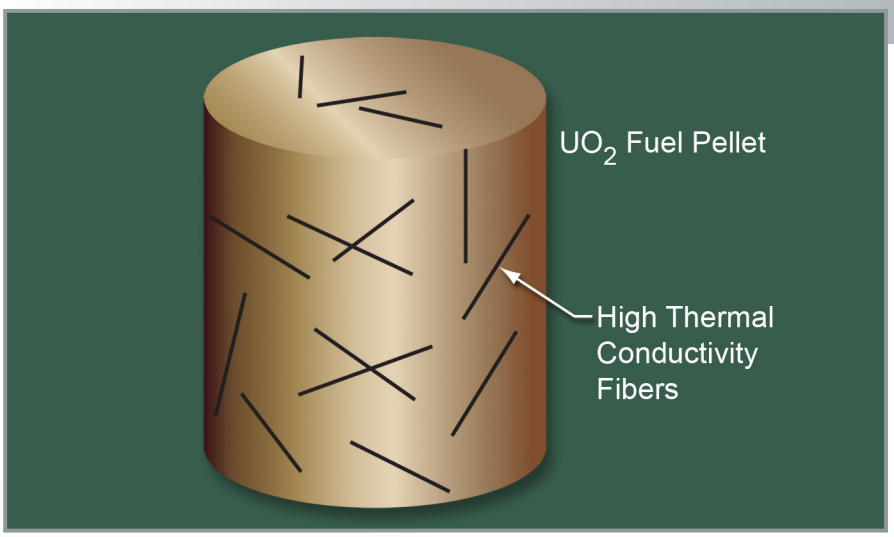

Technology Summary

To improve rates of nuclear power generation, ORNL has patented a way to increase the thermal conductivity of uranium oxide UO_2 fuel. This is achieved by adding high conductivity fibers to form a composite UO_2 fuel pellet. Essentially, the invention is a nuclear fuel pellet with a UO_2 matrix in which long fibers of a high conductivity material are randomly dispersed to act as heat conduits that enhance bulk thermal conductivity.

Presently, uranium oxide (UO_2) is used as fuel in all 436 operable nuclear reactors around the world and is relatively inexpensive to manufacture. But UO_2 has very low thermal conductivity, which decreases even more as the fuel undergoes fission and gives off heat. This limits the rate at which heat energy can be removed from the fuel, which in turn limits the rate of power generation. Highly ordered graphite is being investigated because it has very high thermal conductivity and a very low neutron absorption cross section.

Significantly increasing the fuel's thermal conductivity will allow a nuclear reactor to operate at higher power densities, higher enrichment levels, increased safety margins, and longer burn-up times. This translates to more megawatts per nuclear power plant and less spent fuel, increasing efficiency and decreasing waste. Additionally, this technique may be extended to enhance the thermal conductivity of other ceramics and metals. A silicon carbide layer would protect the graphite from interaction with other materials, allowing this process to be useful in environments hostile to pure graphite.

Advantages

- Reactors may be able to operate at higher power levels
- Higher ^{235}U enrichments may allow the fuel to burn longer
- Fuel will be cooler, experiencing significantly less damage and allowing higher burn-up ratios and higher safety margins

Potential Applications

- Nuclear fuel manufacturers
- Ceramics and metals

Patent

Daniel F. Hollenbach, Larry J. Ott, Theodore M. Bessman, James W. Klett, and Beth L. Armstrong, *Composite Nuclear Fuel Pellet,* U.S. Patent Application 13/489,118, filed July 30, 2009.

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