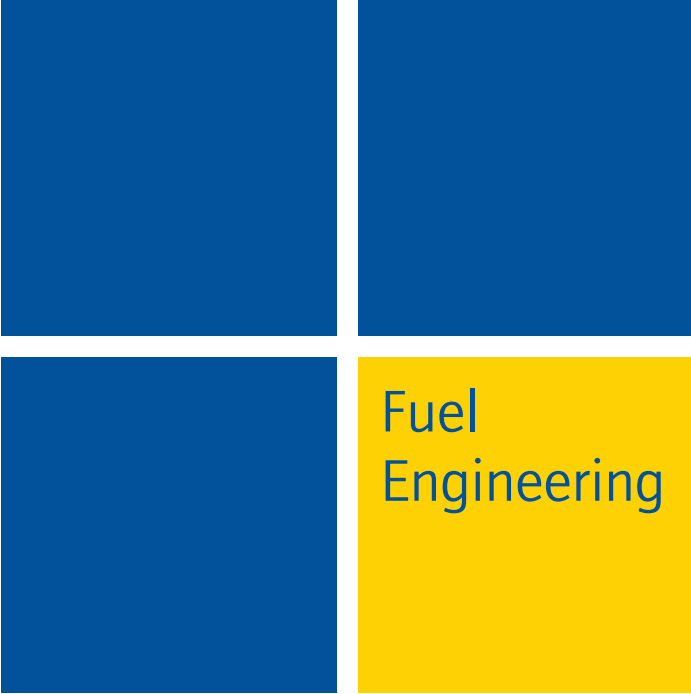


Zirconium Diboride Integral Fuel Burnable Absorbers



Fuel Engineering

Background

Burnable absorbers have become essential to core design as reload cycle lengths and discharge burnups have increased and core loading patterns have become more complex. Zirconium diboride (ZrB_2) integral fuel burnable absorbers (IFBAs) have distinct advantages over the previously used discrete burnable absorbers.

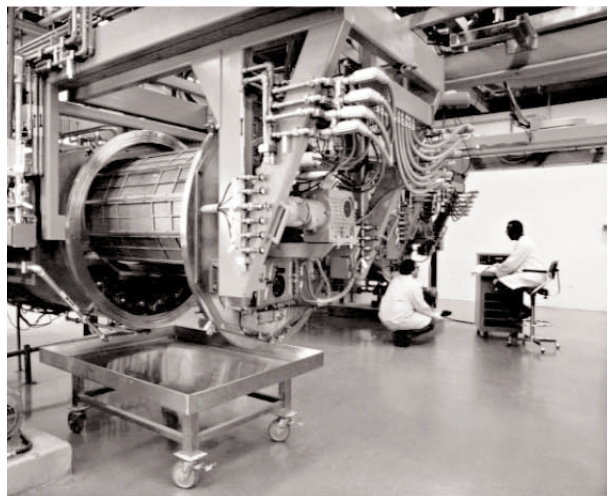
Fresh fuel is rich in fissile uranium and unless its reactivity is controlled, the heat produced may exceed peaking-factor limits. As cycle lengths increased over the years, so did the need for long-term reactivity control. Burnable absorbers, in the form of absorber rods, were developed to provide this reactivity con-

trol while also offering radial and axial power shaping to limit power peaking. IFBAs have the added advantages of directly incorporating the absorber material in the fuel without displacing moderating water.

Benefits

The ZrB_2 IFBA is the most efficient absorber available for PWRs. ZrB_2 offers significant advantages over other materials used to moderate peaking. The ability of ZrB_2 to absorb neutrons is precisely limited so there's no residual absorption penalty. The absorption rate of ZrB_2 IFBAs is closely matched to the fuel's reactivity depletion, so fuel enrichments can be lowered.

- ZrB_2 IFBAs use neutrons more efficiently than previous burnable absorbers. Requirements for fuel enrichment are reduced, resulting in up to a 3% reduction in fuel cycle costs (FCCs).
- More efficient use of neutrons enables fuel to last longer. This helps reduce fuel costs and storage requirements and increases reactor availability.



ZrB_2 coating is applied to fuel pellets with a Westinghouse-developed sputtering process.

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- Because the absorber is part of the fuel rod, separate handling of discrete burnable absorbers during refueling is eliminated. This reduces refueling time and lowers plant personnel exposure to radiation.
- IFBAs do not occupy fuel assembly guide thimbles. This means that any assembly can be positioned under a control rod or neutron source location if necessary. The result is flexibility to develop and implement enhanced fuel loadings.
- IFBAs can be positioned anywhere in the core, allowing for both axial and radial shaping to precisely control excess reactivity and maximize neutron efficiency.
- ZrB_2 IFBAs offer enhanced design flexibility because of the predictability of the boron absorber and lack of residual absorption. Being able to accurately predict burnable absorber depletion helps achieve good power distribution during operation. As a result, it also allows better use of available core margins.

Description

In anticipation of high burnups and long cycles, Westinghouse initiated a search for an optimum in-fuel burnable absorber in the mid-1970s. The objectives included selection of the material best suited to provide the required absorption function and cross-section, depleting at a rate commensurate with fuel depletion, and able to be fabricated together with individual fuel rods.

Westinghouse manufactures IFBAs by applying a thin layer of ZrB_2 to fuel pellets using a self-designed, patented process. The coating adheres strongly and is highly compatible with the fuel pellet and cladding. The IFBA coating does not affect pellet manufacturing or enrichment since it's applied to otherwise finished pellets. Because the IFBA is applied directly to enriched pellets, it can be selectively used with fuel that's enriched to levels that meet fuel management objectives. Likewise, it can be selectively applied only over portions of a fuel rod's length for specific power peaking control.

ZrB_2 IFBAs are a widely accepted feature of Westinghouse-supplied fuel, having demonstrated their capabilities and adding to their experience base at a rate of nearly 100,000 per year.

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