Westinghouse Burnable Absorbers—Advanced Core Management Products

Fuel Engineering

Background

For over 25 years, Westinghouse has been working to advance burnable absorber capability to help our customers meet their core management objectives. Such varied and changing objectives have led to burnable absorbers ranging from discrete, removable absorber rods to burnable absorber materials contained within fuel rods. Westinghouse offers zirconium diboride (ZrB_2), gadolinia (Gd_2O_3), and mixed integral fuel burnable absorbers (IFBAs), as well as discrete wet annular burnable absorbers (WABAs).

Benefits

High-burnup, extended-cycle-length core management is the predominant trend of users in the once-through cycle mode. Increasing fuel cycle length tends to increase fuel cycle costs (FCCs) when compared to earlier core loading and fuel management practices. Using IFBAs and discrete WABAs enhances the performance of traditional cycles and contributes to recovering the efficiency of shorter fuel cycles when used in long cycles. This is achieved by the reducting of the residual reactivity penalty plus increased neutron economy through power sharing to reach higher burnups.

Economic benefits include:

- Reduced uranium requirements
- Reduced separative work requirements
- High fuel utilization and burnup
- Longer fuel cycle lengths
- Reduced fuel fabrication requirements

There is no single value that can be assigned to overall savings, given the variety of user requirements and core management objectives selected for a particular cycle. Because of this, we're prepared to assist our customers assess the economic benefits and help them judiciously plan the use of advanced burnable absorbers for economically sound core design and fuel management.

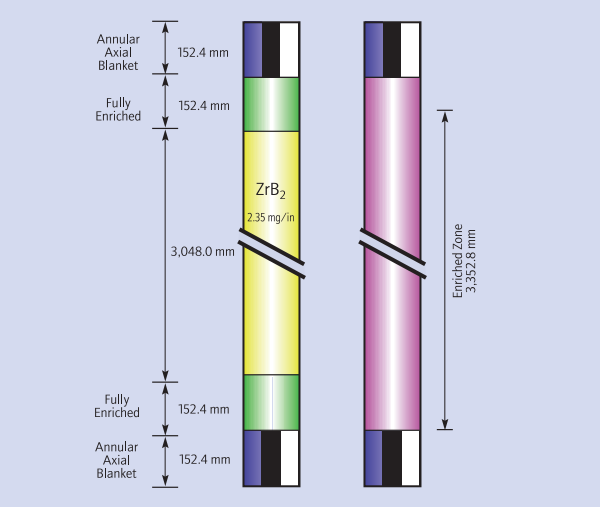
(Continued on back)

Westinghouse

For more information, call your local Westinghouse Electric Company sales representative.

Description

ZrB_2 was selected as an IFBA because of its compatibility with the existing fuel pellet and cladding. ZrB_2 has been shown in tests and operation to adhere strongly to the fuel pellets. The coating's capacity to absorb neutrons is precisely adjusted. ZrB_2 rods use neutrons more efficiently than other burnable absorbers, and more efficient use of neutrons enables the fuel to last longer. This helps reduce fuel costs and storage requirements and increases reactor availability. ZrB_2 rods don't occupy fuel assembly guide thimble locations like discrete burnable absorber rods do, and so provide flexibility to develop and implement improved fuel loadings. The number of rods coated with ZrB_2 can be adjusted to meet individual plant needs.



Gd_2O_3 is also used as a burnable absorber material. The Gd_2O_3 material is mixed with UO_2 fuel and is contained within the fuel rods. Compared to the boron neutron absorber in ZrB_2, the Gd^{155} and Gd^{157} isotopes are stronger neutron absorbers, therefore fewer Gd_2O_3 rods are needed.

The depletion rate can also be tailored by changing the Gd_2O_3 concentration within a fuel rod. Gd_2O_3 is slightly less neutron-efficient than ZrB_2 because other weakly absorbing isotopes of Gd are initially present and also created from neutron absorbtion in Gd^{155} and Gd^{157}.

Mixed IFBAs use both ZrB_2 and Gd_2O_3 burnable absorber rods in the same fuel bundle. Mixing burnable absorber types offer the benefits of Gd_2O_3, while minimizing the associated FCC penalty of these absorber types by using ZrB_2, which has no FCC penalty.

Discrete

WABA is a discrete burnable absorber that utilizes thin annular aluminum oxide and boron carbide (Al_2O_3/B_4C) pellets for neutron absorption, and an annular central passage for reactor coolant. The benefit of WABA rods is that the absorber material depletes with exposure to a residual absorption about half that of Pyrex®. This benefit stems from the dimensionally thin cross-section of the boron-containing pellet, and the neutron moderating effect of reactor coolant water circulation in the annulus, which enhances boron depletion.

Westinghouse Electric Company
Box 355
Pittsburgh, PA 15230

www.westinghousenuclear.com

May 2006

NF-FE-0009