

“Precise Control of Fe Concentration in Feedwater for Co-60 Concentration Reduction”

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The ultra-low Fe-high Ni operation is a method in which Ni(Co)O is formed on the surface of fuel rods due to Fe deficiency, and the Co-60 concentration in the primary coolant becomes higher than the controlled Fe/Ni ratio, however, by forming a dense layer of NiFe₂O₄ on the outer surface of the core, which reduces Co-60 adhesion, this consequently offsets the high concentration and reduces the dose rate of the outer surface of the core. The plant in which ultra low Fe-high Ni operation is applied exhibited very low dose rates in the first four cycles; however, there was an increase in dose rate in subsequent cycles.

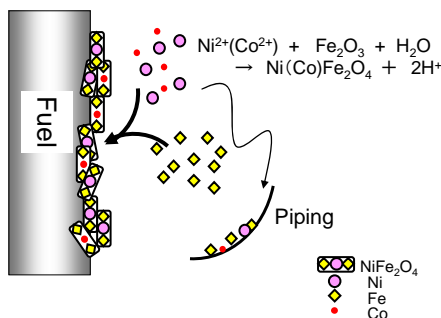
The causes were investigated, and it was concluded that the dense layer of NiFe₂O₄, which was formed on the outer surface of the core at the initial cycle, was damaged by the long operation and NiO was incorporated into Cr₂O₃ (and excessive NiFe₂O₄).

Therefore we decided to implement precise control of the Fe concentration in feed water according to the amount of Ni, thus lowering the Co-60 concentration and adhesion coefficient to the outer surface of the core. The dose rate for the outer surface of the core can be minimized by this method. Several compounds have been tested to study the form of Fe for injection from the aspects of (1) stability, (2) Ni(Co) reactivity, (3) adhesion loss, and (4) adhesion to fuel surface; the results suggest that αFeOOH and iron oxalate are the candidate forms for Fe injection. The CF bypass also has similar effect to Fe injection.

3. Ni control by precise feedwater iron control

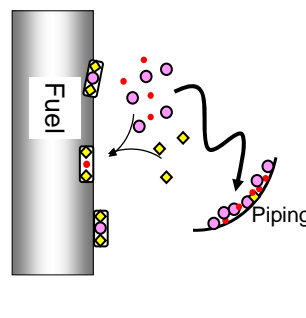
Ni concentration control by Fe solution injection

Optimum Fe conc.



Ni(Co) fixed on fuel rods as Ni(Co)Fe₂O₄
 → Ni(Co) conc. low
 → Ni(Co) deposition on piping lowered
 → **Exposure low**

Too low Fe con.



Ni(Co) does not fixed on fuel rods
 → Ni(Co) conc. high
 → Ni(Co) deposition on piping high
 → **Exposure high**