N85. From Reaction To Proaction -- Taking The Preventative Approach.

Changes In BWR Chemistry

The major trust of the late 1970s and early 1980s to reduce water conductivity has been largely replaced by a more pro-active approach of using additive to control the main problems.

Fe/Ni Ratio. Controlling the iron/nickel ratio to reduce fields, a method pioneered in Japan, has been adopted at Forsmark 2 in Sweden to counteract the effects of Inconel fuel spacer corrosion on cobalt-60 buildup.

Hydrogen Water Chemistry. Hydrogen water chemistry is being used at eight plants in the U.S., as well as in Sweden, Spain, and Japan (Fugen), to control intergranular stress corrosion cracking (IGSCC). Several plants in the U.S. are experiencing a significant increase in shutdown radiation fields -- primarily from cobalt-60 -- after introducing hydrogen injection. The increase is generally less significant at Swedish plants, perhaps because these plants have a small in-core inventory of cobalt-60 available for release as the chemistry becomes more reducing.

Zinc injection passivation is one way of mitigating, but not completely eliminating, this rapid buildup of fields with hydrogen water chemistry. Recent data from the Hope Creek and Millstone 1 boiling water reactors confirm that in normal water chemistry, zinc injection at or below 5 ppm stabilizes fields below 100 mR/h on recirculation piping. Returning to hydrogen water chemistry, several times as much hydrogen as is currently used to protect the piping will be required to mitigate IGSCC of core internals -- probably worsening the cobalt-60 shutdown fields, and undoubtedly increasing steam line fields from nitrogen-16. Some elegant studies reported by Japanese workers have led to suggestions for additive to control nitrogen-16,which will probably be tested in the reactor chemistry loop at the Massachusetts Institute of Technology, as part of a growing program of collaboration between U.S. and Japanese organizations on reactor water chemistry studies.

Approach

Water chemistry is undergoing a revolution from the "purer is better" concept to complex advanced chemistries using additives. The 1991 JAIF Water Chemistry Conference provided a forum for reviewing the progress in this revolution.

With the impetus of developments in diagnostic technology (on-line monitoring) and improvements in the understanding of fundamental processes, and supported by greater management interest, the plant chemist is in the front line of the drive to improve operating performance. The 1991 Water Chemistry Conference in Fukui, Japan, the second organized by JAIF, took the understanding of water chemistry phenomena a significant step forward. Several papers presented sophisticated analyses of the morphology and composition of deposits on fuel, primary systems and secondary systems, pointing the way to future improvements. Controlling these deposits is the key to minimizing corrosion and radiation damage.

PWR Primary Chemistry. Results from several plants confirm that increasing pH above 6.9 significantly reduces radiation field buildup, but it is still not clear if pH 7.4 is better than pH 7.2. Westinghouse workers reported that PWSCC, measured in the laboratory with reverse U-bend specimens, was greater at 3.5 ppm lithium than at 2.2 ppm. These results were confirmed by workers at MHI's Takasago Research Center, who used slow strain rate specimens. These studies showed that 2.2 ppm lithium gave less PWSCC than both lower and higher lithium concentrations at 500 ppm boron -- confirming another Westinghouse finding that using 2.2 ppm lithium gave better results than 0.67 ppm lithium at 315 ppm boron. But in all these tests, it was obvious that chemistry has less effect on radiation buildup than do metallurgical condition and stress, and the effects under study are small compared to the normal spread of

data. Clearly more sensitive tests, including crack growth measurements, are needed to resolve the lithium issue. Innovative methods, such as enriched boron-10, are available to raise pH without increasing lithium.

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