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Sep 30, 2002

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Subject: **Sources of Iodine in Gaseous Streams from Reprocessing Plants**

The fission process produces various isotopes of iodine¹ from mass 127 to 139. However, the most significant of these are ¹²⁹I ($t_{1/2} = 1.6 \times 10^7$ y) and ¹³¹I ($t_{1/2} = 8.05$ d) in terms of radionuclide release concerns. The short half life of ¹³¹I lessens its role in control scenarios after spent fuel cooling times in excess of one year. Therefore, the major concerns in sequestering iodine rests with ¹²⁹I.

For the sake of this discussion, the source of iodine, its chemical form and impurity concerns will be with respect to PWR spent fuel in aqueous reprocessing plants. Other source terms for iodine will vary somewhat, but not to the extent that they alter the considerations and conclusions herein. The purpose of this report is to evaluate the iodine source term with respect to the Molten Hydroxide Trapping (MHT) process² --- to identify the nature and amount of iodine that must be dealt with and the need to remove impurities prior to the introduction of the iodine stream into the process itself. Detailed reports on iodine off-gas treatment, in a more general sense, are available*³; but this discussion will focus on the MHT process alone.

For a typical PWR fuel in a 5 ton/day processing plant, the amount of ¹²⁹I to be treated would be 0.19 Ci (1.12 kg) per day¹. A discharge limit of 5 mCi/GW(e)/y was established³ in January 1983 for this isotope over the uranium fuel cycle. Nearly all of the iodine release comes during reprocessing, so this limit applies, in effect, to reprocessing plants. For a 1500 ton/y plant, it would typically require a decontamination factor (DF) of 220 for the reprocessing plant off-gases --- the primary pathway for iodine movement during processing.

The radioiodine release pathways in a conventional oxide fuel reprocessing plant can proceed through the following off-gas streams: (1) Head-end off-gas, HOG; (2) Dissolver off-gas, DOG; (3) Vessel off-gas, VOG; and (4) Cell ventilation off-gas, CVOG. Of all the above, the DOG would be expected to contain most of the iodine radionuclides and, to simplify the current considerations, will be the only one considered here.

The DOG is expected to have an air flow rate of 50 to 300 m³/h. During dissolution >95% of the iodine present is can be treated to volatilize the iodine into the DOG. The removal efficiency required for iodine is 99.0 to 99.9 % (DF's of 100-1000; cf., typical value of 220 above). More than 90 % of the DOG iodine is expected to be molecular iodine; but some HI, organic iodide (principally

* See, for example, Ref 1

References

- (1) *Radioiodine Removal in Nuclear Facilities*; “Methods and Techniques for Normal and Emergency Situations”; Technical Report Series No. 201, International Atomic Energy Agency, Vienna 1980.
- (2) For a description, see: L. M. Toth, L. D. Trowbridge, E. D. Collins, “The Molten Hydroxide Trapping Process for Radioiodine Removal”, ORNL-TM-XXXX (In preparation).
- (3) R. T. Jubin, “Airborne Waste Management Technology Applicable for Use in Reprocessing Plants for Control of Iodine and Other Off-Gas Constituents”, ORNL-TM-10477, February 1988.
- (4) “Environmental Radiation Protection standards for Nuclear Power Operations, US Federal Register 42, No. 9 (1977) 2358, Washington, D.C.