A FEASIBILITY STUDY ON IODINE BEHAVIOR DURING PYROPROCESSING OF SPENT METALLIC FUEL

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Abstract

Korea has 21 nuclear power plants in operation and as of 2011 about 11,000 ton of spent nuclear fuel was stored at four reactor sites. Currently, spent nuclear fuels are being continuously cumulated with stored at the rate of about 700 ton a year. However, it is reported that the storage pools will begin to be saturated from 2016 and thereby Korean government is on the point to decide the issues for a long-term management of spent nuclear fuel. As a promising option, Korea is developing pyroprocessing technology connected with sodium cooled fast reactor to transmute long-lived nuclides as well as minimize high-level nuclear waste amounts to be disposed of.

Among long-lived nuclides, iodine-129 has a very long half life of 15.7 x 10^6 years and a low cross section for transmutation as well as an impact on a biosphere for a long time even after disposing of it in a deep-geological repository. Therefore, iodine-129 needs to be managed carefully.

Information on a chemical behaviour of iodine in irradiated metallic fuel based on U-TRU-Zr alloy has a little been known, compared to that in oxide fuel. In particular, iodine chemical behaviour in a molten salt bath during pyroprocessing has been never reported and a way for isolation and recovery of iodine liberated from the molten salt was not known as well. In this respects, this study invested a various chemical behaviour of iodine not only in irradiated metallic fuel itself but also in the course of pyroprocessing in terms of thermodynamic feasibility assessment.

It is expected that iodine-129 generated as fission product will mostly exist in as metal iodides in the metallic fuel such as UI_3, ZrI_2, PuI_3, CsI, etc. Although iodine is released from metallic fuel to a gap between cladding and metallic fuel, just a little amount of iodine will be liberated into sodium bond material and produce NaI by a reaction of iodine with sodium.

As a result of thermodynamic prediction, we can anticipate that the incorporated iodine will be ultimately converted to potassium iodide (KI) in the molten salt (LiCl-KCl) in the course of electrorefining with accumulating sodium in the salt.

On the other hand, the cumulated iodine can be easily separated from molten salt. Chlorine gas can substitute iodides with chlorides and subsequently iodine is released from molten salt as off-gas. Hence, the released iodine will be easily captured and recovered by an appropriate way.

Through this procedure, iodine-129 arising from irradiated metallic fuel can be easily managed.

In addition, this study will propose a new molten salt other than LiCl-KCl eutectic salt that is generally being used in electrorefining for recovery of metallic fuel. As substantial amounts of sodium are incorporated and increasingly cumulated in the salt during electrorefining, this can

give rise to a change of various physical and chemical properties of molten salt such as melting temperature, viscosity, density, etc.