Estimation of Hydrogen Gas Production from Oxidation Process of Zirconium Cladding with Water Vapor in Fukushima Daiichi Nuclear Power Plant Unit One at Japan after Earthquake and Tsunami in 2011

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Abstract

It has been an explosion at Fukushima Daiichi NPP caused by the fusion reaction between hydrogen and oxygen. Hydrogen is believed to be generated one of which comes from the oxidation reaction between the fuel zirconium cladding and water vapor in the reactor core due to the failure of coolant (LOCA=Loss of Coolant Accident). The purpose of the present study is to estimate the amount of hydrogen gas that accumulates in the reactor core theoretically by using a model based on equilibrium mole of a chemical reaction. The zirconium cladding material is set as a limiting reagent that limits the formation of hydrogen gas in the reactor core. The estimation results show that the amount of hydrogen accumulated in the reactor is directly proportional to the mass of the oxidized zirconium with water vapor. The amount of hydrogen gas, which accumulates for one fuel rod, reaches about 0.018 kg, for one assembly is about 1.10 kg and for overall at Unit One reaches 441 kg, which these results have been enough to blow up the reactor.

Method of the Measurement

The study of literature in the production of hydrogen in the reactor core nuclear power plant Fukushima Daiichi by the earthquake and tsunami, and showed that the greatest contribution of hydrogen that accumulates in the reactor core is derived from the oxidation reaction between the sleeve and the water vapor at a given temperature, then determine the model reaction will be used in the module (Code), and then create and test the module by entering the input parameters such as: high fuel rod, the diameter of the fuel rod, and the rod and the assembly number on the unit, and then estimate the amount of hydrogen be produced if 25% to 100% of fuel rod oxidized and then analyze the data estimation results.

Conclusion

In this study the authors have succeeded in estimating the amount of hydrogen that accumulates in the reactor unit of the Fukushima Daiichi Japan using one of the hydrogen production concepts using simple equations. The amount of hydrogen that accumulates in the nuclear reactor of the Fukushima Daiichi unit reaches 441 kg and the amount has been able to blow up the reactor building. Has made a (code) named ZROTA that can be used to simulate the accumulation of hydrogen in a nuclear reactor core cooling due to the failure (LOCA = Loss Of Coolant Accident) caused by oxidation events between shells made of zirconium fuel and water vapor at a given temperature.

Objective of the Research

explosion at the Fukushima Daiichi NPP caused by the fusion reaction between hydrogen and oxygen.

Experimental Results

graphs the relationship and the amount of hydrogen oxidation on one rod, in the assembly, at the Fukushima Daiichi reactor unit.