Transactions of the Korean Nuclear Society Spring Meeting
Chuncheon, Korea, May 25-26 2006

Estimation of MELCOR with the updated model of organic iodide generation from pool using Phebus FPT-1 Test Data

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1. Introduction

When the severe accident occurs, if the fission product aerosol or vapor being released from fuel were not removed from the RCS circuit, consequently, most of the surviving fission products may reach the containment. But among all the fission products, the iodine is the most important fission product to be traced. It is because not only the its large amount of inventory but also the radio-biological effect on human is so hazardous.

But all these fission products entering into the containment suffer from a various kind of natural removal processes such as a gravitational settling (on the surface) and a deposition or condensation (on the structural surfaces). Normally, within a few hours, most of the suspended fission products are removed. In addition to these natural removal processes, the engineered safety features such as the spray and the filter system can remove the suspended fission product intentionally.

But the problem is the existence of gaseous form of iodide in the containment. It is because the gaseous iodine is difficult to remove by the engineered safety features. There are multiple sources for forming these gaseous iodides such as I_2 and CH_3I. On the painted surface, the deposited molecular iodine can react with the organic material within the paint and generate the gaseous organic iodide. Also the iodine ion mostly from the dissolved cesium iodide within the pool can react with the organic material such as methane and it is partitioned to the atmosphere depending on the conditions of pool temperature and PH. Recently, On the contrary, the reaction with ozone can destroy the gaseous iodide from the atmosphere [1].

Consequently, there are a repeating cycle between the generation and the destruction of the gaseous iodine within the containment. Finally, an equilibrium level of gaseous iodine concentration in the atmosphere is reached and is remained at the constant level of about 0.08% in the late phase of the severe accident. The Phebus FPT-1 test showed that the time to reach the equilibrium level was around 24 hr after the isolation.

The degree of the level of gaseous iodine concentration in the containment atmosphere has strong effect on the determination of the EAB (Emergency Area Boundary). From the simple scope calculation to see what level of iodine concentration can satisfy the 10CFR100 guideline under the assumption of 700m as the EAB, it is essential that the level of iodine concentration in the atmosphere should be kept less than 1% based on initial inventory. Therefore, it is necessary and important to minimize this level of gaseous iodine concentration as low as possible. This called as " iodine accident management".

The objective of this study is to estimate the updated MELCOR1.8.5 being the phenomena concerning the production of organic iodide from a pool implemented by KAERI. The sensitivity studies on three important phenomena such as the amount of injection of the molecular iodine as a gaseous form into the containment, the organic iodide generation from the painted surface in the atmosphere and the washing of the settled down FP on the floor into the pool were done as the frame of estimating the capability of MELCOR model to predict the gaseous iodine concentration in the atmosphere. All these estimations were done based on the Phebus FPT1 experimental data [2].

2. Description of the Actual Work

The aerosols and pool chemistry phenomena in the atmosphere and the pool for the Phebus FPT-1 experiment facility were simulated with the modified version of MELCOR1.8.5, which can generate the organic iodine from the pool. Especially, the prediction on the evolution of the gaseous iodine concentration in the containment atmosphere and its validation against the FPT-1 experimental data were performed in this study. This updated MELCOR assumes that the organic iodide cannot generate from the atmosphere but only from the pool.

Another modification of the MELCOR is to wash the settled fission product on the floor into the pool of sump by the operation of spray. It is because that the current MELCOR could not transfer the deposited fission product from one place to another by the spray.

The calculation was not performed for the entire experimental system but was confined to the containment. This part calculation is helpful to makes the effect of imposing parameters show clearly. To simulate the

containment part only, it is necessary to supply the boundary and the initial condition by a user. The most important condition is the amount of iodine and its form entering into the containment from RCS. But unfortunately, the measured data concerning the iodine in the containment was only the accumulated mass of elemental iodine and cesium. It implies that the form of the existing iodide in the containment is unknown. Even more, it means that the percentage of the gaseous form of iodide is also unknown. From the current MELCOR, most of the injected forms of the iodine compound were an aerosol as CsI. The gaseous iodine such as I_2 could not survive as a vapor under the current experiment condition but it existed in the test. Therefore, to simulate the existence of gaseous iodine in the containment atmosphere, the molecular iodine as a vapor state was intentionally injected into the containment. Therefore, in this study, the sensitivity work was done to see the effect of the gaseous iodine concentration on its initial level in the containment. This sensitivity study was done with changing the percentage value of the existing gaseous iodine such as I_2 from 5% to 0.5%. The cesium iodide was assumed as another existing form of iodine as an aerosol.

3. Conclusion

The pool chemistry phenomena in the Phebus FPT-1 test was simulated by the updated MELCOR1.8.5 with implementing the models concerning the formation of organic iodide from the pool. The calculation results of Figure.1 implied that the present model insufficient to describe all the phenomena that had been occurred from this test. Especially the too high level of the initial concentration of the gaseous iodine in the containment atmosphere may be occurred by the injection of too much gaseous iodine of 5% based on the initial core inventory into the containment. Therefore the gaseous iodine less than 5% should be injected from the RCS into the containment. As it was already raised as the important issue to be resolved in the Phebus FPT-1 final report, The sensitivity calculation result shows that the initial level of gaseous iodine in the containment was strongly dependent on this amount of gaseous iodine being injected from the RCS. Therefore, the development of the chemistry model within RCS or the finding the representative value of the gaseous fraction among the iodide coming from RCS should be obtained.

The rapid decrease of the gaseous iodine concentration was due to the deposition of molecular iodine on the heat structure surfaces. After this point, the reason for the concentration level being remained at much lower level than the experimental data was because the model for producing the organic iodine from the reaction of the deposited molecular iodine with the paint over the structure surfaces in the atmosphere does not applied in MELCOR. From this study, the contribution of the organic iodine generation solely from the pool to the level of gaseous iodine concentration in the atmosphere was turned out as a trivial. But the qualitative sensitivity study showed that the implementation of the model for generating the organic iodide from the painted surface in the atmosphere could make the level of gaseous iodine concentration more close to the experimental data than that of the omission of this model. Therefore, not only the pool but also the atmosphere phenomena for generating the organic iodide should be considered to well predict the gaseous iodine concentration in the atmosphere. Also the modification concerning the washing could make the gaseous iodine concentration in the containment atmosphere increase slightly after the washing as the experimental data was.

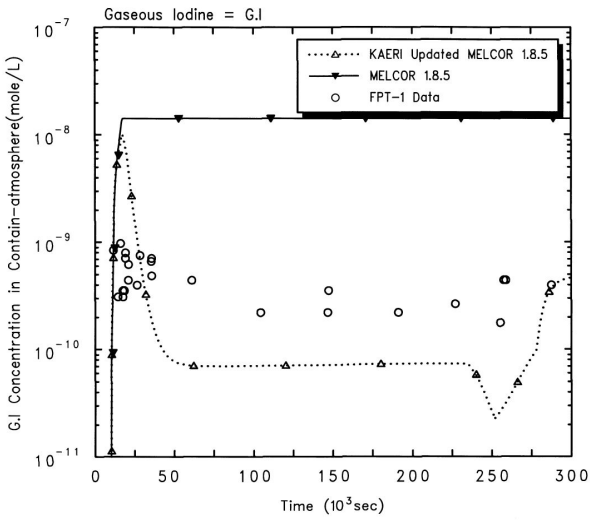

Figure.1 The gaseous iodine concentration in the Phebus FPT-1 containment atmosphere

ACKNOWLEDGEMENTS

We would like to thank MOST for supporting this research with the frame of MOST long term R&D program.

REFERENCES

1. R.O. Gauntt, R.K.Cole, C.M. Erickson, R.G. Gido, R.D. Gasser, S.B. Rodriguez, M.F. Young, " MELCOR 1.8.5 Reference & User manual ", SNL, Albuquerque, Oct 2000.
2. D. Jacquemain, S. Bourdon, Anne de Bremaecker, M. Barrachin "FPT-1 Final Report: vol 1~4", IRSN/DRS/ SEA/PEPF, Dec. 1 2000.