Evaluation of the Charcoal Filter for Removal of I-131 Gas

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1. Introduction

By using the HANARO reactor and Radioisotope Production Facility (RIPF), Korea Atomic Energy Research Institute (KAERI) has produced and supplied Iodine-131 to domestic hospitals and other countries. Because of its short half-life of 8.02 days and useful beta emission, I-131 is used extensively in nuclear medicine. However, exposure to radioactive iodine can cause thyroid problems or cancer of the thyroid. Therefore it should be regulated to prevent the release of radioactive iodine to the environmental atmosphere, and the prevention of even extremely low concentrations of airborne contamination is fundamental to the safe operation of a nuclear facility.

In May 2005, an incident of radioiodine leakage from RIPF of KAERI occurred, and I-131 of which concentration was 0.0017 Bq/L was detected in the rain sample of the vicinity area. The reason of this abnormality was examined carefully. The first reason was that the procedure for the installation of charcoal filter was not obeyed. The halide test which is a prerequisite after replacement of charcoal filter had not been properly conducted. It revealed that the improper installation of the charcoal filters on the filter housing was the main reason. If the halide test was carried out after the replacement of the charcoal filters, this incident might have been prevented.

In order to resolve this problem, the seat of filter housing was adjusted and charcoal filters were replaced with brand-new ones in September 2005. By the halide test, it was confirmed that charcoal filters were properly installed, and the operation of RIPF was resumed in January 2006. Since then, the performance of the replaced charcoal filters have been checked everyday for the preparation against the malfunction of them, and there has been no problem up to now.

In this paper, the procedure for the replacement of charcoal filter and the halide test was reviewed, and the performance record of the charcoal filters was discussed from the nuclear safety point of view.

2. Adsorber In-Place Filter Test

The adsorber in-place filter test (Halide test) is used to verify that there is limited bypass of the installed components, i.e., charcoal filters and their associated mounting frames and housing. However, this test does not give any indication of how well the adsorbent will adsorb radioactive iodides. The standard procedure for the performance of this test may be found in Section 12, ANSI N510 [1].

Nucon F-1000 system which is composed of an electronics main frame, a halide gas generator, and a halide gas detection instrument was employed for the test. The halide challenge gas used for the test was R-11. The summary of test method is as follows. A halide challenge gas is injected into the air-stream upstream of the adsorber bank. Concentrations of R-11 are measured at upstream and downstream of the bank. Percent penetration is determined from the ratio of downstream to upstream concentration. It can be calculated in percentage efficiency by the following formula for the Nucon F-1000 instrument:

$$\% \text{ Efficiency} = 100 - (100 \text{ Cd} / \text{Cu} / \text{C.F.}) \quad \text{--- (1)}$$

where Cd is the concentration of downstream, Cu the concentration of upstream, and C.F. the calibration factor of the instrument.

The halide tests were carried out for all the filter banks of which charcoal filters were replaced. The typical test result is shown in Fig.1. It shows that the efficiency of this filter bank is above 99.95 % which is the acceptance criterion prescribed on ANSI N510. Table 1 summarizes the test results, and it shows that all the filter banks meet the requirement.

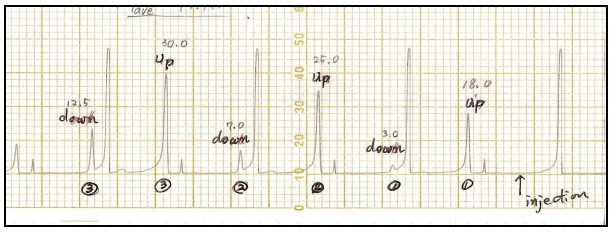

Fig. 1. Halide Concentration chart of upstream and downstream of the adsorber bank.

Table 1. Efficiency of the Filter Bank.

Filter Bank No.	G315	G316	G589	G590
Efficiency (%)	99.95	99.97	99.96	99.97

3. Performance of the Charcoal Filter Bank

KAERI produces I-131 in the hot cell Bank 3 of RIPF,

and the charcoal filter banks of G315/316 and G589/590 are connected to this hot cell to remove the iodine from the downstream. Radioiodine may be in the form of elemental iodine(I_2) or organic iodine compounds, principally methyl iodide(CH_3I). Because the adsorption on activated carbon is the common method for removing radioiodine from gas streams [3], charcoal filter has been installed in the filter banks to adsorb radioiodine gas. Since the production of I-131 was resumed in Bank 3 hot cell of RIPF, dose rate of the filter bank has been checked everyday. Fig. 2 is the trend of dose rates measured by survey meter on the surface of the filter bank. The vertical line on the figure shows the dose rate of the day on which I-131 was produced. It can be seen that all the values for the days marked by vertical lines on the graph are higher than those of other days followed because I-131 adsorbed on the charcoal filter decays as time goes on. This implies that the installed charcoal filter removes I-131 gas well from the downstream of hot cell.

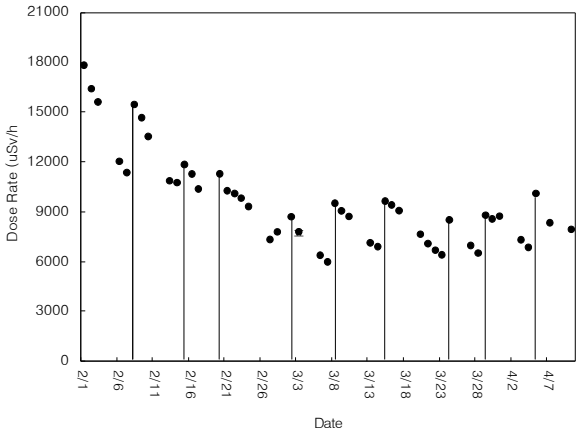

Fig. 2. The dose rate on the surface of the filter bank.

Fig. 3 shows the activity of I-131 in the released gas through the stack of HANARO for the same period as Fig 1. I-131 in the discharge air stream was sampled by the charcoal filter installed in the bypass line of stack, and the concentration was measured by MCA. The released activity was calculated by using the air flow rate through the stack.

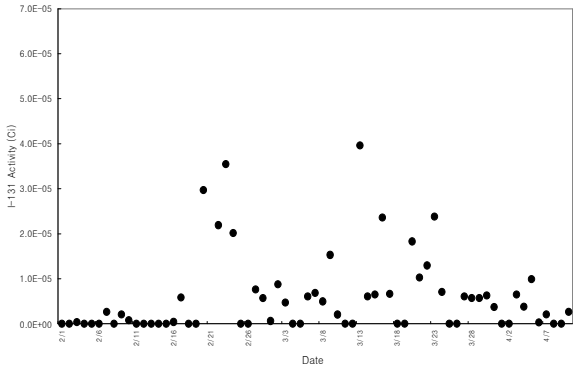

Fig. 3. The activity of I-131 released through stack.

Although the activity of I-131 released for this period does not show any tendency, all the values are very low. Even the highest value is much less than $5x10^{-5}$ Ci which is $2x10^{-4}$ percent of allowable limit value. This result also represents that the replaced charcoal filters work efficiently.

4. Conclusion

After the incident of radioiodine leakage from RIPF of KAERI due to the improper installation of the charcoal filters and the inobservance of the procedure, charcoal filters were replaced and halide tests were carried out. The procedure for the halide test was followed by ANSI N510. Charcoal filters replaced have been checked everyday, and as the result, it can be seen that they remove I-131 gas efficiently from the downstream of hot cell in which I-131 is produced.

REFERENCES

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[3] C.A. Burchsted, J.E. Kahn, A. B. Fuller, Nuclear Air Cleaning Handbook, Design, Construction, and Testing of High-efficiency Air Cleaning Systems for Nuclear Application, Oak Ridge National Laboratory, 1969.