Variation of impurity gas in recovered helium gas for liquid-helium supply and recovery system

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We use recovered helium gas for the liquid-helium supply system. To measure the purity of the recovered helium gas, we introduce a gas chromatography equipment and monitor the recovered gas. We observed the impurities concentration and the recovered helium gas condition for effective operation.[1)] In this study, we report the changes in the concentration of the impurity gases observed in 2022.

The recovered helium was analyzed by SHIMADZU 2014, except on Saturdays and holidays. The data from January 4 to December 28, 2022, is shown in Fig. 1. The left-side axis shows the concentration of N_2 and O_2, and the right-side axis shows that of H_2, CO_2, and CO. The black, gray, red, blue, and green lines correspond to the N_2, O_2, H_2, CO_2, and CO concentrations, respectively.

The fluctuation N_2 concentration was mostly between 1600 to 1800 and O_2 concentration was between 1200 to 1400, almost co-varying with each other. The N_2 concentration is at the same level as that of O_2 from October to December in 2021. The O_2 concentration seems to be slightly higher than that of N_2 2021. We hypothesize that the presence of N_2 and O_2 is due to air entrainment during the recovery process.[1)] However, the ratio of N_2 and O_2 in our analysis is about 0.7 and not the same as 0.25 of the air. The reason for this discrepancy cannot be explicated.

The fluctuation of H_2 concentration was significant. Typically, H_2 concentration stabilized at between 0.1 to 0.2 ppm. The H_2 concentration suddenly increased to 0.5–1.5 ppm on several occasions. However, such a sudden increase in concentration was limited to a single day, and the liquid-helium supply and recovery system was not damaged. The correlation of H_2 concentration fluctuation with that of N_2 and O_2 is unclear. We presume that H_2 impurity intermixed into the recovered helium gas by a different mechanism for N_2 and O_2.

CO_2 was detected almost daily from July to September. CO_2 concentration suddenly increased to 1.2–10 ppm on several occasions. It seems that CO_2 was detected before and after the sudden increase in H_2 concentration. The reason for this phenomenon cannot be explicated. However, CO_2 can be eliminated immediately from the system because the melting point of CO_2 is much higher than that of N_2 and O_2. Therefore, no problem occurred during the operation because of CO_2.

We cannot estimate the concentration of CO impurity because these gases were observed only a few times in this year.

In 2022, we had no serious troubles in the liquid-helium supply and recovery system operations. Especially, our system was not damaged by impurity gases. However, the concentration of impurity gases continued to exhibit chronic elevation. The concentrations of N_2 and O_2 annually become slightly higher. Dealing with such issues will be a critical topic in the near future. Coping with such problems is an important subject in near future.

Reference

1) M. Nakamura *et al.*, RIKEN Accel. Prog. Rep. **55**, 181 (2022).

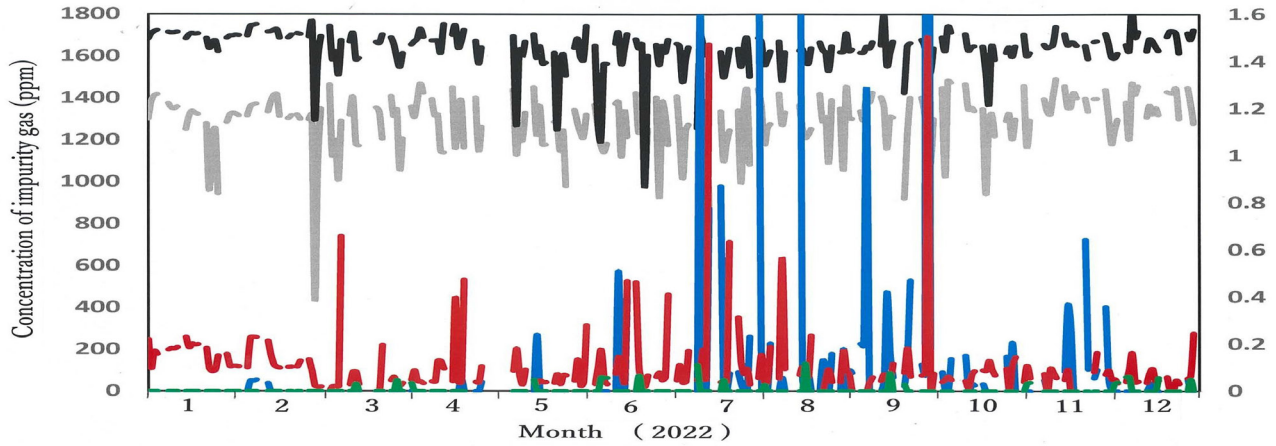

Fig. 1. Impurity concentration in recovered helium gas in 2022.

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