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Preliminary Test of QMS in the Fission Gas Puncturing System for the Post Irradiation Examination in a Hotcell

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1. Introduction

A fission gas release is related to the fuel rod sustainability during reactor operation. Many fuel rods were punctured to measure the amount of fission gas with burnup. After a fuel pin and small fuel rig for R/D were irradiated in a research reactor, a small amount of the fission gas exists in the internal void in a pin and a rig. The laser puncturing technique was developed to solve the measurement of a small amount of fission gas[1]. Moreover, a QMS(Quadruple Mass Spectrometer) was installed in the system for a gas quantitative analysis. This system is good for measuring the total fission gas amount and the contents of each gas element at the same time.

2. Experimental

2.1 Apparatus

A laser puncturing system consists of a puncturing chamber, laser device, and QMS, as shown in Fig. 1. A QMS is capable to measure 1~200 amu of elements in a high vacuum state[2].

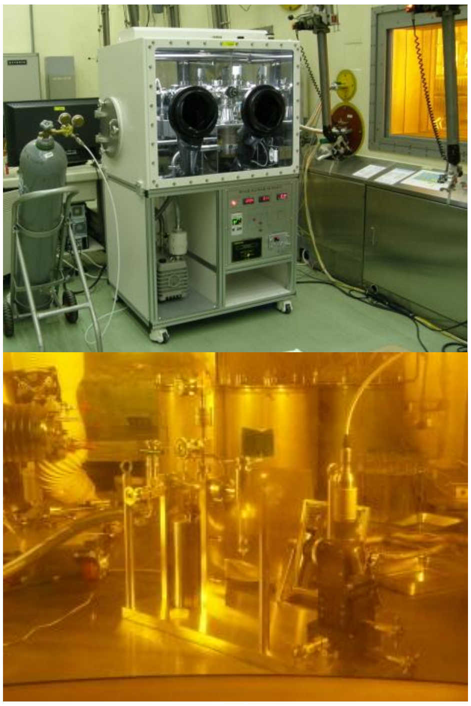

Fig. 1 Laser puncturing system in IMEF

It was installed in a glove-box with a high vacuum pump and a fine controlling valve, as shown in Fig.2. In this study, helium, xenon, and krypton were considered based on the contents of the fission gases.

Fig. 2 QMS in glove-box

2.2 Sample preparations

To check the reliability of a QMS, three standard mixed gases were made; 3%, 5%, and 10% of xenon in a helium base. They were connected to a vacuum line to the QMS chamber. A computer program was activated to check the xenon portions in helium as shown in Fig. 3.

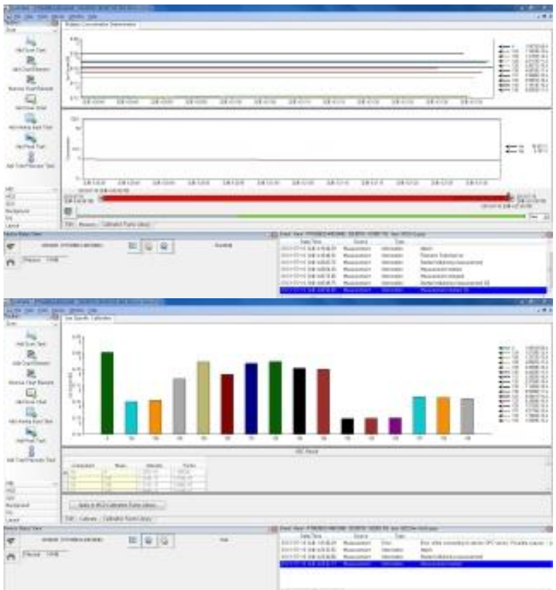

Fig. 3 QMS software with calibration and detection

Two standard gases were prepared: Xe(5%)+Kr(5%) and Xe(45%)+Kr(5%) in helium. Two gases were used to measure portions of Xe and Kr.

First, an ~10^{-7} torr vacuum existed in the QMS chamber, and residual elements (impurities) were checked. One of standard gases flowed in the chamber at 2×10^{-5} torr for calibration. Then, other gases were measured and results are shown in Tables I and II.

Table. I The results of STD gases of Xe(helium base)

Gases	Meas. of (3% of Xe)	Meas. of (5% of Xe)	Meas. of (10% of Xe)
3% of Xe	2.96 %	3.46 %	8.33 %
5% of Xe	3.57 %	5.05 %	11.21 %
10% of Xe	4.55 %	6.09 %	9.9 %

Table. II The results of STD gases of Xe & Kr(helium base)

Gases	Meas. of (Xe-5% & Kr-5%)	Meas. of (Xe-45% & Kr-5%)
Xe-5% & Kr-5%	5.12%(Xe) 4.9%(Kr)	40 %(Xe) 5.5 %(Kr)
Xe-45% & Kr-5%	7.7 %(Xe) 5.99 %(Kr)	44.5 %(Xe) 4.9 %(Kr)

3. Results

One of xenon standard gases was calibrated, and measured. This gas would be good coincidence with the content after measurement. However, two other xenon standard gases had slight errors. Changing the xenon standard gas showed the same results. Xenon-krypton mixed standard gases showed the same results as the three xenon gas tests.

Based on the QMS test with standard gases, the error was in fluctuation depending on the Xe or Kr amounts. This means the contents of the fission gases must be estimated in advance. Several parameters for calibration and optimization must be considered to control the QMS measurement.

4. Conclusions

A QMS was equipped in the laser puncturing system in an IMEF(Irradiated Materials Examination Facility). After laser puncturing of the fuel rod, released fission gases were measured for a quantitative analysis. In particular, helium, xenon, and krypton were considered in fission gases. Standard gases, various contents of xenon and krypton, were measured to check the reliability of the QMS. The all results must be studied with the contents of the fission gases. Standard gas will be prepared according to the contents of the fission gases.

REFERENCES

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[2] Manual of PrismaPlus QMG-220 F2, PFEIFFER vacuum Korea.
[3] Advice of Laser welding company(IPG Photonics).