§2. Observation of Hydrogen, Methane and Carbon Monoxide in an Atmosphere by Trace Reduction Detector and Flame Ionization Detector

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The trend and the variations of atmospheric tritium concentration at Toki site should be understood for the future plasma experiments. Atmospheric tritium mainly consists of three different chemical forms HTO, HT and hydrocarbon like CH_3T. For the monitoring of atmospheric tritium levels at Toki site, there is an accumulation of data acquired through observations of 8 years, 2004 - 2011. As the results, the concentration of tritiated hydrogen [HT] tended to increase in spring. The tritium in the stratosphere, which is produced by nuclear spallation reactions between cosmic rays and air, transports into the troposphere in spring. Then, the level of tritium concentration shall be increased and it calls “spring peak”. The atmospheric tritiated methane [CH_3T] concentration level tended not to vary widely. However, when the sampling term was 1 week, the tritiated methane concentration was about twice than that of the one month sampling. Consequently, this result might indicate the variation of atmospheric tritium concentration with a short term tritium emission.

To investigate the cause of the variation of atmospheric tritium, we focus on the behavior of atmospheric hydrogen isotopes and start to determine the variation of atmospheric hydrogen [H_2], methane [CH_4] and carbon monoxide [CO].

i) Sampling and measurements techniques

Air sample was collected by an auto sampling system at the second flower of plasma diagnostic building in NIFS Toki site. The height of sampling point was about 6 m above local ground. The sampled air was injected to a gas analysis system every 2 hours. The sample gas volume was 2 cm^3. The gas analysis system consists of a gas chromatograph system [GTR tech, G2700TF] and a trace reduction gas analyzer [Round Science Inc., TRD-1]. This system is equipped two detectors. One is a flame ionization detector (FID) for the measurement of methane. Other is a reduction gas detector for the measurement of hydrogen and carbon monoxide. The sampled air are separated over two separation columns [molecular sieves 5A and porapak Q, the length of separation column: 2 m] kept at a temperature of 70^oC. The injection line after gas separation is switched for injection to the preferable detectors. The analytical system is calibrated with standard gas of 1 ppm for hydrogen and methane. Figure 1 shows a typical gas chromatogram spectrum measured by FID and TRD. The gas injection line is switched twice between FID and TRD. The first peak of TRD signal represents hydrogen gas, last peak is carbon monoxide. For FID signal, first peak represents oxygen gas and the following peak is methane gas. These peaks are kept separate one from the other. The concentrations of c.a. 0.6 ppm for hydrogen gas and c.a. 2 ppm for methane gas in atmosphere at Toki are generally observed.

ii) Results of measurements

The variation of methane concentration in air was hardly observed for a specified time. However, hydrogen concentration in air changed considerably, because there was hydrogen gas emission for a certain period by a water electrolytic cell at a location about 8m from sampling point to the south. Hence, we focus on the behavior of carbon monoxide to distinguish whether the variation of hydrogen concentration attributes to the facility or not. It is known that hydrogen and carbon monoxide in atmosphere have a good correlation[1]. The correlation of hydrogen and carbon monoxide is shown in figure 2. It was recognized that the correlation was much different by the presence or absence of hydrogen emission. There is a possibility of being able to assess the environmental impact from nuclear fusion facilities by comparing with the monitoring data of atmospheric hydrogen and tritium.

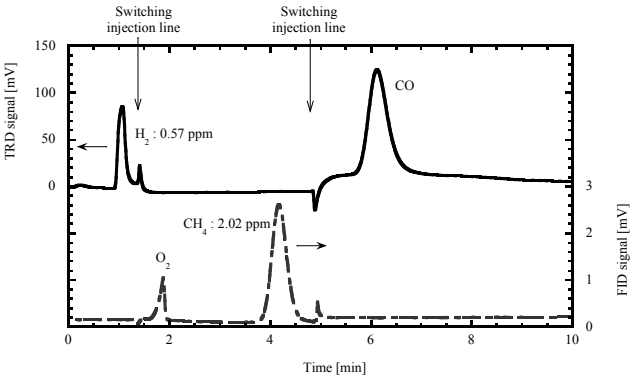

Fig. 1: A typical gas chromatogram spectrum signal from the detectors of FID and TRD.

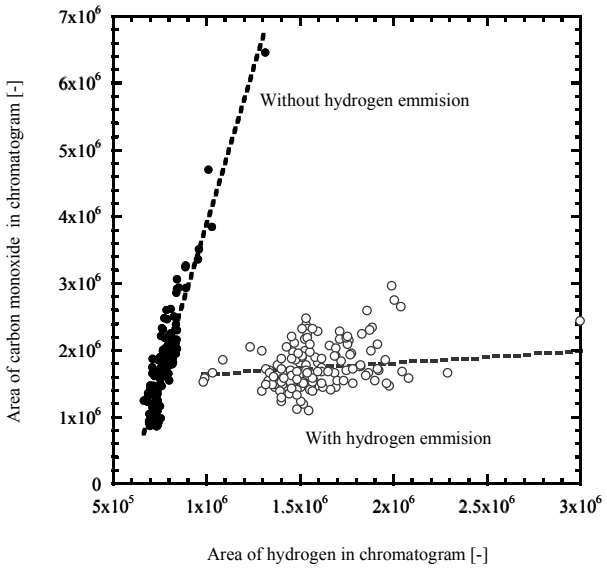

Fig. 2: Correlation of hydrogen and carbon monoxide in air by comparing with the presence (○) or absence (●) of hydrogen emission.

1) Hammer, S., et al., Tellus, 61B, (2009), 547.