§1. Atmospheric Concentration and Deposition Flux of Radionuclides at NIFS Site

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Introduction

Tritium (^{3}H) is the radioisotope of hydrogen and it decays to ^{3}He with a half-life of 12.3 y. Most of tritium as natural origin are produced via nuclear reactions between secondary cosmic rays and N or O atoms in the upper atmosphere. A deuterium plasma experiment is being planned to produce higher-performance plasma at Large Helical Device (LHD). In deuterium experiments, a small amount of tritium will be produced by a fusion reaction, and tritium will be released as gaseous exhaust into the surrounding environment.

Naturally occurring radionuclides are useful tracers for studying processes in the atmospheric environment. Berylium-7 ($T_{1/2}$ = 53.3 d) is a short-lived natural radionuclide produced in the stratosphere and upper troposphere through a spallation reaction of O and N by cosmic rays. Its production rate depends on altitude, geomagnetic latitude and the 11-year period solar cycle. Produced ^{7}Be rapidly attaches to sub-micro size aerosol particles in the upper atmosphere and these are deposited onto the ground. It is expected that natural occurring ^{7}Be and ^{3}H is similar behavior in the environment. Here, we reported atmospheric concentration and deposition flux of ^{7}Be at Toki area.

Materials and Methods

The sampling site was located on the building of National Institute for Fusion Science (NIFS). We collected monthly total atmospheric aerosols and bulk deposition since October 2013. Total atmospheric aerosol samples were collected using high-volume air sampler (HV-100F, SIBATA, Japan) with quartz fiber filter (QR-100, ADVANTEC, Japan). Flow rate is 1000L min^{-1}. Bulk atmospheric deposition samples, each a mixture of wet and dry depositions, were collected by using large polyethylene basin that had open surface area of 0.178 m^2. From July 2000 to March 2006, samples were collected every 15–18 days with a single basin; from April 2006 to March 2011, samples were collected monthly with four basins; and from April 2011 to the end of the sampling period, samples were collected monthly with basin. The collected deposition samples were passed through a column holding a mixture of Powdex PAO and PCH resins (Ecodyne Co., USA) to separate ionic radioactivity together with particulate one from the sample. The homogenized resin was dried, and then it was packed into a plastic case. The concentrations of ^{7}Be was determined by using germanium detectors (GX-3018, Canberra, USA). The counting efficiency of the detectors was calibrated by using standard radioactive sources (MX033U8PP, Japan Radioisotope Association, Tokyo). Measured values were corrected for radioactive decay to the middle day of the sampling period.

Results and discussion

Figure 1 show the seasonal variation of atmospheric concentration and deposition flux of ^{7}Be collected at Toki site. Atmospheric concentration of ^{7}Be in this sampling period ranged from 2.06 to 5.33 mBq m^{-3} with mean value (±Standard Deviation; S.D.) of 4.19±0.93 mBq m^{-3}. And they are low in summer, and high in other seasons. Some recent atmospheric ^{7}Be concentration in Japan have been reported in the literature. Akata et al. (2008) [1] summarized as Table. Our results were comparable to the other reported values. Monthly atmospheric deposition of ^{7}Be ranged from 71.0 to 281.6 Bq m^{-2} with mean value of 150.5±70.7 Bq m^{-2}. Akata et al. (2015) [2] reported that monthly ^{7}Be deposition at Rokkasho, Aomori ranged from 57 to 513 Bq m^{-2}. Our results were similar to the reported values. This deposition pattern is high in summer and low in other seasons. Our results are only about one year. In order to clarify the background level and natural trend, long-term continuous monitoring is important. In future plan, we surveyed atmospheric concentration and deposition flux of radionuclides at NIFS site to understand the background level.

[1] Akata et al., Journal of Radioanalytical and Nuclear Chemistry, 277 (2008) 347-355.
[2] Akata et al., Journal of Radioanalytical and Nuclear Chemistry, 303 (2015) 1217-1222.

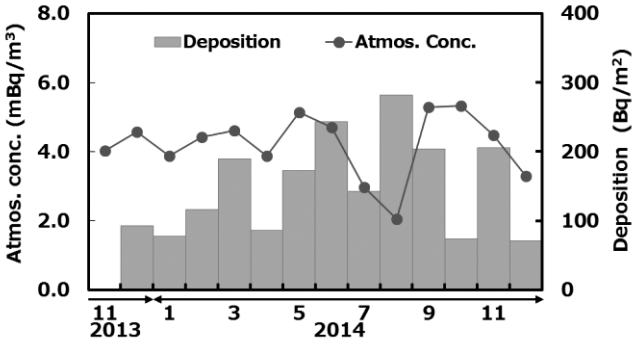

Fig. 1 Seasonal variation of atmospheric concentration and deposition flux of ^{7}Be collected at Toki site.