Development of Measurement Method of Gaseous Boron and Selenium Compounds in Flue Gases

Background

Recent studies clarified that boron and selenium are partitioned into gas and ash particles in flue gas, and this partition ratio depends on coal properties and combustion conditions. Therefore, it is necessary to measure these trace elements included in both the gas and the particle. However the official measurement method of gaseous boron has not been established yet. On the other hand, although the official measurement method *1 of gaseous selenium is established, that method is not clear the adaptability to flue gas. The development of high accuracy and practicable measurement for gaseous boron and selenium is important to ensure the monitoring and application of future reduction strategies.

Objectives

The purpose of this study is to develop an advanced sampling and analysis method of gaseous boron in flue gases and to clarify the adaptability of the official gaseous selenium method to flue gases.

Principal Results

1. The development of the gaseous boron measurement method

(1) Repeatability of the sampling method was tested using HNO_3/H_2O_2 absorbent. The recovery rates of boron were 100±2% in the simulated coal combustion flue gas (Fig.1). Sampling loss caused by the sampling system was made small by keeping the tubing temperature at 407K.

(2) The measurement method (Fig.2) was also applied to an actual coal flue gas. The flue gas was sampled at 407K for five times at the same combustion condition. The result showed very good repeatability, where the average concentration was 2.81 mg/m^3 and the relative standard deviation of measurements was 0.014 mg/m^3 (Fig.3).

(3) We proposed the developed measurement method of gaseous boron to ISO (International Organization for Standardization)

2. The adaptability of the official method of gaseous selenium to flue gases

The recovery rate of gaseous selenium measured with the official method was about 25% in flue gases. It was found that the main reason for low recovery rate was the sticky selenium adhered to the internal surface of tubing. The amount of sticky selenium recovered by the method to analyze selenium in solid material was shown in Fig.4. To improve the accuracy of the measurement, it was found that the development of recovery method of sticky selenium is important.

Incidentally, this study was carried out as research funded from NEDO (New Energy and Industrial Technology Development Organization).

Future Developments

The developed measurement method of gaseous boron will be proposed to JIS (Japanese Industrial Standard). Furthermore, the recovery method of selenium adhered to a sampling tube will be established, and the development of advanced sampling and analysis method of gaseous selenium will be performed.

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Reference

N. Noda, et al., 2009, “The development of advanced sampling and analysis of gaseous trace elements”, NEDO annual report (in Japanese)

*1 : JIS K 0083 and EPA method 29

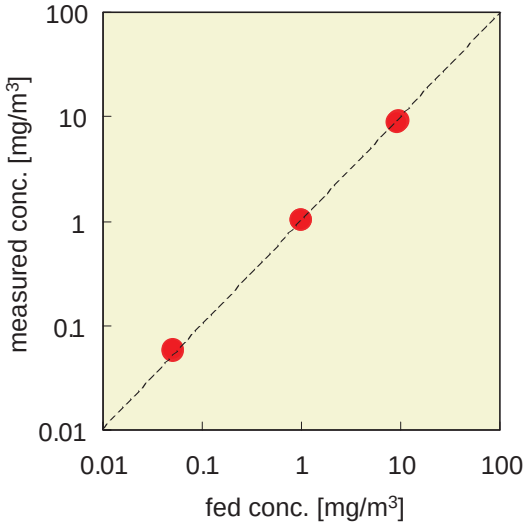

Fig.1 Accuracy of gaseous boron measurement using HNO_3/H_2O_2 absorbent in a simulated flue gas

The measurements agree with the feeds, and the measurement method has very high accuracy in the necessary range.

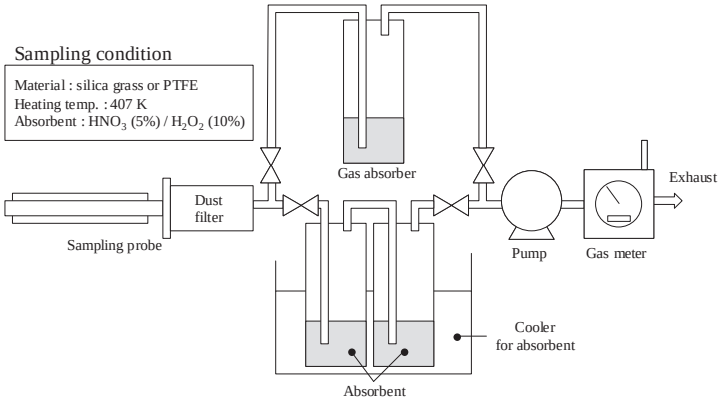

Fig.2 Schematic diagram of sampling system for gaseous boron in combustion flue gases

The sampling conditions such as heating temperature of sampling tube, an absorbent for gaseous boron etc. are optimized.

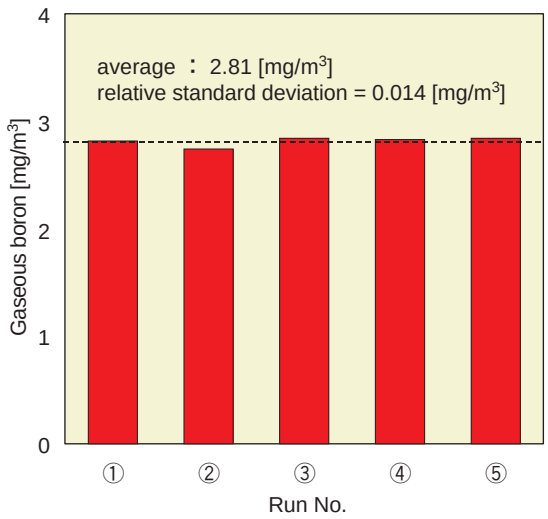

Fig.3 Repeatability of gaseous boron measurement in an actual coal combustion gas

The developed measurement method has very good repeatability in an actual coal combustion gas.

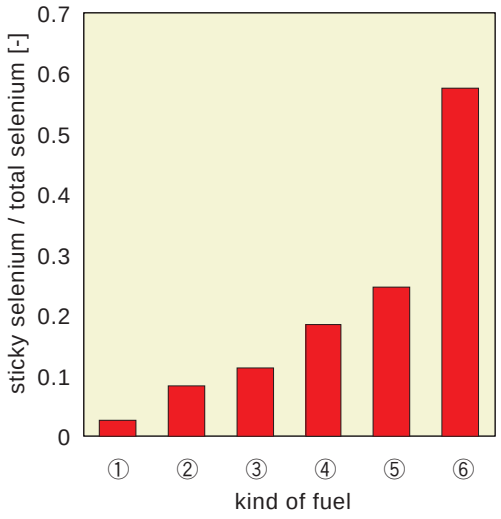

Fig.4 The rate of sticky selenium in sampling tube

The rate of sticky selenium in sampling tube changes widely according to the kind of fuel.