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TOC-L Total Organic Carbon Analyzer + SSM-5000A Solid Sample Combustion Unit

Application News

# Measuring the Carbon Content in Fly Ash

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## User Benefits

- The TOC solid sample measurement system can easily quantitate the carbon contained in fly ash by measuring the total carbon (TC) and inorganic carbon (IC) content.
- By using oxygen as the carrier gas to promote the combustive oxidation reaction, unburned carbons in the samples can be efficiently combusted to evaluate the total carbon content.

## ■ Introduction

In coal-fired power plants, finely ground coal powder is burned in a boiler, but this combustion process generates large quantities of coal ash. Most of the coal ash consists of fine spherical particles called fly ash, which are collected in an electric dust collector. Because the principal components of fly ash are silica and aluminum, fly ash is commonly mixed with cement and other products to increase durability and watertightness. Since the spherical particles increase fluidity during the concrete construction process, fly ash is often used as an admixture for concrete. Therefore, a variety of parameters are measured for quality control purposes. One of which is the quantity of unburned carbon.

This article describes an example of using the TOC solid sample measurement system to measure the quantity of unburned carbon contained in fly ash.

## ■ TOC Solid Sample Measurement System

The TOC solid sample measurement system (Fig. 1), which consists of TOC-L total organic carbon analyzer combined with SSM-5000A solid sample combustion unit, quantitates the carbon content in solid samples by detecting the carbon dioxide generated from either combustive oxidation or acidic dissociation of carbonate. For total carbon (TC) measurements, samples are oxidized by combustion at 900 °C in a high-temperature furnace to measure the total quantity of carbon. For inorganic carbon (IC) measurements, samples are acidified with phosphoric acid and then heated to 200 °C to extract carbon dioxide and measure the quantity of carbon derived from carbonate. Neither measurement requires any complicated sample pretreatment steps, so measurement operations are quite simple. Furthermore, samples can be measured very quickly, with only about 10 minutes required for measuring TC and about 8 minutes for measuring IC.

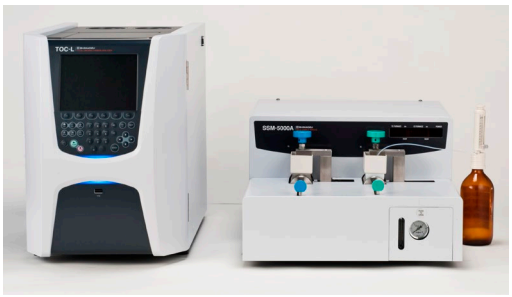


Fig. 1 TOC Solid Sample Measurement System

## ■ Analysis Method

In this example, two types of fly ash were prepared as samples. The analysis methods are shown in Fig. 2. About 70 mg of the samples were weighed on the sample boats. For TC measurements, the sample boat was placed in the TC sample port and then inserted into the TC furnace at 900 °C for measurement. For IC measurements, the sample boat was placed in the IC sample port with phosphoric acid dropped onto the sample by a specialized dispenser. Next the sample was inserted into the IC furnace at 200 °C to measure the IC content. The measurement conditions are listed in Table 1.

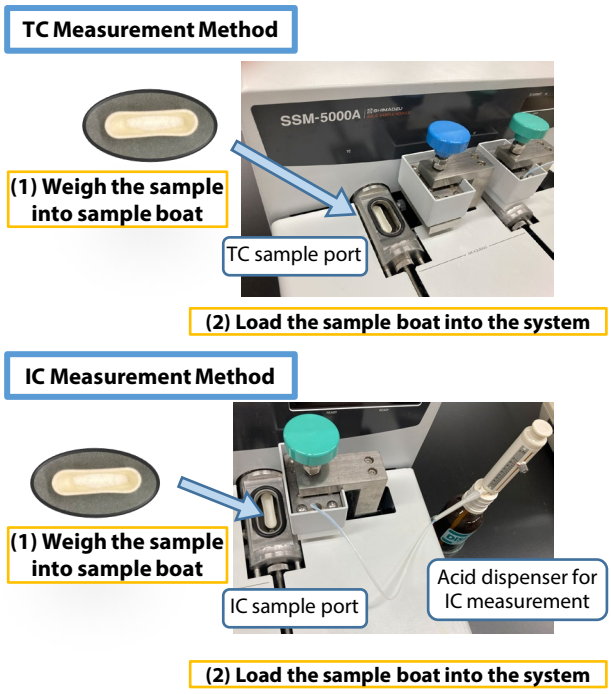



Fig. 2 Analysis Methods (Samples Shown are Standard Substances for Calibration Curve Measurements)

Table 1 Measurement Conditions

| | |
|---|---|
| Analyzer: | TOC solid sample measurement system (TOC-$L_{CPH}$ total organic carbon analyzer + SSM 5000A solid sample combustion unit) |
| Cell Length: | Short |
| SSM Carrier Gas: | 500 mL/min oxygen gas |
| TC Measurement Method: | Combustive catalytic oxidation (TC furnace at 900 °C) |
| IC Measurement Method: | Acidification by phosphoric acid (IC furnace at 200 °C) |
| Measurement Parameters: | TC (total carbon) and IC (inorganic carbon) |
| Calibration Curves: | TC: 1-point calibration curve using glucose powder reagent<br>IC: 1-point calibration curve using sodium carbonate powder reagent |
| Samples: | 2 types of fly ash |

## ■ Calibration Curve

The analyzer was calibrated using calibration curves prepared with a glucose powder reagent (40.0 % carbon concentration) for TC measurements and sodium carbonate powder (11.3 % carbon concentration) for IC measurements. The respective calibration curves are shown in Fig. 3.

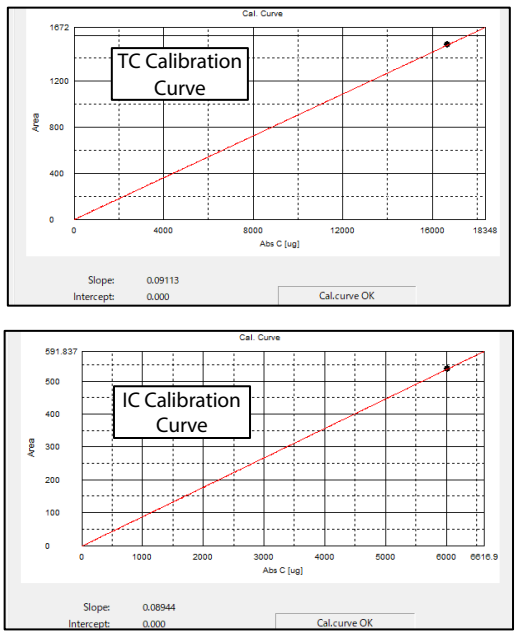


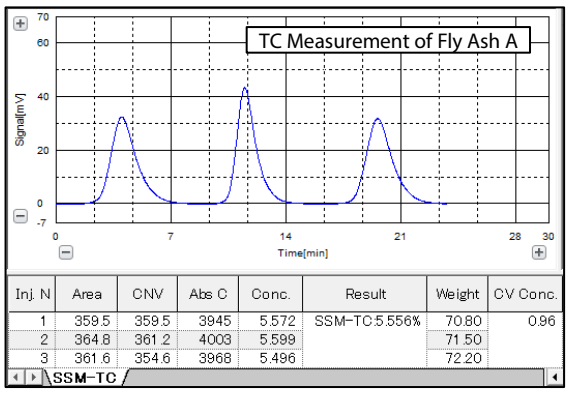

Fig. 3 Calibration Curves

## ■ Measurement Results

The results of the TC and IC measurements of fly ash are listed in Table 2. The corresponding measurement data is shown in Fig. 4. The results show that the two types of fly ash have different TC concentrations. Since the coefficient of variation for respective TC measures was 2 % or less, that indicates the total carbon concentration in the fly ash samples was measured with good accuracy. The IC concentration was zero in both samples, so neither sample contained any carbon derived from carbonate.

Table 2 Measurement Results

| Sample Name | TC Conc. (%) | IC Conc. (%) |
|---|---|---|
| Fly Ash A | 5.56 | 0.0 |
| Fly Ash B | 1.35 | 0.0 |



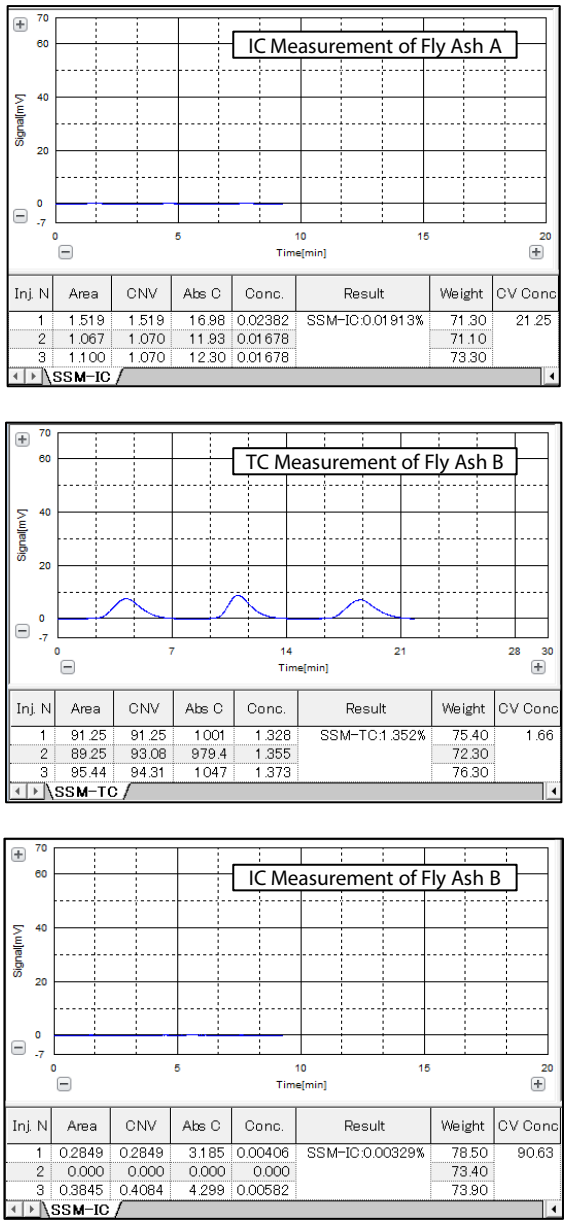




Fig. 4 Sample Measurement Data

## ■ Conclusion

This example shows that the TOC solid sample measurement system can be used to accurately measure the concentration of unburned carbon in fly ash. That means the TOC solid sample measurement system can be used for quality control of fly ash. Also, please refer to Application News No. 01-00325-en, which describes using the TOC solid sample measurement system to evaluate the quantity of $CO_2$ that was absorbed in concrete made with fly ash as an admixture.

Carbon can be difficult to detect and quantitate if X-ray fluorescence is used to measure the concentration of all the elements in fly ash. However, using the carbon concentration values measured by the TOC solid sample measurement system, the concentrations of all elements can be accurately determined.

01-00622-EN First Edition: Nov. 2023

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