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Application News

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

Evaluating the Carbonation of Concrete by TOC Solid Sample Measurement System

A. Goto

User Benefits

- The amount of calcium carbonate in concrete can be measured quickly and easily by measuring inorganic carbon (IC) using the TOC solid sample measurement system.
- Up to 1 g of a sample can be measured, reducing the impact of sample maldistribution.
- Quantitation enables numerical evaluation of slight differences in state, unlike evaluation by typical visual observation using phenolphthalein.

■ Introduction

In modern society, concrete is an indispensable material for public works and construction. It is applied to a variety of projects including buildings, roads, and tunnels. Concrete is obtained by mixing and hardening cement, aggregates, and water, so it is very sturdy, but can deteriorate for a variety of reasons including voids and cracks. One of the greatest causes of deterioration is known to be carbonation. Concrete contains a large amount of calcium, so it is normally strongly alkaline. However, when it absorbs carbon dioxide from the air, it turns into calcium carbonate, and gradually becomes neutralized. For this reason, in studying how to improve concrete products and in materials development, it is important to reliably assess the amount of calcium carbonate in materials in order to quantitatively evaluate carbonation. This article introduces an example of the evaluation of the carbonation of a standard sample of cement, which is a component of concrete, by evaluating the amount of inorganic carbon (IC) using the TOC solid sample measurement system in Fig. 1.

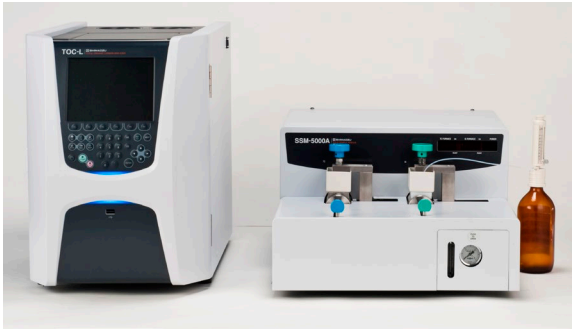


Fig. 1 TOC Solid Sample Measurement System

■ Analysis Method

In this experiment, a standard sample of powdered cement was prepared. IC measurements were performed on the sample just after it was unsealed, and after leaving it undisturbed but exposed to the air for approximately 3 months. As shown in Fig. 2, approximately 50 to 100 mg of the sample was weighed into the sample boat, and it was then mixed with 0.1 mL of pure water. Next, the sample boat was placed on the sample port, phosphoric acid for IC measurement was added using a special dispenser, after which it was loaded into the IC furnace, and the IC was measured. The measurement conditions are shown in Table 1.

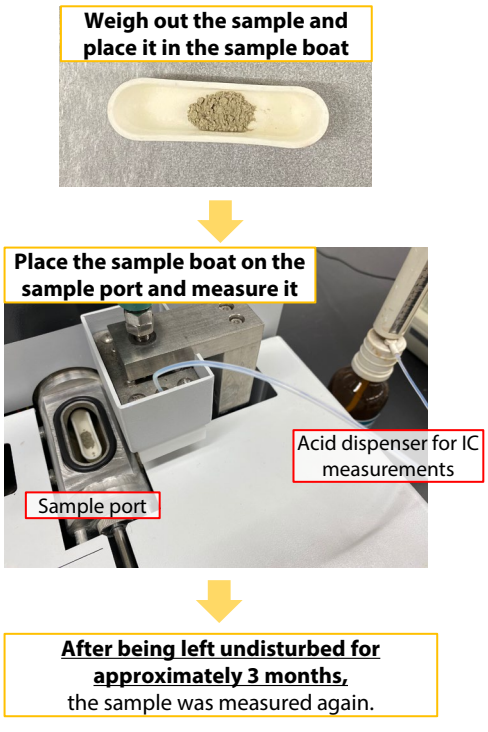


Fig. 2 Analysis Method

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 cell
SSM Carrier Gas:	500 mL/min oxygen gas
IC Measurement Method:	Extraction of carbon dioxide by phosphoric acid acidification (IC furnace 200 °C)
Measurement Items:	Inorganic carbon (IC)
Calibration Curve:	Single point calibration curve using powdered sodium carbonate reagent
Sample:	Standard cement sample (commercial cement)

■ Calibration Curve

To calibrate the analyzer, a powdered sodium carbonate reagent (11.3 % carbon concentration) was placed in a sample boat. A calibration curve was created by measuring the IC. The measurement data is shown in Fig. 3.

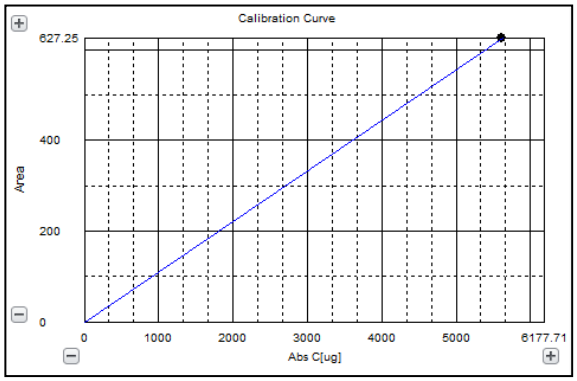


Fig. 3 Calibration Curve Measurement Data

■ Measurement Results

The measurement results for the standard cement sample are shown in Fig. 4, and the measurement data is shown in Fig. 5. The IC concentration was below the quantitative lower limit in the standard cement sample immediately after it was unsealed, so the concentration value could not be quantitated. In contrast, when the sample left undisturbed for approximately 3 months was measured, the IC concentration was 1.005 %, indicating that the IC concentration had increased significantly compared with immediately after it was unsealed. This was likely due to absorption of carbon dioxide in the air through contact of the unsealed sample with the air. Note that the coefficient of variation was 2 % or less. when the measurement was repeated, indicating favorable repeatability.

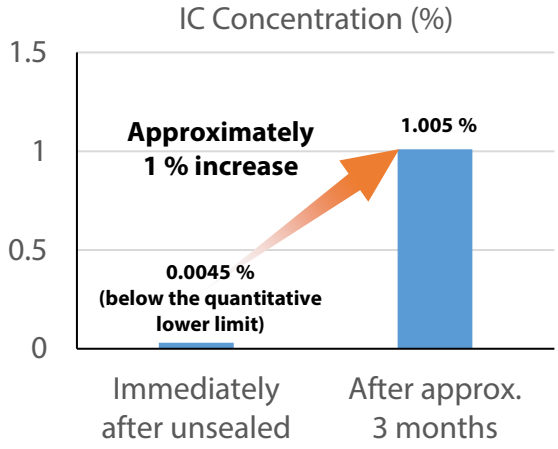
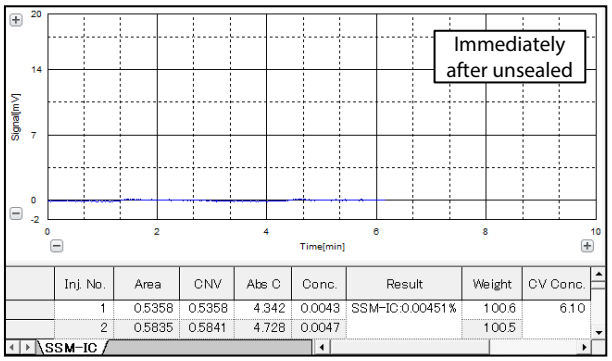


Fig. 4 Measurement Results



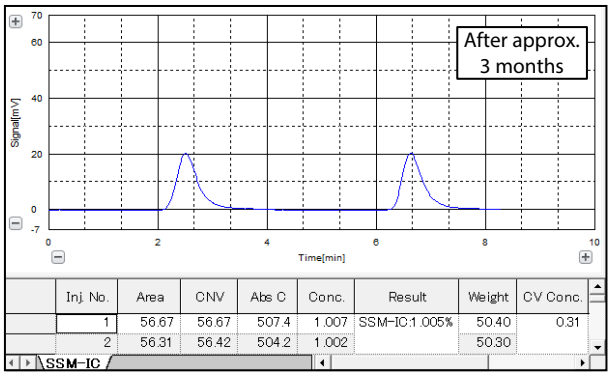


Fig. 5 Sample Measurement Data

■ Conclusion

In this article, the inorganic carbon (IC) in a standard cement sample was measured using the TOC solid sample measurement system. The sample contained almost no IC immediately after it was unsealed. However, when the sample was left undisturbed but exposed to air for approximately 3 months, it absorbed carbon dioxide from the air, and the IC concentration increased to approximately 1 %. In this way, it was possible to quantitatively check the change in the amount of carbonate in cement over time.

Note that this system can be used to measure either the total carbon (TC) or inorganic carbon (IC), enabling the determination of total organic carbon (TOC) from the difference. Refer to Application News No. O56, which introduced an example of the measurement of TOC in a cement admixture in pulverized concrete.

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