

Evaluation of the Quantity of CO₂ Emitted by Combustion of Paper Products

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User Benefits

- ◆ The quantity of CO₂ emitted by the combustion of paper samples can be quickly and simply measured.
- ◆ Using oxygen as the carrier gas enhances the combustion oxidation reaction, and the organic compounds in samples can be burned with high efficiency.
- ◆ The quantity of carbon in solid samples can be measured with good accuracy.

Introduction

Global warming, a worldwide environmental problem, is caused by the increase in greenhouse gases in the atmosphere. In response, research is being promoted into reducing the emissions of CO₂, one of the greenhouse gases.

Paper is made from wood, and CO₂ is emitted in each stage of the lifecycle of paper products, from manufacturing to disposing and recycling. Research is being conducted to reduce these emissions by developing paper products with low CO₂ emissions. Therefore, it is particularly important to determine the quantity of CO₂ emitted in the combustion of paper products during their disposal.

The solid sample measurement system consisting of the Shimadzu TOC-L Total Organic Carbon Analyzer and the SSM-5000A Solid Sample Combustion Unit measures the quantity of carbon contained in solid samples. This article provides an example of how this solid sample measurement system evaluates the quantity of CO₂ emitted during combustion by measuring the quantity of carbon in paper products.

TOC Solid Sample Measurement System

The solid sample measurement system, which consists of the Shimadzu TOC-L Total Organic Carbon Analyzer and the SSM-5000A Solid Sample Combustion Unit (Fig. 1), measures the total quantity of carbon (TC) in a solid sample by heating it to 900 °C and then measuring the CO₂ generated in the combustion. This enables simple and rapid analysis of the TC without requiring laborious pretreatment process.

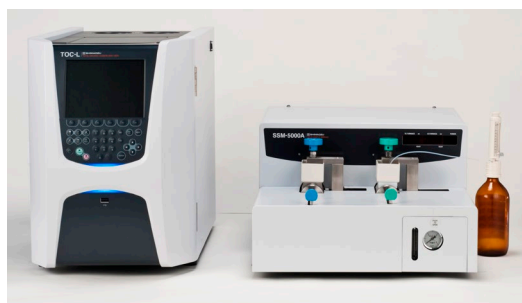


Fig. 1 TOC Solid Sample Measurement System

Analysis Method

Three types of commercial paper products were prepared as measurement samples. The samples were cut into pieces about 0.5 cm × 2 cm, and 1-5 pieces were placed on a sample boat and weighed (Fig. 2). To prevent dispersion of a sample during combustion, heat-treated ceramic fiber was placed over it, and it was set in the TC sample port of the SSM-5000A and then inserted into the TC electric furnace, where the TC was measured (Fig. 3). The measurement conditions are shown in Table 1.



Fig. 2 Paper Samples Placed on a Sample Boat

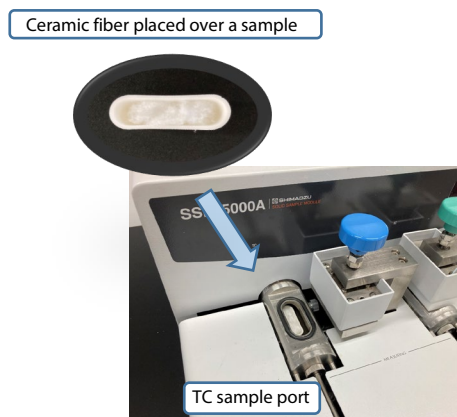


Fig. 3 Analysis Method

Table 1 Measurement Conditions

Analyzer:	TOC Solid Sample Measurement System (Total Organic Carbon Analyzer TOC-L _{CPH} + Solid Sample Combustion Unit SSM-5000A)
Cell Length:	Short cell
SSM Carrier Gas:	500 mL/min oxygen gas
TC Measurement Method:	Combustion catalytic oxidation
TC Furnace Temperature:	900 °C
Measurement Item:	TC (total carbon)
Calibration Curve:	One-point calibration curve using a glucose powder sample (carbon concentration 40.0 %)
Samples:	Commercial paper products (high-quality paper, coated paper, and glossy paper)

■ Calibration Curve

The instrument was calibrated using a glucose powder reagent (carbon concentration 40.0 %) as the standard substance. The glucose was sampled on a sample boat, and by measuring its TC, the calibration curve was produced. The calibration curve data is shown in Fig. 4.

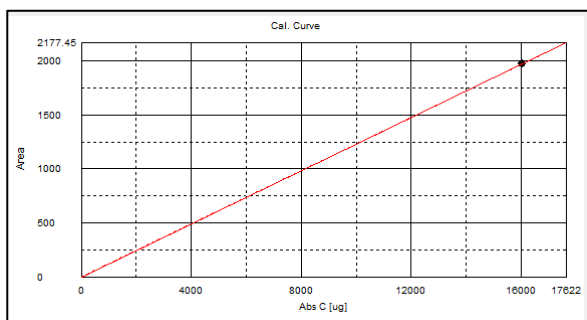


Fig. 4 Calibration Curve Data

■ Measurement Results

The TC concentration results obtained by measuring the three types of paper products are shown in Table 2, and the measurement data is shown in Fig. 5. It can be seen that each product has a different TC concentration. The function of coated paper is to look aesthetically pleasing by having a smooth surface, while the high absorption of ink on glossy paper produces a glossy quality. As a result, the carbon content in the paper products is different, which is probably why the TC concentrations were also different. Furthermore, it can be seen that the coefficient of variation in each of the measurements is less than 2 %, so the paper samples could be measured with good accuracy.

Table 2 Measurement Results

Sample Name	TC Concentration (%)	Coefficient of Variation
High-quality paper	40.7	1.19
Coated paper	39.2	1.35
Glossy paper	51.1	0.18

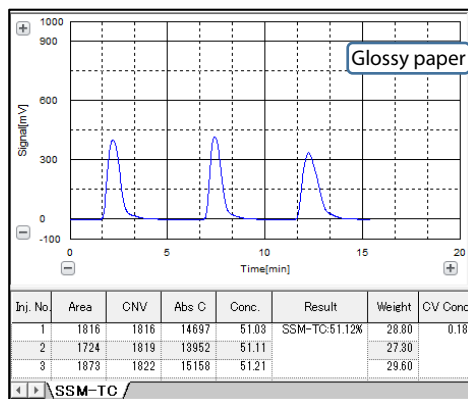
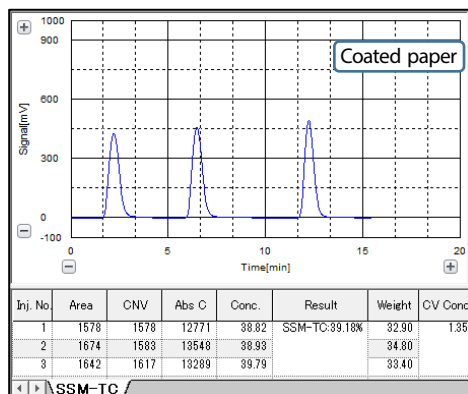
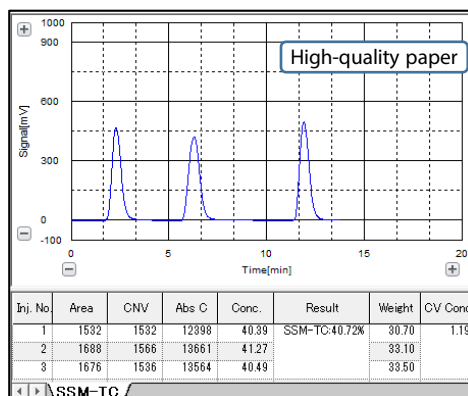


Fig. 5 Sample Measurement Data

■ Conclusion

It was shown that the TC in paper products can be obtained using the TOC solid sample measurement system, and, therefore, the quantity of CO₂ emitted by combustion can be evaluated from the quantity of carbon in the paper products. It is also expected that the TOC solid sample measurement system can be used in experimental research into reducing CO₂ emissions from not only paper products but various other types of products.