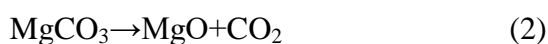


## Total Carbon in Raw Meal (Farin) Sample

### Introduction

Emissions of carbon dioxide (CO<sub>2</sub>) in cement production processes can be classified in two categories as direct and indirect emission. The direct CO<sub>2</sub> emissions mainly include the CO<sub>2</sub> emissions from chemical reactions in the cement production process (mainly from limestone calcination) and the CO<sub>2</sub> emissions from fossil fuel use for cement production [1]. Electricity consumption for cement production mainly causes indirect CO<sub>2</sub> emissions [2]. Fossil fuel combustion and electricity consumption cause direct and indirect CO<sub>2</sub> emissions, respectively. However, these emissions are usually considered as energy-related CO<sub>2</sub> emissions [1]. On the other hand, calcination reaction in the cement production process are usually called cement process CO<sub>2</sub> emissions. Calcination of calcium carbonate (CaCO<sub>3</sub>) and magnesium carbonate (MgCO<sub>3</sub>), as in the reactions 1 and 2, in raw meal cause mainly CO<sub>2</sub> emissions. [3]



Cement production is a major source of CO<sub>2</sub> emissions in many countries and the estimation of the CO<sub>2</sub> emissions from

cement production has attracted important attention. This carbon dioxide emissions can be calculated by using detailed input method based on analysis of the CO<sub>2</sub> released from total carbon (TC) of raw meal [4]. This application note reports total carbon (TC) results of raw meal samples which provides calculation of carbon dioxide (CO<sub>2</sub>) emissions of cement process.

### Principle of operation

Samples were dried in an oven at 95 °C over a night and then total carbon (TC) measurements were made with [TRL-CN analyzer](#) by HTCO method under the following conditions.

**Table 1: Analysis Parameters**

| Parameters                 | Total Carbon (TC) |
|----------------------------|-------------------|
| <b>Decomposition</b>       |                   |
| <b>furnace temperature</b> | 1100 °C           |
| <b>Catalytic</b>           |                   |
| <b>furnace temperature</b> | 500 °C            |
| <b>Air pressure</b>        | 2 bar             |
| <b>Air flow rate</b>       | 3 L/min           |
| <b>NDIR gas flow rate</b>  | 100 mL/min        |
| <b>Detector</b>            | NDIR              |

**TC Analysis:** Samples were carefully weighed in to quartz sample boat without any pretreatment and weights of the samples were input to the Trl-CN software. Quartz sample boats with compost samples were placed in the sample loading car. The sample was automatically moved into the decomposition reactor with the starting of the analysis. The total carbon concentrations of the sample was then calculated against the calibration curves created before.

### Results

TC results and RSD values are shown in table 2.

**Table 1:** TC results

| Repeat Number | Sample Size (mg) | TC Results (%) | Rsd (%) |
|---------------|------------------|----------------|---------|
| 1             | 300              | 9.50           | 2.28    |
| 2             | 303              | 9.08           |         |
| 3             | 301              | 9.24           |         |

### Conclusions

In this study, total carbon in raw meal sample of a cement plant were analyzed with [Trl-CN analyzer](#). The results showed high repeatability and reasonable RSD value with 2.28 %. Although complete decompositon of carbonates is complex, [Trl-CN analyzer](#) achieved to analyze TC content of raw meal samples with high sample loading and high repeatability. On the other hand, decomposition furnace

temperature of Trl-CN were set to 1100 °C which provides simple and fast TC analysis of carbonates even high sample size.

### References

[1]: CSI (Cement Sustainability Initiative), 2005. CO2 Accounting and Reporting Standard for the Cement Industry, Version 2.0. < <http://www.wbcdcement.org> >

[2]: Ke, J., Mcneil, M., Price, L., Khanna, N. Z., & Zhou, N. (2013). Estimation of CO2 emissions from China’s cement production: Methodologies and uncertainties. *Energy Policy*, 57, 172-181. doi:10.1016/j.enpol.2013.01.028

[3]: Einstein, D., Worrell, E., & Khrushch, M. (2001). Steam systems in industry: Energy use and energy efficiency improvement potentials. Proceedings of the 2001 ACEEE Summer Study on Energy Efficiency in Industry, 1, 535– 548 Tarrytown, NY, July 24–27th, 2001

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