

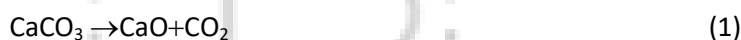
## APPLICATION NOTE

### INDUSTRIAL APPLICATIONS

#### Total Carbon In Raw Meal

##### 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.<sup>[1]</sup> Electricity consumption for cement production mainly causes indirect CO<sub>2</sub> emissions.<sup>[2]</sup> Fossil fuel combustion and electricity consumption cause direct and indirect CO<sub>2</sub> emissions, respectively. However, these emissions are usually considers as as energy-related CO<sub>2</sub> emissions.<sup>[1]</sup> 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.<sup>[3]</sup>



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.<sup>[4]</sup> 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 under the following conditions for raw meal samples .

**Table 1:** TC Analysis Parameters

Parameters	Total Carbon (TC)
Method Mode	TC High Mode
Sample furnace temperature	1100 °C
Catalyst furnace temperature	500 °C
Air pressure	2 bar
Carrier gas flow	3000 mL / min
Analyzer gas flow	100 mL / min

**TC Analysis:** Pre-weighed samples were put in to quartz combustion boat which is inserted in to TC decomposition furnace automatically with sample loading car when analysis start.

## Results

TC results and RSD values were shown in table 2.

**Table 2:** TC Results

Repeat Number	Sample Size	Raw Data	TC Results (%)	Average TC Results(%)	Rsd (%)
1	300 mg	124.367	9.5	9.28	2.28
2	303 mg	120.497	9.081		
3	301 mg	121.718	9.244		

## 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 %. According to TC result 9.28 %, CO<sub>2</sub> emission of the plant can be calculated. Although complete decomposition 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.

## References

- [1]: CSI (Cement Sustainability Initiative), 2005. CO<sub>2</sub> 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 CO<sub>2</sub> 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
- [4]: Select a Method for Determining CO<sub>2</sub> Emissions from Calcination. (n.d.). Retrieved May 06, 2016, from [http://www.cement-co2-protocol.org/v3/Content/Internet\\_Manual/tasks/select\\_calcination\\_CO2\\_method.htm](http://www.cement-co2-protocol.org/v3/Content/Internet_Manual/tasks/select_calcination_CO2_method.htm)