95 cm x 110 cm

Development of a Novel Process for the Production of Calcium Sulfoaluminate

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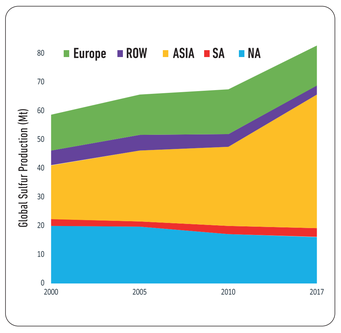
Motivations



The surplus of elemental sulfur from **the oil and gas industry** has become a major global challenge.

To deal with the scale of this overproduction, new uses must be found in products which are produced on an equally massive scale.

~8%

of global CO_2 emissions from the **Cement Industry**

The cement sector is required to make drastic changes to mitigate increasing demands.

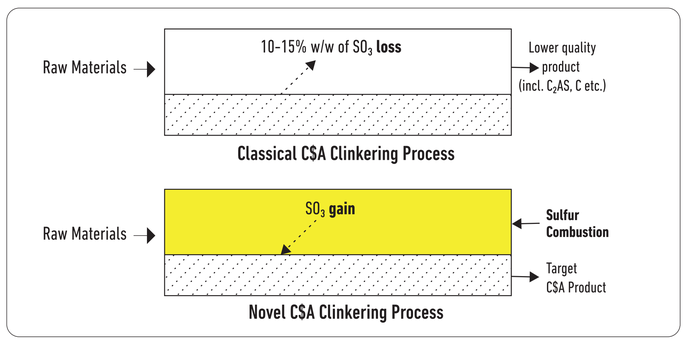
Calcium Sulfoaluminate (C$A) cements are attractive from an environmental perspective as they have considerably lower raw-material and fuel-derived CO_2.

Proposed Solution

Herein, a novel process for C$A production is proposed whereby SO_3 is completely/partly supplied through the **combustion of sulfur**. The objective of introducing elemental sulfur is twofold:

i. as a fuel, reducing the need for hydrocarbon fuels and thereby lowering carbon dioxide emissions

ii. to supply the SO_x necessary to synthesise the desired clinker mineralogy while avoiding sulfur volatilisation.



Process Economics

C$A cements have a lower carbon footprint relative to OPC (Figure 3). However, they require an extra source of aluminium oxide which has an important effect on process economics (Figure 4). Using a life cycle assesment, our first estimation of CO_2 avoidance costs is below 30 USD per tonne of CO_2 eq.

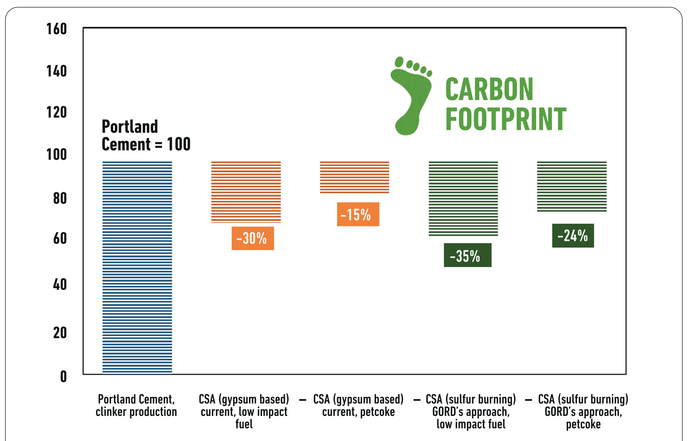


Figure 3: Relative carbon footprint of C$A cements

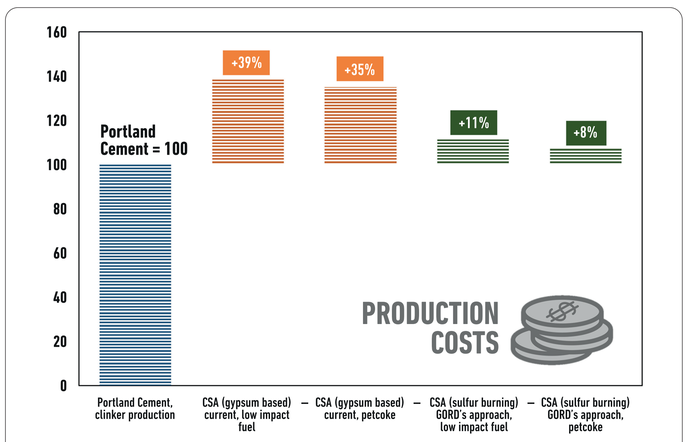


Figure 4: Relative production costs of C$A cements

Pilot Scale Trials

Following investigations conducted at lab scale for the synthesis C$A clinker in SO_x containing atmospheres, a series of pilot trials were conducted using a direct fired rotary kiln at IBU-Tec AG (Figure 1). Results from the latest pilot trials in August 2018 (Table 1) showed successful control of kiln conditions which achieved satisfactory SO_3 sequestration into the clinker solids with minimal formation of residual anhydrite. The compressive strengths of the produced mortar are also shown in Figure 2.

	$C_4A_3\$$	C_2S	C_2AS	C$	Minor Phases
Avg	42.53 (40.00)	41.53 (48.88)	7.66 (0)	3.15 (0)	5.13 (11.13)

Table 1: Average clinker composition for samples that were "in spec" with the target values predicted by thermodynamics (in parenthesis) for the final pilot trials.

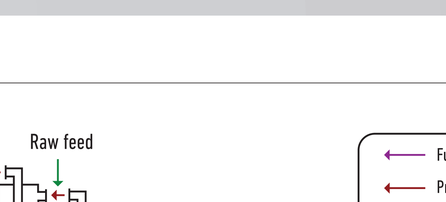


Figure 1: The KDO kiln at IBU-Tec AG was used for the pilot trial series.

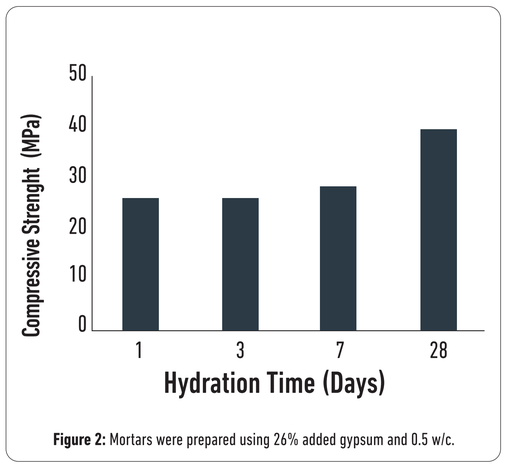


Figure 2: Mortars were prepared using 26% added gypsum and 0.5 w/c.

Key Process Technology

- The technology used here utilises sulfur combustion in the kiln **(6)** to produce a **protective atmosphere preventing volatilisation of SO_3** from the clinker phase, ensuring ye'elimite does not decompose.
- Additional sulfur combustion in the calciner **(5)** can significantly **offset fuel demand**, even producing excess SO_x which is sequestered via a scrubber **(4)** in gypsum that is required to control setting time.
- The technology is **compatible with cheap sulfurous fuels** such as coal or sour crude oil as well as waste H_2S from the Oil & Gas refineries saving the expense/energy of operating a Claus process to convert the H_2S to solid sulfur for transport/storage.

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