

Fundamentals of Chlorine Cycling in Cement Clinker Production

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ABSTRACT

The intensive use of alternative fuels (plastic chips, biomass pieces ...) in cement clinker burning leads to an increase of chlorine in the overall process and in the final product. A cycling behavior is observed in the rotary kiln between the sintering zone with a clinker bed temperature of ~1450°C (vaporization) and the kiln entrance with a bed temperature of ~900°C (condensation).

Typical clinker chlorine levels range from 0.01% to 0.05% depending on the input levels. It is important to mention, that the amount of chlorine in the final product is limited to 0.1% due to normative constraints. At the kiln entrance, chlorine values as high as a few percent are observed.

These high chlorine levels may lead to negative process issues such as ring or ball formation and often result in a shutdown of the production. In order to limit the circulating amount of chlorine, by-pass systems were installed in many plants.

In these systems, a certain amount of gas (which includes the gaseous chlorides) is by-passed and cooled down to condense the chlorides. Like this, the overall load in the process can be reduced to acceptable levels.

It is difficult to determine the exact chemical nature of the chlorides due to their low concentration. Alkali chlorides such as NaCl and KCl are the main circulating chemical species in the process. However, a careful mass balance study reveals that alkali chlorides alone do not explain the observed levels and other chlorides (CaCl₂, MgCl₂, FeCl₃...) must also be present.

A simplified thermodynamic study was performed using FactSage, ChemSheet and the FTOxid / FTSalt databases. The results of these simulations will be presented.