Sustainability measures in quicklime and cement clinker production

Matias Eriksson

Akademisk avhandling

som med vederbörligt tillstånd av Rektor vid Umeå universitet för avläggande av teknologie doktorsexamen framläggs till offentligt försvar i sal N420, Naturvetarhuset 420,
fredagen den 29 januari, kl. 13:15.
Avhandlingen kommer att försvaras på engelska.

Fakultetsopponent:
Associate Professor, **Flemming Jappe Frandsen**
Department of Chemical and Biochemical Engineering,
Technical University of Denmark, Lyngby, Denmark.

Thermochemical Energy Conversion Laboratory
Department of Applied Physics and Electronics
Umeå universitet/Umeå University
Umeå 2015

Organization
Umeå University
Thermochemical Energy Conversion Laboratory
Department of Applied Physics and Electronics

Document type
Doctoral thesis

Date of publication
18 December 2015

Author
Matias Eriksson

Title
Sustainability measures in quicklime and cement clinker production

Abstract
This thesis investigates sustainability measures for quicklime and cement clinker production. It is the aim of this thesis to contribute to the effort of creating a more sustainable modus of industrial production.

The methods used comprises process simulations through multicomponent chemical equilibrium calculations, fuel characterization and raw materials characterization through dynamic rate thermogravimetry.

The investigated measures relate to alternative fuels, co-combustion, oxygen enrichment, oxyfuel combustion, mineral carbonation and optimizing raw material mixes based on thermal decomposition characteristics.

The predictive multicomponent chemical equilibrium simulation tool developed has been used to investigate new process designs and combustion concepts. The results show that fuel selection and oxygen enrichment influence energy efficiency, and that oxyfuel combustion and mineral carbonation could allow for considerable emission reductions at low energy penalty, as compared to conventional post-combustion carbon dioxide capture technologies. Dynamic rate thermogravimetry, applied to kiln feed limestone, allows for improved feed analysis with a deeper understanding of how mixing of different feed materials will affect the production processes. The predictive simulation tool has proven to be of practical value when planning and executing production and full scale campaigns, reducing costs related to trial and error.

The main conclusion of this work is that several measures are available to increase the sustainability of the industry.

Keywords
Limestone, quicklime, cement clinker, sustainability, oxygen, carbon dioxide, thermal decomposition, dynamic rate thermogravimetry, predictive multicomponent chemical equilibrium calculations, mineral carbonation.

Language
English

ISBN
978-91-7601-392-2

Number of pages
82 + 7 papers