EBS_Oxyfuel

Oxyfuel Processes in Rotary Kilns of the Cement Industry: Experimentally Validated Prediction of the Flight, and Conversion Behavior of Refuse Derived Fuels and Their Impact on Clinker Quality

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Project partners:

- Ruhr-University Bochum (project management), Institute of Energy Plant Technology (LEAT)
- Karlsruhe Institute of Technology (KIT), Institute for Technical Chemistry (ITC)
- Karlsruhe Institute of Technology (KIT), Institute for Automation and Applied Informatics (IAI)

At present, the German cement industry faces two key challenges: reducing CO_2 emissions while maintaining its international competitive strength. Oxyfuel combustion is a promising technology which facilitates reduction of both process-related and fuel-related CO_2 emissions. The combustion takes place in an oxygen-rich, nitrogen-free atmosphere. The resulting flue gas is composed primarily of CO_2 and water vapor. After the water vapor condensation, nearly pure CO_2 remains, which can be efficiently utilized or stored, respectively. In order to reduce fuel related costs, the cement industry is increasingly utilizing Refused Derived Fuels (RDF). These fuels consist of various mixtures of waste materials, including plastics, rubber, wood, textiles, paper, and organic residues. Consequently, RDFs contain biogenic fractions, which are considered carbon-neutral. If used in combination with oxyfuel combustion, the biogenic components can even contribute to negative CO_2 emissions, thus effectively creating a carbon sink.

The project encompasses the following research steps:

- Investigation of the combustion behavior of individual real RDF particles under oxyfuel conditions in a drop-shaft reactor
- Single-particle modeling for the extension and validation of existing CFD models
- Further development and validation of the plenoptic camera–based measurement system for real RDF particles for application in a hot rotary kiln under conventional, as well as oxyfuel conditions
- Retrofitting of the pilot plant BRENDA for operation under oxyfuel condition
- Rotary kiln experiments at the BRENDA pilot plant under both conventional and oxyfuel conditions
- Further development of AI-assisted analysis algorithms for the classification of fuel particle fractions according to their flight and burnout behavior
- Validation and assessment of the project results in industrial cement rotary kilns under conventional and oxyfuel operating conditions at industrial partners sites

ITC, in collaboration with IAI will conduct combustion experiments under oxyfuel conditions at the BRENDA pilot plant to investigate the flight dynamics and combustion behavior of various RDF particles. The recorded particle trajectories will be used to derive relevant material parameters, such as drag and lift coefficients.

The aim of the project is the development and validation of AI-assisted CFD models for prediction of the flight and combustion behavior of RDF particles under oxyfuel conditions. By coupling of these models with a clinker bed model, the impact on clinker quality can also be evaluated.

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