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Ph.D. Thesis

INVESTIGATION OF FIXED-BED COMBUSTION PROCESS IN SMALL SCALE BOILERS

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THIS THESIS WAS REALIZED IN THE FRAME OF THE AGREEMENT BETWEEN SILESIA
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Investigation of fixed-bed combustion process in small scale boilers

Abstract of Ph.D. Thesis

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This study is dedicated to examining of combustion processes in a small - scale retort boiler fired with specially prepared coal (or biomass pellets).

The present study aims at improving the combustion process in such boilers. Herein, the searching for design improvements is based on scientific background, which is a new approach in this boiler sector. In order to find out the best design solutions a CFD - based mathematical model has been developed.

The fixed-bed sub-model developed in this thesis constitutes the heart of the overall CFD-based boiler model. The fixed-bed sub-model has been validated against measurements of temperature and gas composition of a fixed-bed of EKORET coal.

The newly developed fixed-bed sub-model has been implemented into the CFD Fluent code to simulate a commercial boiler unit. Perfecting the boiler design resulting in reduced emission of pollutants, (CO and fly ash) can be achieved by repositioning of the deflector, redirection of air supply paths into the combustion chambers as well as reshaping of the combustion chamber.

Finally, an optimized boiler design has been proposed, which features the circular combustion chamber and combustion air swirling. The decrease of CO emission by more than 90% is foreseen at excess air ratio of 2.0.