Fakultät für Maschinenwesen

Autor(en) des Beitrags:
Blume, M.

Titel des Beitrags:
Oxyfuel-combustion of coal in 210 kWth test rig - aspects of burner design and process control

Abstract:
At the Institute for Energy Systems at TUM a 210 kWth test rig is used to investigate the combustion behaviour of lignite under oxyfuel conditions. The combustion chamber has an inner diameter of 700 mm, the inner height is 4000 mm. A number of radially arranged measurement ports are used for measurements with a suction pyrometer, flue gas analysis, video surveillance and radiation measurements. Flue gas treatment incorporates particle removal with cyclone/torch filter, cooling using a gas/gas heat exchanger and drying in a water cooled condenser. The flue gas train is equipped with a system of valves allowing for wet and dry recirculation. The research focus is to investigate non-stoichiometrical burner operation as a means to control the temperature distribution and heat exchange with low recirculation rates and thus to lower the additional energetic and tangible expenditure of oxyfuel operation compared to the retrofit case with its higher flue gas recirculation rates. Non-stoichiometrical burner operation leads to gradual release of combustion enthalpy and thus to lower (adiabatic) flame temperatures. In order to achieve an overall stoichiometry between $\frac{m_1}{m_1} = 1.0 - 1.15$ and low oxygen concentrations at the combustion chamber outlet a multiburner arrangement of up to three vertically aligned burners will be investigated. Based on experiences with staged natural gas oxyfuel combustion and thermodynamic simulations a first coal burner design was developed and investigated under non-stoichiometrical single burner conditions. The data obtained
was then used to modify models for CFD-based burner optimization with respect to aerodynamical behavior. Currently a second-generation burner is investigated. Simultaneously the test rig is being equipped with the components necessary for multiburner operation. First results show that the flame temperature profile obtained by increasing the stoichiometry fits well to the calculated adiabatic reference case. The maximum flame temperature is shifted to higher stoichiometries, though, probably due to inhomogeneities in the oxygen distribution and effects of the combustion process. A clear trend of increased NOx formation at higher stoichiometries could be observed. Radial gas profile analyses for flame characterization have shown a clear distinction between flame core (low oxygen and NOx concentration) and outer combustion zone (high oxygen and NOx concentration). Radial gas profiles taken below the flame nevertheless show a rather constant trend indicating an almost completed burnout. The NOx reduction potential of the subsequent flame level is subject to further investigations.

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