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ABSTRACT

This dissertation shows how to minimize NO_x emissions from a circulating fluidized bed boiler to
a concentration of 150 mg/um^3_{usr} on the example of three fluidized bed boilers with an electrical output of 261 MW_e each. These boilers are lignite-fired boilers. The non-catalytic nitrogen oxide reduction (SNCR) method applied after minimization by primary methods was used to reduce NO_x emissions.

In the thesis, an optimization problem was formulated and the effects of the automatic control systems of the unit, excess oxygen ratio λ, air volume flux, temperature, limestone mass flux on NO_x emissions were determined. Details of the construction and design of the SNCR system are shown, including the selection of the urea solution injection point, the selection of the injection nozzle and the urea mass flux and the operating pressure in the system. Experimental results are discussed. The influence of air and aerodynamics of the circulating fluidized bed is presented in form of the model and the original relationship between Reynolds numbers, Froude numbers and the aerodynamic drag coefficient C_D. The contribution of this manuscript to the field of environmental protection against pollution from lignite combustion in a power boiler, in addition to showing the original way of designing such a system, is also the determination of the dependence of NO_x emissions from a power boiler on about 190 different variables measured by the control systems of this boiler in the form of NO_x emissions-variable correlation. On this basis, it was concluded that single variables such as the temperature of the circulating fluidized bed or air in different parts of the boiler, the oxygen O_2 content in the flue gas, the fuel-air ratio, the mass flux and the urea pressure are not sufficient to describe mathematically the process of NO_x minimization by the non-catalytic method. The literature gap is filled -
a novelty within the NO_x minimization system using SNCR plant is applied by designing a control system that can maintain a urea concentration setpoint or a urea pressure setpoint. Also new is the experimental demonstration that the reaction between NO_x and the reactant can be achieved at a lower temperature of 750°C in some parts of the boiler, which has not previously been shown in the available literature.

The own results were compared with the studies of other authors. A better result was achieved in the reduction of NO_x emissions as measured by statistical distributions of emission measurements on the same type of units and the absence of plant failures.