MSc. Grzegorz Ojczyk

Title of doctoral thesis: Research and modeling of the operation of a multi-fuel boiler fired with biomass in the form of wood pellets

Summary:

The thesis contains an analysis in the field of multi-fuel boilers in exploitation in Poland and the expected direction of technical development of solid fuel boilers on the basis of statistical data, the state of research, the legal status, and users' preferences. The thesis discusses in detail the properties of the basic and substitute fuel of the tested boiler, solid fuel combustion ways and design solutions for multi-fuel burners.

The aim of the study was to perform thermal tests of an automatic multi-fuel boiler for which the basic fuel is hard coal, while the substitute fuel is wood pellets. Boiler tests were carried out during the combustion of wood pellets to develop its basic thermal characteristics and to determine the possibility of carrying out the combustion process in a continuous, safe, controlled and environmentally friendly way.

In order to test and improve the combustion parameters, continuous measurement of the flue gas temperature at the outlet of the combustion chamber and the chemical composition of the flue gas at the outlet of the boiler was carried out. In addition, the temperature of the flue gas at the boiler outlet and the current thermal power of the boiler were measured. Based on the observations and analysis of the measurement results, empirical relationships were developed between fan efficiency and maximum temperature in the combustion chamber, oxygen level in the flue gases and maximum efficiency of the boiler, as well as relationships between fan and fuel feeder volume output as a function of boiler power.

Based on these, guidelines were developed for the development of an algorithm for controlling the operation of the fuel feeder and the boiler forced-draught fan when combusting alternative fuel. The need to develop a control algorithm for the alternative fuel arose from the different dynamics and combustion procedure of hard coal and wood pellets.

In this study, the CKTI method of thermal calculation of combustion chambers of power boilers was adopted for the combustion chamber of a low-power boiler. The measurements carried out experimentally confirmed the correctness of the adopted mathematical model. The conclusions developed on the basis of the research and the proposed mathematical model can be generalized in the future to units with higher powers and for other types of solid biofuels.

The observations and results of the measurements form the basis for proposals for design changes in automatic low-power multi-fuel boilers. The thesis includes recommendations for further modernization work on the boiler under test, as well as forecasts and predictions for the direction of technical development of multi-fuel boilers in the future.

Grzegorz Ojczyk

2023-03-30