ABSTRACT

The aim of this dissertation was to implement a control system for the process of dosing a modifier into the pyrolysis zone of a high-powered dust boiler. The work started with a patent application dated 20.04.2016, which was extended to a European application dated 19.04.2017 and subsequently confirmed by the granting of a European patent on 30.10.2019 (*Bulletin 2019/44 - EP 3 239 279 B1*). The author of the presented work is a co-author of the above-mentioned patent.

Solid fuel combustion processes are extremely complex and difficult to optimise operations; however, they represent a major source of energy generation. In order to meet energy policy guidelines, such as minimising harmful emissions, low energy prices and ensuring security of supply, the author focused on using flow control and multiphase fluid atomisation methods to optimise combustion processes. The modifier is delivered via pneumatic transport and is a solid catalyst in suspension.

A multiphase system has been developed with Raney nickel particles as the active part and a mixture of isopropyl alcohol, water and a viscosity-enhancing stabiliser as the carrier. In this paper, the author analyses the complex phenomena associated with multiphase flows and determines the requirements for the form and form of the catalyst and its delivery method. Studies and numerical simulations show that in order to avoid evaporation of the fluid carrying the catalyst, the optimum droplet diameter of the fluid carrying the catalyst particles must be controlled.

In the following part of the paper, the results of tests for obtaining an efficient catalyst delivery method are presented. The author presented the developed design of the aerodynamic multiphase reactor together with the control system. This design is described in an application for a further European patent (filed with EPO 25.02.2022). The idea of model-based control of the atomisation process in the system in advance is used. This paper presents the results of studies on controlling the size/diameter of the generated droplets by varying the settings of the spray nozzle and the operational and control parameters of the process and the spray itself. The research described was carried out both on a laboratory scale, on a 0.5 MW experimental bench at the Institute of Power Engineering in Warsaw, and on a real object with a capacity of approximately 400 MW at the Siekierki CHP Plant in Warsaw. It was shown that both simulation and experimental

results confirm the possibility of controlling the process of catalyst supply to the fuel feed system of a power boiler. The results obtained and the experiments and simulations carried out by the author represent an original solution, which is at the stage of being implemented in real pulverised fuel boiler systems.