The use of soft hybrid methods for combustion process diagnostics

Abstract

This doctoral thesis presents the problem of diagnostics of the combustion process of coal dust and its mixtures with biomass in the field of recognizing the states of flame intensity changes. Nowadays, coal is one of the key energy resources, and therefore, the combustion process diagnostics is still a current topic of scientific research. The purpose of the study was to determine the optical parameters of the flame that indicate danger or increased emissivity. Measurement flame data were acquired by a monitoring system with a fibre-optic probe and were recorded as a time series. A hybrid classification model is proposed to solve the problem of recognizing the stable and unstable flame states. Time and frequency analysis of flame signals is carried out in the model. Measurement data preprocessing techniques such as normalization and downsampling are used. Additionally, flame intensity signals are checked for trends. Recognition of flame states is carried out by neural network models. Selected structures of fuzzy neural networks and recurrent neural networks are used for this. Classification of states is implemented in two ways. The former one recognizes the flame binarily as stable or unstable states. The second approach recognizes the following states: stable, unstable and the disappearance of the flame. Furthermore, the model implements a flame intensity forecasting process using the ARMA model.

Keywords: *combustion process, flame intensity, flame state classification, fuzzy neural networks, recurrent neural networks*