DIAGNOSTICS OF THE COMBUSTION PROCESS USING OPTICAL METHODS

Abstract

More than 80% of the world's electricity is generated by burning fossil hydrocarbon fuels (oil, coal, gas, biomass). Coal is one of the oldest and currently the key energy source for thermal power generation in many countries of the world. Despite the active development of renewable energy sources, coal will remain a popular source of electricity generation for the foreseeable future. However, the combustion of hydrocarbon fuels is not only a source of energy, but also a source of environmental pollution. Today's emission standards are very stringent and meeting them requires highly accurate and selective diagnostic monitoring and control systems. One of the supporting technologies is flame intensity monitoring – a non-invasive solution, and information on the state of the process is obtained with minimal delay.

The thesis is that the use of optical measurement signals in the observation of the combustion process of coal dust will allow for early detection and accurate recognition of failure states. A method was proposed to identify undesirable combustion states for which the excess air ratio is greater or less than the value ensuring complete combustion. Three architectures of deep recurrent neural networks were investigated for the classification of flame intensity time series. The best results were obtained using a convolutional long-term short-term memory model, which provided an accuracy of 86.5% to 99.8% as a function of thermal output. The prediction time of a single data sequence was about 0.6 ms. The high accuracy and low time-consumption of the proposed method create the possibility of its application in industrial combustion systems of coal dust and its mixture with biomass.

Keywords: diagnostics, combustion process, optical methods, neural networks, deep networks.