**Summary of PhD thesis:**

# „EVALUATION OF COMBUSTION BEHAVIOUR OF SOLID FUELS BY NEURAL NETWORKS AND EXPERIMENTAL INVESTIGATIONS"

**Mgr inż. Sławomir Kakietek**

Supervisor: **prof. dr hab. inż. Wiesław Rybak**

Despite continued reduction in contribution to the global primary energy market in the next few decades, coal remains one of the major energy source nowadays. However due to the stricter EU emission regulation together with increasing cost of energy production from coal, electricity producers have been forced to use lower quality coals. The specification of these low quality coals very often fall outside the normal range of acceptable fuel properties, which can potentially results in a number of technical challenges, particularly on combustion related issues in pulverized coal-fired boilers.

The primary aim of this PhD thesis is thus to develop robust models, based on Artificial Neural Network (ANN) techniques, for predicting a number of key performance indicators related to the combustion characteristics of coal. The database used for developing these ANN's models have been gathered from substantial laboratory experiments for a wide range of coals, which investigated the impact of fuel quality change on the behaviour of ignition, devolatilization, char combustion and $NO_x/SO_x$ emission. The major advantage of using ANNs is that, once trained with adequate amount of representative data, the models are able to predict unseen situations and consequently saving both the time and cost which would otherwise be necesary for new coals. For the purpose of this research, a new laboratory test facility was built where a host of measurements were conducted for several fuels: three hard coals, two lignite and one anthracite coals. These fuels were also investigated in other test facilities in order to supply ignition, devolatilization and char combustion parameters. These parameters together with the proximate and ultimate fuel analyses and the host of measurements from the newly built reactor were then used to train the ANN models.

In the current research several architectures of feedforward ANNs were investigated. The best results were obtained for hybrid PCA-MLP neural network with Oja's weights adaptation rule and with Levenberg'a-Marquardt'a training algorithm. It was conluded that the level of accuracy of the ANN's predictions increases with increasing number of input parameters, which is of special interest especially where small amount of training data is avaiable. It was also found that the performance of the ANN models depend greatly on the different input parametes for the training. The most important input parameters were the proximate and ultimate fuel analyses, burnout and ignition parameters measured from the newly built reactor (temperature and gas species concentrations). A cascaded approach was also explored where predicted parameters from one ANN model are used as inputs to another ANN model. This was found to be particularly effective when predicting kinetic parameters for devolatilization and char combustion. Despite the major importance of the above mentioned input parameters on ANN's performace, removing other less relevant inputs usually decreases the accuracy of the ANN's models. The research was further supplemented by sensitivity analysis (e.g. influence of particle diameters among others) and parametric studies in order to check the creditibility of the trained ANNs. Satisfactory results were obtained.

Conducted research on ANN utilization in coal behaviour evaluation during combustion revealed that ANNs are not only good predicting tool for coal ignition, devolatilization and combustion parameters, but also cognitive and validation tool of real world phenomena.

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