Neural Network Approach for Predicting Drum-boiler Dynamics in Coal-fired Subcritical Power Plant

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Abstract

When thermal power plants are connected to electricity grid, they are subjected to changing load demands. The ability of the plant to follow load depends on the drum-boiler characteristics and this makes the drum-boiler an important component of thermal power plants. This necessitates accurate prediction of the drum-boiler dynamics for proper monitoring and control.

Studies mostly using first principle modelling approach on drum-boiler dynamics are widely reported in literature (Åström and Bell, 2000). The drum-boiler has complicated geometry and it is difficult to model it from first principle without the need for partial differential equations. Such models are hardly used for monitoring and control purposes. Simplified first principle models which show some good predictions exists (Åström and Bell, 2000). However, such fit for purpose simplified first principle models of the drum-boiler are difficult to develop and may not be used easily for everyday operation of the power plant.

In this study, a data-driven approach using artificial neural networks (ANN) is proposed. ANN has the capacity to approximate complex behaviours based on input-output data. This approach has been used for drum-boiler dynamics prediction (Prakash et al., 2010). However, most of the existing studies focus on drum level prediction and steam flowrate in some cases. In this study, an ANN model of a drum-boiler which predicts drum level and drum pressure is presented.

The data used for the ANN training was obtained using a first principle model obtained based on a 160 MW power plant unit in Sweden (Åström and Bell, 2000). The ANN model was validated by comparing the predictions against the predictions of the first principle model. Different process scenarios involving perturbations in different input conditions, namely feedwater flow, steam flow and fuel flow were investigated and compared against similar scenarios from the first principle model. The results showed good performance of the ANN model.

Keywords: Artificial neural networks, drum-boiler, modelling and simulation, control

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