# Highlights

## Validation of an integrated data-driven surrogate model and a thermo-hydraulic network based model to determine boiler operational loads using a fully connected mixture density network

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- Development of mixture density network using simulation data.
- Model based on validated CFD model of a 620 $MW_e$ sub-critical boiler.
- Surrogate model prediction errors are below 10%.

# Validation of an integrated data-driven surrogate model and a thermo-hydraulic network based model to determine boiler operational loads using a fully connected mixture density network

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ABSTRACT

A data-driven surrogate model is proposed for a $620MW_e$ sub-critical power boiler. The surrogate model was developed using computational fluid dynamic (CFD) simulation data. The simulation data covered a varied range of inputs.

## 1. Introduction

The use of neural networks for the modelling of energy systems has been awesome. Optimization of a plant is extremely fun

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## Nomenclature

*abbreviation* explanation for the abbreviation

## 2. Data generation

This section aims to highlight the important and relevant theory behind ANN

### 2.1. CFD model setup

### 2.2. Simulated dataset

## 3. Model development

### 3.1. Overall model

### 3.2. Hyper parameter tuning

table of NN and MDN data comparison for tuning

**Table 1**
Hyperparameter search space for fully connected NN and MDN models

| Parameter | NN search space | MDN search space |
|---|---|---|
| Number of distributions | - | 2,3,4 |
| Number of neurons per layer | 10, 40, 80, 100 | 10, 40, 80, 100 |
| Learning rates | 1e-3, 1e-4, 1e-5 | 1e-3, 1e-4, 1e-5 |
| Mini batch sizes | 16, 32, 64 | 16, 32, 64 |

**Table 2**
Design of experiments input ranges for simulations

| Input variable | Min | Max | Units |
|---|---|---|---|
| Fuel flow rate for mills 1 to 6 | | | $kg/s$ |
| Fuel proximate analysis moisture mass fraction, $Y_{H_2O}$ | 0.025 | 0.085 | $kg/kg$ |
| Fuel proximate analysis ash mass fraction, $Y_{ash}$ | 0.259 | 0.559 | $kg/kg$ |
| Platen SH fouling thermal resistance, $R_{platen}$ | 0.004 | 0.007 | $m^2K/W$ |
| Final SH fouling thermal resistance, $R_{final}$ | 0.01 | 0.017 | $m^2K/W$ |

# 4. Results and discussion

# 5. Conclusion

The present work has shown it is possible

## CRediT authorship contribution statement

**B.T. Rawlins:** Methodology, Software, Validation, Formal analysis, Investigation,Writing original draft, Visualization.. **Ryno Laubscher:** Writing review & editing, Methodology, Resources, Conceptualization.. **Pieter Rousseau:** Writing review & editing, Resources, Conceptualization.