STUDY ON THE IMPACT OF COMBUSTION RELATED BOILER OPERATING PARAMETERS ON "LOSS ON IGNITION'' OF FLY ASH OF LAKVIJAYA COAL POWER PLANT

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Degree of Master of Engineering

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Thesis submitted in partial fulfilment of the requirements for the degree
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Declaration

I solemnly affirm that this thesis is solely the product of my own efforts and does not contain any material formerly presented for a degree or diploma at any other institution of higher learning, to the best of my understanding and belief.

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Prof. R A Attalage

Abstract

Fly ash, an inevitable by-product of coal combustion in power generation, possesses diverse potential applications, such as serving as a raw material for cement production. The quality of fly ash, however, depends on various factors, with Loss on Ignition (LOI) being the paramount parameter. LOI denotes the presence of combustible matter in fly ash which is attributed to the quality of coal and combustion conditions. This study was conducted for the Lakvijaya Power Plant (LVPP) (3x300MW), which is the sole coal-based power generation facility in Sri Lanka, providing 40% of the country's total electrical energy demand.

The aim of this study was to develop a model which could map the relationship between boiler operating parameters and LOI, using Artificial Neural Networks (ANNs) with the support of high-level programming language, MATLAB. The dataset consisted 1,615 observations, each with 25 input variables and a single output variable. The investigation utilized different combinations of ANN training algorithms and activation functions and the results were elaborated in each case. A preliminary analysis was conducted using the maximum available samples (1615). Further investigations were then carried out using classified datasets based on the Mill Configuration (656 samples) and Load Point (435 samples). To represent real time variations in coal quality, a separate index was introduced in the model incorporating “Load to Coal” ratio in the final analysis.

The analysis revealed that feedforward two hidden layer ANN with “Bayesian Regularization Backpropagation” being the training function and “Tanh” being the activation function performed well for the dataset. The Correlation Coefficient (R) of unclassified samples 0.71, could be improved to 0.80 by means of data classification. By introducing “Load to Coal” ratio as a separate input variable, R could be further improved to 0.86. The study culminated in the development of sensitivity analysis plots that depict the relationship between LOI and boiler operating parameters i.e., coal to total air ratio, coal to primary air ratio, burner tilt angle, wind box pressure, air flow proportions of individual burner (14 Nos) and coal flow proportions of individual mill (4 Nos). The sensitivity analysis revealed that the uppermost primary burner air flow proportion, the lowermost primary burner air flow proportion and the burner tilt angle have the highest impact on LOI.

Key Words: Fly Ash, Loss on Ignition, Artificial Neural Networks, MATLAB

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

APH	Air Pre Heater
ANN	Artificial Neural Network
BMCR	Boiler Maximum Continuous Rating
BR	Bayesian Regularization
CEB	Ceylon Electricity Board
CNN	Convolutional Neural Networks
DCS	Distributed Control System
ELU	Exponential Linear Unit
ESP	Electro Static Precipitator
FD	Forced Draft
GUI	Graphical User Interface
ID	Induced Draft
LM	Levenberg-Marquardt
LOI	Loss On Ignition
LVPP	Lakvijaya Power Plant
MSE	Mean Squared Error
OFA	Over Fire Air
PA	Primary Air
PCA	Principal Component Analysis
R	Correlation Coefficient
RNN	Recurrent Neural Network
SCG	Scaled Conjugate Gradient