FEASIBILITY OF INTEGRATING BITUMINOUS COAL STEAM PRE-DRYING: CASE OF LAKVIJAYA COAL POWER PLANT, SRI LANKA

A. N. Sudasingha

(178263K)

Degree of Master of Engineering

Department of Mechanical Engineering

University of Moratuwa

Sri Lanka

September 2023

FEASIBILITY OF INTEGRATING BITUMINOUS COAL STEAM PRE-DRYING: CASE OF LAKVIJAYA COAL POWER PLANT, SRI LANKA

Asanka Nayanashantha Sudasingha

(178263K)

Thesis submitted in partial fulfilment of the requirements for the degree

Master of Engineering

Department of Mechanical Engineering

University of Moratuwa

Sri Lanka

September 2023

Declaration

I’m declaring that this thesis consists of solely my own work and not copied or inherited by any other publications inside or outside of the country. The details of the data or information gathered from external sources are mentioned in the references.

I hereby granting my permission to the University of Moratuwa to distribute and reproduce the content in the thesis as part or complete in any media. I will retain the right to use the contents in the thesis as complete or part for my future works.

Signature: ..... Date: .....30-09-2023..... A.N Sudasingha

The above candidate has carried out research for the Masters Thesis under my supervision

Signature: ..... Date: .....30-09-2023.....

Professor R.A Attalage

Abstract

Bituminous coal is considered less in inherent moisture. However, significant water quantity is added during handling and dust suppressing activities resulting an elevated total moisture level. This causes various O&M issues in power generation plants that are designed to accept lower coal moisture variations. Although Lignite pre-drying technology has been a popular study, information on integration of steam driven bituminous coal pre-drying system into sub-critical power plant is limited. In this study, Rotary Steam-Tube Dryer is selected as a viable drying technology. Then, potential of utilizing waste heat extracted from Continuous Blow Down (CBD) to operate the Dryer was theoretically modelled and benefits were evaluated. A case analysis was performed on the 3x300MWe coal fired power plant in Sri Lanka. All three identical generation units were combined with minimal physical modifications to the existing system and extractable steam flow within desired parameters was calculated by varying the CBD rate along 1% to 1.5% of BMCR of a single unit. Up to 0.025 kg/kg degree of pre-drying could be achieved in typical operating total coal moisture range from 6% to 15%. By considering only the major contributor, moisture evaporation heat in flue gas, system input energy reduction model was developed. Resultant generation efficiency gain was 0.25% when 1.5% boiler blow down rate is used. Capital Cost analysis is performed with CECPI escalation. 8 months of Payback period was calculated for 1.5% boiler blow down rate. Sensitivity analysis was performed on major parameters. Actual financial benefit would be much higher when considering auxiliary power reduction and reduced unplanned outages due to O&M emergencies that is frequently caused by elevated coal moisture levels.

Acknowledgement

I am expressing my sincere gratitude to Professor Rahula Anura Attalage, Pro Vice-Chancellor (Academic) of Sri Lanka Institute of Information Technology (SLIIT) for extending me his fullest support for successfully completing this research as the supervisor of the research. Also, I am extremely grateful to Dr. Indrajith D. Nissanka and Dr. Pubudu Kumarage to guide me to complete this dissertation. My thank should spread to Power Plant Manager and his technical staff, Lakvijaya Power Plant, Norochcholai for allowing me to access the Operational Parameters and Maintenance Statistics for this study. Furthermore, I would express my special thanks to Eng. R.P.S Kumara, Eng. K.R Attapattu, Eng. D.S Kulathilaka, Eng. A.R.M.U.E Abeyrathna, and Eng. W.M.A.M.L Wasala, Senior Operation Engineers of the Lakvijaya Power Plant for encouraging and helping me in many ways to accomplish this task including Eng. H.A.J.M.Sameera. Last but not least I would like to say a special word of thanks for my family members, my wife, son, my parents for bearing the inconvenience caused during my research and encouraging me to complete the research successfully.

Table of contents

List of Figures

List of tables

List of abbreviations

GCV	Gross Calorific Value
NCV	Net Calorific Value
VM	Volatile Matters
THA	Turbine Heat Acceptance
BMCR	Boiler Maximum Continuous Rating
HHV	Higher Heating Value
LHV	Lower Heating Value
CBD	Continuous Blow Down
DCS	Distributed Control System