FEED WATER HEATER FOR INCREASING BOILER EFFICIENCY
CASE STUDY AT PELW ATTE SUGAR INDUSTRY

A dissertation submitted to the
Department of Electrical Engineering, University of Moratuwa
in partial fulfilment of the requirements for the
Degree of Master of Science

By

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2010

Abstract

Sugar cane is grown in rural areas in Sri Lanka, and the residue of sugar cane production called bagasse, can be a cheap source of primary boiler fuel, when processing sugar cane. For each 100 tones of sugar cane harvested and milled, 9-10 tones of sugar is produced together with 29-33 tones of solid waste in the form of crushed cane, or bagasse. Typically, the mill uses about 53% of bagasse in a low efficiency steam cycle to produce the electricity and steam which needs for own use. Surplus bagasse is sometimes used for paper making or cattle feed but in Sri Lanka neither of these applications are effectively used. Bagasse is a major bio-mass fuel, which can be used to produce significant quantity of surplus electricity. Progressive sugar cane companies are beginning to see the advantages of creating a substantial additional cash flow by setting up cogeneration power plants fuelled by bagasse.

Using proven technology a 5000 tones/day cane mill can use its own bagasse to supply the mill with steam and power and export approximately 22 MW of electricity. Some large sugar cane mills currently have co-generation power plants that export over 25 MW. In Pelwatte sugar industry, there is 3MW electricity generation and 90T/h steam generation to meet its total demand. Modern conversion systems also ensure lower air emissions meeting latest environmental standards. Because of the harvesting of sugar cane is seasonal, maximum utilization of the co-generation plants is only achieved, if bagasse is stored for use in the off season or other biomass or fossil fuels are employed. Therefore, optimum usage of bagasse is important for minimizing fossil fuel usage. In Sri Lanka, price of fossil fuel is increasing rapidly. If the sugar factory consumes fossil fuels, then those factories are directly affected by the price changes of fossil fuels. For the existence of Sri Lankan sugar industry, and to compete with other sugar industries all over the world, optimum usage of bio-mass usage, such as bagasse is very important.

For the optimum usage of bagasse consumption, various methods can be used. But the sugar factories, which are already installed, have been equipped with some of

these methods. Later modification for optimization and saving of bagasse directly affects the whole system. To optimize bagasse usage, and to minimize fossil fuel usage, it was decided to increase existing boiler efficiency by introducing a feed water heater. But for that, extensive studies were conducted. By this modification it was revealed that an increase of 3% in boiler efficiency could be achieved thereby a saving of 54.2 million LKR could be gained annually. In addition, an obvious reduction of fossil fuel usage and reduction of emissions are the other achievements. Outcomes of this project are significant and it is bound to benefit sugar industry in Sri Lanka.

DECLARATION

The work submitted in this dissertation is the result of my own investigation, except where otherwise stated. It has not already been accepted for any degree, and is also not being concurrently submitted for any other degree.

UOM Verified Signature

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Date 05/02/2010

I endorse the declaration by the candidate.

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Acknowledgement

Thanks are due first to my supervisor, Eng. W.D.A.S. Wijayapala, Senior Lecturer, Department of Electrical Engineering, University of Moratuwa, **Sri Lanka** for his great insights, perspectives, guidance and sense of humor. My sincere thanks go to the officers in Post Graduate Office, Faculty of Engineering, University of Moratuwa, for helping in various ways to clarify the things related to my academic works in time with excellent cooperation and guidance. Sincere gratitude is also extended to the people who serve in the Department of Electrical Engineering office.

I gratefully thank Dr. Karunadasa, Head of the Electrical Engineering Department, University of Moratuwa for his encouragement, insightful comments, and hard questions.

I gratefully acknowledge Mr. Ariyaseela Wicramanayaka, Managing Director, Mr. Prasad, Group General Manager, and Mr. A. Priyantha, Operational Manager, Pelwatte Sugar Company, Sri Lanka for their advice, supervision, and crucial contribution, which made them a backbone of this project and so to this thesis.

Lastly, I should thank many individuals, friends and colleagues who have not been mentioned here personally in making this educational process a success. May be I could not have made it without your supports.

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List of principal Symbols

u_w - Velocity of water

u_f - Velocity of flue gas

ρ - Density kg/m^3

L - Length

V - Velocity

μ - Dynamic Viscosity

Re - Reynolds numbers

N_u - Nussel number

h_f - Surface heat transfer coefficient

D - Diameter of the tube

K - Heat transfer conductivity coefficient

P_r - Prandle number

C_1 - Correction factor

m - Mass flow rate

Cs - Specific heat coefficient

θ - temperature difference

ε - Effectiveness of heat transfer

C - Constant

I - Moment of inertia

M - Bending moment

σ - Stress (nominal)

w - Force per unit area

d - Thickness of the plate

P - Force per unit area

E - Young modulas of elasticity

δ - Deflection

List of Abbreviations

ASTM - American Society of Testing and Materials Construction

ASME - American Society for Mechanical Engineers

AWS - American Welding Society

C - Carbon

CDM - Clean Development Mechanism

CO - Carbon Oxide

CO_2 - Carbon Dioxide

FD - Forced Draft

H - Hydrogen

IRR - Internal Rate of Return

IPCC - Intergovernmental Panel on Climate Change

UNFCC - United Nations Framework Convention on Climate Change

ID - Induced Draft

N - Nitrogen

NO_2 - Nitrogen Dioxide

PM - Particulate Matter

S - Sulfur

SO_2 - Sulfur Dioxide

TOC - Total Organic Compounds

VOC - Volatile Organic Compounds