

LB/TH/39/2025

TH5977

**THERMAL PERFORMANCE ENHANCEMENT OF
ALUMINUM CASTING PROCESSES IN FOUNDRY
OPERATIONS: A CASE STUDY AT CEYLON
ELECTRICITY BOARD**

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Degree of Master of Engineering

Department of Mechanical Engineering

University of Moratuwa

Sri Lanka

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Thesis/Dissertation submitted in partial fulfilment of the requirements
for the degree Master of Engineering in Energy Technology

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DECLARATION

I declare that this is my own work and this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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Prof. Saliya Jayasekara

7/21/25

Date:.....

**This work is lovingly dedicated to my dear wife,
Manoja, and my two wonderful children, Sandamini
and Sajan, whose unwavering love, support, and
encouragement have been my constant source of
strength and inspiration.**

ABSTRACT

The Ceylon Electricity Board (CEB) foundry plays a vital role in Sri Lanka's energy sector by producing aluminum components for the national grid. However, reliance on outdated sand casting methods and inefficient oil-fired furnaces has led to low energy efficiency, high operational costs, and environmental concerns. This study addresses these challenges by designing and implementing a waste heat recovery system integrated with a welded plate heat exchanger to enhance energy efficiency and optimize foundry operations.

The research evaluated the performance of existing furnaces, revealing significantly low Specific Fuel Consumption (SFC) compared to the initial fuel consumption values, with the pit furnace operating performing at 0.681 *l/kg* and the tilting furnace operating at 0.294 *l/kg*. A welded plate heat exchanger was fabricated and integrated into the combustion system to preheat combustion air using exhaust gases. Computational Fluid Dynamics (CFD) simulations were employed to optimize the heat exchanger design and predict performance. Experimental results showed a 29.5% reduction in fuel consumption and a 32% decrease in melting time, with the heat exchanger achieving an energy recovery rate of 40%.

The findings demonstrate the feasibility of waste heat recovery in improving thermal efficiency and reducing emissions, providing a scalable solution for small and medium-scale foundries. This study recommends further modernization, including advanced monitoring systems and renewable energy integration, to enhance sustainability. By reducing reliance on imports and promoting local production, this research aligns with Sri Lanka's economic and environmental goals, offering a robust framework for energy-efficient aluminum casting practices.

ACKNOWLEDGMENT

I would like to extend my sincere gratitude and appreciation to Prof. Saliya Jayasekara, in the Department of Mechanical Engineering, University of Moratuwa, for his invaluable support and guidance throughout this research project. The contributions of Prof. Jayasekara have been paramount to the success of this research, I am deeply grateful for her assistance.

Furthermore, I would like to express my gratitude to Dr. Nissanka, Senior Lecturer and Course Coordinator of the M.Eng/PG Diploma on Energy Technology at the Department of Mechanical Engineering, University of Moratuwa, for his generous support and involvement at every stage of this research. The assistance of Dr. Nissanka has been essential to the successful completion of this study, and I am deeply grateful for his guidance.

The research was conducted under the supervision of Prof. Saliya Jayasekara, and I acknowledge my indebtedness to him for his invaluable guidance, kind-hearted cooperation, and encouragement throughout the project. My gratitude extends to my colleagues in the post-graduate programme, who provided unwavering support and assistance, allowing for the successful completion of this research.

Finally, I would like to express my appreciation to all those who contributed to the success of this study in various ways, as their support was of utmost importance in bringing this effort to fruition.

TABLE OF CONTENTS

DECLARATION	i
ABSTRACT	iii
ACKNOWLEDGEMENT	iv
TABLE OF CONTENTS	v
LIST OF FIGURES.....	ix
LIST OF TABLES.....	xi
LIST OF APPENDICES.....	xi
LIST OF NOMENCLATURE	xii
LIST OF ABBREVIATIONS.....	xiii

TABLE OF CONTENTS

CHAPTER 1: INTRODUCTION AND OUTLINE OF THE RESEARCH	15
1.1. Background	15
1.2. Problem Identification.....	16
1.3. Aim	16
1.4. Objectives.....	17
1.5. Methodology	17
CHAPTER 2: LITERATURE REVIEW.....	18
2.1. Global Aluminum Foundry Industry.....	18
2.1.1. Overview of the Global Aluminum Foundry Industry.....	18
2.1.2. Key Consumer Industries	18
2.1.3. Leading Producers and Growth Dynamics.....	19
2.1.4. Recycling and Sustainability.....	19
2.2. Foundry Industry in Sri Lanka	19
2.2.1. Overview of the Foundry Industry in Sri Lanka	19
2.2.2. Current Challenges	20

2.3. Aluminum Casting Processes.....	21
2.3.1. Sand Casting:.....	21
2.3.2. Permanent Mold Casting:.....	23
2.3.3. Die Casting:.....	25
2.4. Furnace Types and Combustion Processes	26
2.4.1. Types of Melting Furnaces.....	27
2.5. Energy Efficiency in Foundry Operations	30
2.5.1. Energy Sources.....	30
2.5.2. Energy Requirements and Thermal Efficiency	30
2.5.3. Operational Parameters	31
2.6. Waste Heat Recovery Technologies For Foundry Applications.....	32
2.6.1. Plate Heat Exchangers (PHEs).....	32
2.6.2. Shell-and-Tube Heat Exchangers (S&T)	34
2.6.3. Plate-Fin Heat Exchangers (PFHE).....	35
2.6.4. Plate-and-Shell Heat Exchangers	35
2.6.5. Welded Plate Heat Exchanger Technology.....	36
2.6.6. High Temperature Heat Exchangers (HTHEs):	37
2.6.7. Heat Pipe Heat Exchangers (HPHEs)	38
2.6.8. Comparison of Prominent Heat Recovery Technologies.....	40
2.7. Combustion Techniques Used in the Foundry Industry.....	40
2.7.1. Mechanical Atomizing Burners	41
2.7.2. Pressure Atomizing Burners	42
2.7.3. Air Atomizing Burners.....	43
2.7.4. Dual-Fuel Burners	43
2.7.5. Waste Oil Burners	44
2.7.6. Considerations for Using Waste Oil or Diesel Fuel.....	44
CHAPTER 3: INTRODUCTION TO THE CEB FOUNDRY	45
3.1. Overview of the CEB Foundry.....	45

3.2. Location of the CEB Foundry	45
3.3. Products Manufactured at the CEB Foundry	46
3.4. Summary of Production Data	48
3.5. Casting Methods and Equipment	49
3.6. Initial Foundry Layout	53
3.7. Foundry Layout After Modifications	53
 CHAPTER 4: PERFORMANCE EVALUATION AND METHODOLOGY FOR COMBUSTION AIR PREHEATING AND ENERGY OPTIMIZATION	
57	
4.1. Introduction	57
4.2. Efficiency Analysis of Existing Furnaces	57
4.2.1. Pit Furnace Efficiency Analysis	57
4.2.2. Tilting Furnace Efficiency Analysis	60
4.3. Review of Combustion System Designs	63
4.3.1. Combustion Principles and Their Applications	63
4.3.1.1. Crucible Shape and Size	63
4.3.1.2. Airflow and Combustion Dynamics	64
4.3.1.3. Chimney and Ventilation Design	65
4.4. Modelling of Crucible Furnace and Study of Combustion Mechanism Using Ansys Fluent	65
4.4.1. Simulation Simplifications Applied	65
4.4.2. Computational Model Setup	66
4.4.3. Boundary Conditions and Inputs	67
4.4.4. Mesh and Geometry	68
4.4.5. Solution and Solution Controls	69
4.4.6. Key Findings from the Simulation	69
4.5. Development of the Combustion Air Preheating Methodology	75
4.5.1. Rationale for Combustion Air Preheating	75
4.5.2. Proposed Methodology	75

4.5.3. Design Objectives	77
4.6. Design of the Heat Exchanger.....	78
4.6.1. Design Calculations.....	78
4.7. Modeling of Heat Exchanger and Study of Heat Transfer using ANSYS Fluent Simulations.....	83
4.7.1. 3D Modeling	83
4.7.2. Simplified Simulation Approach for Welded Plate Heat Exchanger	84
4.7.3. Simulation Setup for Welded Plate Heat Exchanger:	85
4.7.4. Boundary Conditions.....	86
4.7.5. Mesh and Geometry of the Welded Plate Heat Exchanger	86
4.7.6. Solution and Solution Controls	89
4.7.7. Key Findings from the Simulation.....	90
CHAPTER 5: FABRICATION AND EXPERIMENTAL SETUP	94
5.1. Fabrication of the Welded Plate Heat Exchanger	94
5.1.1. Material Selection and Construction Details.....	94
5.1.2. Assembly Techniques and Equipment Used.....	94
5.2. Experimental Setup	96
5.3. Measurement and Instruments	97
5.4. Procedure for Evaluating Heat Exchanger Performance.....	103
CHAPTER 6: RESULTS AND DISCUSSION	106
6.1. Overview	106
6.2. Experimental Challenges and Setup.....	106
6.3. Experimental Results before the integration of combustion air preheating system.....	106
6.4. Experimental results after integration of combustion air preheating system 107	
6.5. Comparative Analysis: Experimental Results Before and After Heat Exchanger Integration.	110
6.6. Simulation Results Intepretation	114

6.7. Correlation Between Simulation and Experimental Findings.....	115
6.8. Economic Analysis of the welded plate heat exchanger	115
6.8.1. Payback Associated with the Fuel Saving.....	115
6.8.2. Time Saving and Associated Labor Cost Benefit	116
6.9. Deviations, Limitations and Future Scope	117
CHAPTER 7: CONCLUSIONS AND RECOMMENDATIONS.....	119
7.1. Conclusion.....	119

LIST OF FIGURES

Figure 1-Global Aluminum Production, Production of Aluminum Castings and Aluminum Annal Price.....	18
Figure 2-Sand Casting Process	22
Figure 3-Mould Section and casting nomenclature	22
Figure 4-Pattern attached with gating and risering system	23
Figure 5-Schematic of permanent mould casting process.....	24
Figure 6-Steel moulds left unused at the Foundry	24
Figure 7-Schematic of a hot chamber horizontal die casting setup.....	26
Figure 8-Cold chamber horizontal die casting process.	26
Figure 9-Plate-and-frame PHE (construction scheme): 1—stack of plates with gaskets; 2—fixed frame plate; 3—moving plate of frame; 4—carrying bar; 5—tightening bolts (courtesy of OAO Alfa Laval Potok, Korolev, Moscow region, Russian Federation [19]).....	33
Figure 10-Geometrical features of a single pass WPHE. Crossflow arrangement [22].....	37
Figure 11-High Temperature Heat Exchanger (HTHE) and heat recovery system [23].....	38
Figure 12-Schematic of a Heat Pipe [24].....	39
Figure 13-Heat Pipe Heat Exchanger Used in the Steel Industry	39
Figure 14-Schematic of a Rotary Cup Burner (courtesy of AATRAL ENGINEERING) [26]	41
Figure 15-Schematic of a pressure jet burner (Courtesy Lennox Industries Inc.)	42
Figure 16-Schematic of an air atomizing burner [29].....	43
Figure 17-Aluminum clamps manufactured at the CEB foundry	46
Figure 18-A bronze casting pump end cover produced by CEB foundry	47
Figure 19-Aluminium anodes each 70kg produced by CEB foundry	48
Figure 20-Sand cast mould ready for pouring.....	49
Figure 21-Starting the ignition using a burning piece of cloth	50
Figure 22-Flame spreading inside the furnace	50
Figure 23-Improper construction of the pit furnace.....	50
Figure 24-Measuring aluminum.....	50
Figure 25-Loading aluminum into the crucible	51
Figure 26-Furnace covered by a lid	51
Figure 27-Pouring, Cooling and knocked out castings	51
Figure 28: Tilting furnace covered with various materials due to non-use.....	52
Figure 29-Foundry layout modification.....	54
Figure 30-Desired position for the burner flame entry into the furnace	61
Figure 31-Rounded and Conical bottom crucibles	63

Figure 32-Fig. 1: Schematic diagram of a fuel-fired and tiltable crucible furnace. 1) Crucible, 2) Furnace lining (permanent lining), 3) Firing compartment, 4) Gas or oil burner, 5) Emergency tap (leading towards the emergency accumulation pit), 6) Refractory base, 7) Exhaust port, 8) Stack	64
Figure 33-Temperature contour across the X-Y plane of the burner	70
Figure 34-Velocity streamline of the flow inside the air body of crucible furnace in a burner designed for high air velocity.....	72
Figure 35-Study of the effects of burner angle for temperature distribution	73
Figure 36-Designated path for flame travel around the crucible	74
Figure 37-3D model of the Welded plate heat exchanger.....	79
Figure 38-Effectiveness for Heat Exchangers [36].....	82
Figure 39-3D Wireframe model of welded plate heat exchanger assembly	84
Figure 40-Temperature volume rendering diagram for plate heat exchanger.....	91
Figure 41- Temperature contours across the hot gas inlet to hot gas outlet.....	91
Figure 42-Temperature contour across the cold air inlet to hot air outlet.....	92
Figure 43-Heat exchanger and Furnace air-body considered for CFD study	Error!
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Figure 44-Fabricaiton of the welded plate heat exchanger	95
Figure 45-Integrated assembly of welded plate heat exchanger and the tilted crucible furnace consisting all the instrumentation for testing	96
Figure 46-Molten aluminum temperature measurement using a K-type thermocouple	98
Figure 47-Digital temperature controller for temperature measurement, 1) T1-Cold air inlet, 2) Hot air outlet, 3) T3-Hot gas inlet, 4) T4-Hot gas outlet, 5) For temperature measurements inside the liquid aluminum.....	99
Figure 48-Gauge for fuel temperature measurement	100
Figure 49-Fuel temperature adjustment	100
Figure 50-Fuel pressure gauge.....	101
Figure 51-Fuel tank dipstick	101
Figure 52-Blower damper position indicator	102
Figure 53-Burner characteristic curve.....	103

LIST OF TABLES

Table 1: Comparison of Heat Exchanger Types	40
Table 2- Summary of Production Data	48
- Table 3: Operational Data Summary for Pit Furnace Aluminum Casting Test	58
Table 4: Operational Data Summary for Tilting Furnace Aluminum Casting Tests	62
Table 5- Combustion air preheater performance evaluation test data	107
Table 6- Operating Conditions and System Parameters for the Combustion Air Preheating Test	107
Table 7- Temperature Variation at Measuring Points on the Plate Heat Exchanger	108
Table 8- Performance Analysis of Tilting Furnace with Combustion Air Preheating System	109

LIST OF APPENDICES

Appendix 1- Production Data of Manufactured Components at CEB Foundry	122
Appendix 2- Waste oil calorific value test report	127
Appendix 3- Weishaupt burner data sheet	128

LIST OF NOMENCLATURE

A_s	Area	m^2
c_p	Specific heat capacity	$J/kg \cdot K$
E	Energy	J (Joules)
h	Specific enthalpy	kJ/kg
h_c	Convective heat transfer coefficient	$W/m^2 \cdot K$
k	Thermal conductivity	$W/m \cdot K$
m	Mass	kg
\dot{m}	Mass flowrate	kg/s
NTU	Number of Transfer Units	--
Nu	Nusselt Number	--
P	Pressure	Pa (Pascals)
Q	Thermal Energy	J
Re	Reynold Number	--
t	Time	s (seconds)
T	Temperature	K
U	Overall heat transfer coefficient	$W/m^2 \cdot K$
v	Velocity	m/s
\dot{V}	Volume flowrate	m^3/s
ΔT	Temperature difference	K
ε	Heat exchanger Effectiveness	--
η	Efficiency	--
ρ	Density	kg/m^3

LIST OF ABBREVIATIONS

AFR	Air to fuel ratio
AL	Aluminum
CAD	Computer aided design
CAM	Computer aided manufacturing
CEB	Ceylon Electricity Board
CFD	Computational Fluid Dynamics
HE	Heat Exchanger
FDSI	Foundry Development and Services Institute
GCV	Gross Calorific Value
HPHE	High Pressure Heat Exchanger
HTHE	High Temperature Heat Exchanger
IDB	Industrial Development Board
KCCP	Kelanitissa Combined Cycle Power Plant
kWh	Kilowatt hour
NTU	Number of Transfer Units
ORC	Organic Rankine Cycle
PHE	Plate Heat Exchanger
WHR	Waste Heat Recovery
WPHE	Welded Plate Heat Exchanger