

DEVELOPMENT OF AN OPERATOR FRIENDLY BOILER PERFORMANCE CALCULATOR

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DECLARATION

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ABSTRACT

Saving fuel by optimising the equipment performance has become a goal for almost all global organisations and boilers which contribute to a major share of global resources consumption was subjected to the present study. This study was conducted to develop a boiler performance evaluation tool. Different performance indicators and methods of evaluating those indicators were studied. Performance calculator was developed based on British Standard, which can estimate performance of steam, hot water boilers and thermal fluid heaters with limited inputs and standard measurements. The calculator was used to estimate direct efficiency, indirect efficiency and evaporation ratio of selected cases using secondary data. Calculated values of respective performance indicators were compared with measured values. Calculated results of indirect efficiencies have 0.897 to 0.950 correlation and the excess air percentages were 99.5% agreed with measured values. This can be developed using advance software including an expanded version of the steam table.

Keywords: Boiler performance, boiler efficiency



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TABLE OF CONTENT

Declaration.....	i
Abstract.....	ii
Acknowledgement.....	iii
Table of Content.....	iv
List of Abbreviations	viii
List of APPENDICES.....	x
INTRODUCTION.....	1
1.1. Background 1	
1.2. Research Problem 1	
1.3. Research Objectives 2	
1.4. Scope of the Study 2	
1.5. Significance of the Study 3	
1.6. Report Outline 3	
LITERATURE REVIEW	4
2.1. Introduction 4	
2.2. Overview of Boilers 4	
2.2.1 Thermal oil boiler 4	
2.2.2 Steam or hot water boiler 6	
2.3. Boiler Classification 7	
2.4. Boiler Performance 8	
2.4.1 Importance of performance evaluation 9	
2.5. Boiler Efficiency 9	
2.5.1 Combustion efficiency 9	
2.5.2 Thermal efficiency 10	
2.5.3 Fuel to steam efficiency 10	
2.6. Evaporation Ratio 10	
2.7. Reference Standards 10	
2.7.1 British standards, BS845: 1987 11	
2.7.2 ASME standard: PTC-4 power test code for steam generating units 12	

2.7.3	Indian standard for boiler efficiency testing	12
2.8.	Boiler Efficiency Estimation Methods	12
2.9.	Direct Method	13
2.9.1	Calculation of boiler efficiency using direct method	13
2.9.2	Measurements required to calculate the direct efficiency	15
2.10.	Indirect Method	16
2.10.1	Calculation of boiler efficiency using indirect method	17
2.10.2	Measurements required to calculate the indirect efficiency	19
2.10.3	Test conditions and precautions for indirect method testing	20
2.11.	Factors that do not Influence the Efficiency	22
2.12.	Errors in Efficiency Calculation Standards	23

METHODOLOGY 24

3.1.	Introduction	24
3.2.	Calculation Procedure and Equations for Indirect Method	24
3.2.1	Calculation of dry flue gas loss, L_1	24
3.2.2	Losses due to enthalpy in water vapour in the flue gases, L_2	25
3.2.3	Losses due to unburned gases in the flue gases, L_5	26
3.2.4	Losses due to radiation, convection and conduction, L_6	26
3.2.5	Losses due to combustible matter in ash and riddling, L_7	27
3.2.6	Losses due to combustible matter in grit and dust, L_8	28
3.2.7	Excess air	28
3.3.	Calculation Procedure and Equations for Direct Method	28
3.3.1	Mass flow rate of steam/hot water/thermal oil	29
3.3.2	Mass flow rate of fuel	30
3.4.	Properties of Fuels	30
3.5.	Conceptual Framework of the Calculator	31
3.6.	Data Collection and Analysis	34

Results and Discussion..... 35

4.1.	Introduction	35
4.2.	Features of the Efficiency Calculator	35
4.3.	Calculated Indirect Efficiency of Steam Boilers	37
4.4.	Calculated Indirect Efficiency of Thermal Fluid Heaters	41
4.5.	Calculated Direct Efficiency of Boilers	44
4.6.	Limitations	45

CONCLUSION AND FUTURE WORK	46
REFERENCES.....	48
APPENDICES	52



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List of Figures

Figure 2.1: Schematic diagram of a thermal fluid boiler [6]	5
Figure 2.2: Schematic diagram of a steam boiler	7
Figure 2.3: Methods of evaluating the boiler efficiency.....	13
Figure 2.4: Heat balance diagram by direct method	14
Figure 2.5: Heat balance diagram by indirect method.....	17
Figure 3.1: Variation of Surface losses with boiler loading	27
Figure 3.2: Flow diagram for indirect efficiency calculation	32
Figure 3.3: Flow diagram for direct efficiency calculation	33
Figure 4.1: View of operator interface of the calculator.....	36
Figure 4.2: Variation of measured and calculated efficiencies of steam boilers	39
Figure 4.3: Variation of calculated indirect efficiency of steam boilers with measured values ...	39
Figure 4.4: Variation of measured and calculated excess air of steam boilers	40
Figure 4.5: Variation of calculated excess air percentage with measured excess air of steam boilers.....	40
Figure 4.6: Variation of measured and calculated efficiencies of thermal heaters	42
Figure 4.7: Variation of measured and calculated excess air of Thermal heaters	42
Figure 4.8: Variation of calculated efficiency with measured values for thermal oil heaters	43
Figure 4.9: Variation of calculated excess air with measured values for thermal oil heaters.....	43
Figure 4.10: Variation of measured indirect efficiency, calculated direct efficiency and evaporation ratios of steam boilers	45

List of Tables

Table 2.1: Summary of boiler classification	8
Table 3.1: Sievert constant and V/CO ₂ factor for selected fuels	25
Table 3.2: Hydrogen, moisture content and Constant K ₁ for selected fuels	25
Table 3.3: Summary of fuel properties	31
Table 4.1: Summary of measured and calculated indirect efficiencies for steam boilers.....	37
Table 4.2: Summary of Measured and calculated indirect efficiencies for Thermal oil heaters ..	41
Table 4.3: Summary of calculated direct efficiencies and evaporation ratios for steam boilers ..	44

LIST OF ABBREVIATIONS

A	Total external surface area of boiler	m ²
A ₁	Water or steam backed external surface area of the boiler	m ²
A ₂	Flue gas backed external surface area of the boiler	m ²
a ₁	Carbon content of ashes and riddling, dry basis	%
a ₂	Carbon content of dust and grit, dry basis	%
a ₃	Combustion excess air	%
C	Carbon content of fuel as fired	%
C _p	Specific heat capacity of fluid	kJ/kg.K
GCV	Gross calorific value	kJ/kg
H	Hydrogen content of fuel	%
h _f	Enthalpy of water	kJ/kg
h _g	Enthalpy of steam	kJ/kg
K ₁	Constant	--
k	Siebert constant	--
L ₁	Dry flue gas loss	%
L ₂	Loss due to enthalpy in water vapour	%
L ₃	Loss due to moisture in fuel	%
L ₄	Loss due to moisture in air	%
L ₅	Loss due to unburned gases	%
L ₆	Loss due to radiation, convection and conduction	%
L ₇	Loss due to combustible matter in ashes and riddlings	%
L ₈	Loss due to combustible matter in grit and dust	%
l ₁	Thickness of insulation on water or steam backed area	mm
l ₂	Thickness of insulation on gas backed area	mm
\dot{M}_f	Amount of fuel consumed in time t	kg
M ₁	Quantity of ashes and riddling collected in time t	kg
M ₂	Quantity of dust and grit collected in time t	kg
m _{H₂O}	Moisture content of fuel	%
\dot{m}_s	Steam flow rate	kg/h
p	Operating pressure of the boiler	Bar
Q _a	Actual rate of heat input during test	kW
Q _R	Rate of heat input at rated output of the boiler	kW
SFR	Steam to fuel (Evaporation) ratio	--

T_a	Ambient temperature	$^{\circ}\text{C}$
T_f	Temperature of the fuel	$^{\circ}\text{C}$
T_{fg}	Temperature of flue gas	$^{\circ}\text{C}$
T_g	Temperature of gaseous fuel	$^{\circ}\text{C}$
T_k	Heat carrier flow temperature	$^{\circ}\text{C}$
V_g	Volume flow rate of gaseous flue	m^3/s
w	Specific humidity of combustion air	kg/kg
W	Stoichiometric air for the fuel	kg/kg
X_f	Excess air factor	%
%CO	Volume of CO in flue gas	%
%CO ₂	Volume of CO ₂ in flue gas	%
%O ₂	Volume of O ₂ in flue gas	%
η	Efficiency	%



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LIST OF APPENDICES

Appendix 1: Semi-structured Questionnaire for Service providers	52
Appendix 2: Semi-structured Questionnaire for Boiler Owners.....	54



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