

THERMAL PERFORMANCE OF REGENERATORS
AND WASTE HEAT RECOVERY

by

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CERTIFICATE

This is to certify that the thesis entitled "THERMAL PERFORMANCE OF REGENERATORS AND WASTE HEAT RECOVERY" has been prepared under my supervision in conformity with the rules and regulations of the Indian Institute of Technology, Delhi. I further certify that the thesis has attained a standard required for a Ph.D. degree of the Institute. The results contained in this thesis have not been submitted in part or full to any other University or institution for the award of any degree or diploma.

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ABSTRACT

The effects of steam addition to combustion air on the thermal performance of counterflow regenerators have been studied. Based on its merits, the Alternating Direction Approximation has been selected for the purpose.

Experiments have been carried out to calculate the convective heat transfer coefficients in a regenerator model. For the limited range of velocities and temperatures for which the experiments are conducted, the values of heat transfer coefficients obtained from experiments compare favourably with the corresponding published data.

The Dufort and Frankel scheme has been developed for the numerical integration of the one-dimensional regenerator model. The thermal ratios calculated for various cases agree very closely with those obtained from other methods. It has been shown that this integrating scheme, for one-dimensional model, requires only two-third of computer time, as compared to the trapezoidal method, with only a little sacrifice on accuracy.

Alternating Direction Approximation and Dufort and Frankel schemes have been developed for two-dimensional regenerator model. The thermal performance of regenerators has been evaluated for a large number of regenerator data.

It is shown that the Alternating Direction Approximation is superior to the Dufort and Frankel scheme for the two-dimensional model.

The two-dimensional model and the Alternating Direction Approximation are employed to study the effects of injecting 0-15 percent steam, by volume, to combustion air on the regenerator performance. It is established that adding small quantities of steam improves the regenerator performance and results in considerable saving in fuel requirements of the furnace. The optimum value of steam quantity to be added depends upon the regenerator operating and design parameters. It is predicted that a furnace using 60 Scms air, in some cases, can save upto 5 million rupees per annum by adding 10 per cent steam to combustion air.

A non-linear model is proposed for studying the effect of steam addition on regenerator performance and the consequent fuel savings. The results obtained from the linear and the non-linear models are compared. It has been shown that the linear model predicts considerably low values of the savings in fuel costs, though it requires half the computer time needed for the proposed non-linear model. It is recommended that for better accuracy in predicting the effects of steam injection on regenerator performance, the non-linear model should be used.

CONTENTS

	<u>Page No</u>
CERTIFICATE	
ACKNOWLEDGEMENT	-
ABSTRACT	i
NOTATIONS	iii
CONTENTS	vii
CHAPTER 1 INTRODUCTION	1
1.1 Importance and Classification of Regenerators	1
1.2 Objective of the Present Work	5
1.3 Consolidation of the Present work	6
1.4 Justification of the Necessity of the Present Work	10
CHAPTER 2 TECHNICAL LITERATURE REVIEW	13
2.1 Representation of Simplified Mathematical Model by Differential Equations	13
2.2 Closed Methods of Solution	16
2.3 Open Methods	18
2.4 Convergence Criterion	20
2.5 Long Regenerators	21
2.6 Analogue Methods	23
2.7 Effect of Fluid Hold up	25
2.8 Two Dimensional Models	26
2.9 Waste Heat Recovery	28

CHAPTER 3	CALCULATION OF HEAT TRANSFER COEFFICIENTS IN REGENERATOR ANALYSIS	30
3.1.	Heat Exchange between Solid and Fluids	30
3.2.	Convective Heat Transfer Coefficient	31
3.3.	Radiative Heat Transfer Coefficient	34
3.4.	Experimental Verification of Convective Heat Transfer Coefficient	39
3.4.1.	Experimental Set up	39
3.4.2.	Test Procedure	42
3.4.3.	Calculation Procedure and Results	44
3.4.4.	Comments on Results and Conclusions	47
CHAPTER 4	DUFORT AND FRANKEL SCHEME FOR ONE DIMENSIONAL MODEL	49
4.1.	Mathematical Model	49
4.2.	Scheme of Solution	51
4.3.	Results and Discussion	55
4.4.	Conclusion	60
CHAPTER 5	TWO-DIMENSIONAL REGENERATOR MODEL - TWO RELATIVELY NEW FINITE DIFFERENCE TECHNIQUES	62
5.1.	Introduction	62
5.2.	Mathematical Model	63
5.3.	Setting up of Differential Equations	65
5.4.	Solution of the Governing Differen- tial Equations	70
5.5.	Comparison of Results by the Two Methods and Discussion of Results	79
5.6.	Conclusion	93

CHAPTER 6	EFFECT OF STEAM ADDITION ON THERMAL PERFORMANCE OF REGENERATORS - WASTE HEAT RECOVERY	98
6.1.	Introduction	98
6.2.	Method of Analysis	99
6.3.	Results and Discussion	101
6.4.	Conclusion	116
CHAPTER 7	WASTE HEAT RECOVERY - A NONLINEAR MODEL	118
7.1.	Introduction	118
7.2.	Results and Discussion	119
7.3.	Conclusion	129
CHAPTER 8	CONCLUSIONS	131
	REFERENCES	137
	APPENDIX I	139
	APPENDIX II	147
	APPENDIX III	151
	APPENDIX IV	156
	APPENDIX V	157
	APPENDIX VI	167