## CONTENTS

Title Page	i
Dedication	iii
Certificate	v
Declaration	vii
Curriculum Vitae	ix
Acknowledgement	xi
Contents	xiii
Nomenclature	xvii
Abstract	xix

## Chapter 1: Introduction and literature review

1.1	Introdu	Introduction		
1.2	Literati	Literature review		
	1.2.1	Studies of	on natural convection from horizontal cylinder	
		with ann	with annular fins	
	1.2.2	Studies on horizontal cylinder with eccentric annular fins		
	1.2.3 Studies on natural convection from vertical cylinder with			
	annular fins			4
		1.2.3.1	Natural convection from unfinned vertical	
			cylinder	4
		1.2.3.2	Natural convection from vertical cylinder with	
			fins	5
	1.2.4	Studies of	on entropy generation due to natural convection	6
1.3	Motiva	tion and ob	ojective of the present work	9
Chap	oter 2: Na	atural conv	vection heat transfer from a horizontal cylinder	
	W	ith annula	r fins	
2.1	Introdu	ction		11
2.2	Probler	n descriptio	on and a second s	11
2.3	Mather	Mathematical modeling		12
2.4	Numer	ical procedu	ure	16
2.5	Results	and discus	sion	23
	2.5.1	Effect of	fin spacing and fin diameter on heat transfer	23

2.5.2	Effect o	f fin diameter and Rayleigh number on optimum	
	fin spac	ing for maximum heat transfer	23
2.5.3	Effect o	f $S/d$ and $D/d$ on $Nu_D$ and fin efficiency	26
2.5.4	Effect o	f fin spacing on temperature plume	29
2.5.5	Effect o	f fin diameter on temperature plume	31
2.5.6	Effect o	f Rayleigh number on temperature plume	33
2.5.7	Effect o	f fin spacing on flow field around the fins	33
2.5.8	Effect o	f fin diameter on flow field around the fins	35
2.5.9	Effect o	f Rayleigh number on flow field around the fins	37
2.5.10	Temper	ature Plume and flow field as seen from the side of	
	the tube	e (on z-y plane)	37
Some u	seful corre	elations	39
2.6.1	Correlat	tion for Nusselt number	39
2.6.2	Correlat	tion for optimum fin spacing	40
2.6.3	Correlat	tion for fin efficiency	42
Conclus	sions		43
pter 3: Ef	fect of ec	centricity on natural convection heat transfer	
fı	rom a hor	rizontal cylinder fitted with annular fins	45
Introdu	ction		45
Problem	n descripti	ion	45
Mathematical modeling		46	
Numeri	Numerical procedure		48
Results	and discu	ssion	49
3.5.1	Effect o	f eccentricity ratio on heat transfer	49
3.5.2	Effect o	f eccentricity on temperature plume	51
	3.5.2.1	Effect of positive eccentricity ratio on	
		temperature plume at the fin section	51
	3.5.2.2	Effect of negative eccentricity ratio on	
		temperature plume at the fin section	52
	3.5.2.3	Effect of eccentricity on temperature plume in	52
		between the fins in z-y plane	53
	2571	Httppt of accontricity on tomporature plume	
	3.5.2.4	around the fins x-y plane	54
3.5.3	3.5.2.4 Effect o	around the fins x-y plane f eccentricity on flow field around the fins	54 55
3.5.3 3.5.4	3.5.2.4 Effect o Variatio	around the fins x-y plane f eccentricity on flow field around the fins on of heat transfer with eccentricity	54 55 57
	2.5.2 2.5.3 2.5.4 2.5.5 2.5.6 2.5.7 2.5.8 2.5.9 2.5.10 Some u 2.6.1 2.6.2 2.6.3 Conclus <b>pter 3: Ef</b> Introduc Problem Mathen Numeri Results 3.5.1 3.5.2	2.5.2Effect o fin space2.5.3Effect o 2.5.42.5.4Effect o 2.5.52.5.5Effect o 2.5.62.5.6Effect o 2.5.72.5.7Effect o 2.5.82.5.9Effect o 2.5.102.5.10Temper the tube Some useful correlat 2.6.22.6.1Correlat 2.6.32.6.2Correlat 2.6.32.6.3Correlat Conclusionsoter 3: Effect of ec from a hor Introduction Problem descripti Mathematical mod Numerical proceous 3.5.1S.5.2Effect o 3.5.2.13.5.2.13.5.2.2 3.5.2.3	<ul> <li>2.5.2 Effect of fin diameter and Rayleigh number on optimum fin spacing for maximum heat transfer</li> <li>2.5.3 Effect of <i>S</i>/<i>d</i> and <i>D</i>/<i>d</i> on Nu<sub>D</sub> and fin efficiency</li> <li>2.5.4 Effect of fin spacing on temperature plume</li> <li>2.5.5 Effect of fin diameter on temperature plume</li> <li>2.5.6 Effect of Rayleigh number on temperature plume</li> <li>2.5.7 Effect of fin spacing on flow field around the fins</li> <li>2.5.8 Effect of Rayleigh number on flow field around the fins</li> <li>2.5.9 Effect of Rayleigh number on flow field around the fins</li> <li>2.5.9 Effect of Rayleigh number on flow field around the fins</li> <li>2.5.0 Temperature Plume and flow field as seen from the side of the tube (on z-y plane)</li> <li>Some useful correlations</li> <li>2.6.1 Correlation for Nusselt number</li> <li>2.6.2 Correlation for fin efficiency</li> <li>Conclusions</li> </ul> <b>oter 3: Effect of eccentricity on natural convection heat transfer from a horizontal cylinder fitted with annular fins</b> Introduction Problem description Mathematical modeling Numerical procedure Results and discussion 3.5.1 Effect of eccentricity on temperature plume 3.5.2.1 Effect of positive eccentricity ratio on temperature plume 3.5.2.2 Effect of negative eccentricity ratio on temperature plume 3.5.2.3 Effect of negative eccentricity ratio on temperature plume at the fin section 3.5.2.3 Effect of negative eccentricity ratio on temperature plume in hortwark the fire is on unlease

Chaj	pter 4: N	atural convection heat transfer from a vertical cylinder	
	v	vith annular fins	61
4.1	Introdu	ction	61
4.2	Probler	n description	61
4.3	Mather	natical modeling	63
4.4	Numer	ical procedure	67
4.5	Results	Results and discussion	
	4.5.1	Effect of fin spacing and fin diameter on heat transfer	72
	4.5.2	Effect of fin diameter and Rayleigh number on optimum fin spacing for maximum heat transfer in turbulent flow	75
	4.5.3	Effect of <i>S</i> / <i>d</i> and <i>D</i> / <i>d</i> on Nusselt number	76
	4.5.4	Effect of <i>S</i> / <i>d</i> and <i>D</i> / <i>d</i> on fin efficiency	78
	4.5.5	Effect of fin spacing on temperature plume	82
	4.5.6	Effect of fin diameter on temperature plume	83
	4.5.7	Effect of Rayleigh number on temperature plume	85
	4.5.8	Effect of fin spacing on flow field around the fins	86
	4.5.9	Effect of fin diameter on flow field around the fins	89
	4.5.10	Effect of Rayleigh number on flow field around the fins	91
4.6	Some u	seful correlations	93
	4.6.1	Correlation for Nusselt number	93
	4.6.2	Correlation for optimum fin spacing	95
	4.6.3	Correlation for fin efficiency	96
4.7	Conclu	sions	98
Chap	oter 5: Ei	ntropy generation due to natural convection heat transfer	
	fr	rom horizontal cylinder with annular fins	99
5.1	Introduction		99
5.2	Mather	natical modeling	99
5.3	Results	Results and discussion	
	5.3.1	Effect of fin spacing and fin diameter on the ratio $(I/Q)_{\text{finned}}/(I/Q)_{\text{unfinned}}$	100
	5.3.2	Comparison of heat transfer irreversibility and fluid friction irreversibility	101

5.3.3 Contours of entropy generation rate per unit volume with varying fin spacing 102

<b>-</b> 4	<u> </u>
5 /	Conclucton
.).+	CONCIUSION

Cha	pter 6: E	ntropy generation due to natural convection heat transfer	
	f	rom vertical cylinder with annular fins	105
6.1	Introduction		
6.2	Mathematical modeling		
6.3	Results	Results and discussion	
	6.3.1	Comparison of heat transfer irreversibility and fluid	
		friction irreversibility	107
	6.3.2	Effect of fin spacing and fin diameter on the ratio	
		$(I/Q)_{\text{finned}}/(I/Q)_{\text{unfinned}}$	109
	6.3.3	Effect of fin spacing and fin diameter on Bejan number	111
	6.3.4	Contours of entropy generation rate per unit volume with	
		varying fin spacing	113
6.4	Conclu	sions	115
Refe	rences		117