

TABLE OF CONTENTS

CONTENTS	Page No.
Acknowledgement	I-II
Abstract	III-IX
Table of Contents	X-XIII
List of Tables	XIV-XV
List of Figures	XVI-XVIII
List of Abbreviations	XIX-XXIII
CHAPTER 1: INTRODUCTION	1-15
1.1 Need of drying for agricultural application	1-2
1.2 Solar energy resource of India	2-3
1.3 Solar drying technology	3-4
1.4 Application of PCMs in solar drying	4-6
1.5 Importance of sustainable technology in agricultural product processing	6-7
1.6 Motivation and gap of research	7-8
1.7 Objectives of research	8
1.8 Organisation of the Thesis	9-10
1.9 Graphical representation of the Thesis	11
References	12-15
CHAPTER 2: REVIEW OF LITERATURE	16-41
2.1 Characterisation of PCM in relation to its selection	16-21
2.1.1 Thermal stability: A critical parameter for selection of PCMs	21
2.1.2 Compatibility of PCMs with construction material of storage device	22
2.2 Applications of PCMs in Solar air heater and solar dryer	22
2.2.1 PCM based SAH	22-25
2.2.2 PCM based solar dryers	25-27
2.3 Application of modelling and simulation software for SAH design	27-30
2.4 Economic and environmental analysis of solar dryer	30-31
2.5 Summary	31-32
References	33-41

CHAPTER 3: SELECTION OF PCM AND ASSESSMENT FOR THERMAL STABILITY AND COMPATIBILITY		42-76
3.1	Introduction	42-43
3.2	Materials and methods	44
3.2.1	Scope and goals of PCM selection	44
3.2.2	PCM Selection methodology	44-46
3.2.3	Thermal stability analysis of the selected PCMs	46
3.2.3.1	Thermogravimetric analysis (TGA)	46
3.2.3.2	Differential scanning calorimetry (DSC)	46-47
3.2.4	Compatibility study of metal containers with selected PCMs	48
3.2.4.1	Corrosion test	48-49
3.2.4.2	Microscopic imaging and surface roughness study	50
3.3	Results and Discussions	50
3.3.1	Selection of PCM	50-53
3.3.2	Thermal stability analysis of the selected PCMs	53
3.3.2.1	Thermal degradation behaviour of PCM	53-55
3.3.2.2	Thermophysical properties of the PCM on repeated thermal cycles	55-62
3.3.3	Compatibility study of PCM	63
3.3.3.1	Corrosion study	63-64
3.3.3.2	Surface degradation imaging of the metal samples	64-66
3.3.3.3	Surface roughness profiling of the metal samples	66-70
3.4	Summary	70-71
	References	72-76
CHAPTER 4: DESIGN AND PERFORMANCE ANALYSIS OF PCM INTEGRATED SAH		77-111
4.1	Introduction	77-78
4.2	Materials and Methods	78
4.2.1	Geographical location of experimental site	78-79
4.2.2	Design of PCMSAH	79
4.2.2.1	Sizing of PCMSAH	79-80
4.2.2.2	Energy balance for design of PCMSAH	80-90
4.2.3	Performance evaluation of designed PCMSAH	91-92
4.3	Results and Discussions	93

4.3.1	Effect of theoretical outlet temperature of PCMSAH with varying air mass flow rate and absorber plate length	93-97
4.3.2	PCM quantity sizing	97-99
4.3.3	Development of PCMSAH based on simulation outcome	99-100
4.3.4	Comparison of performance of SAH (with and without PCM)	100-103
4.3.5	Energy analysis of SAH (with and without PCM)	104-106
4.3.6	Uncertainty analysis for thermal efficiency of PCMSAH	106-107
4.4	Summary	107-108
	References	109-111
CHAPTER 5: ENERGY, EXERGY, ECONOMIC AND ENVIRONMENTAL ANALYSIS OF PCM BASED SOLAR DRYER		112-148
5.1	Introduction	112-114
5.2	Materials and Methods	114
5.2.1	System description	114-116
5.2.2	Experimental procedure	116
5.2.2.1	Determination of initial moisture content of tomato	116
5.2.2.2	Tomato drying in PCMSD and open sun dry	116-119
5.2.3	Energy analysis of PCMSD	119
5.2.3.1	Energy analysis of PCMSD collector	119
5.2.3.2	Energy analysis of PCMSD drying chamber	119-120
5.2.4	Exergy analysis of PCMSD	120
5.2.4.1	PCMSD collector exergy analysis	120-121
5.2.4.2	Exergy analysis of the PCMSD drying chamber	121
5.2.5	Economic analysis of PCMSD	122
5.2.5.1	Annualized cost method	122-123
5.2.5.2	Economic payback period	123
5.2.6	Environmental analysis of PCMSD	124
5.2.6.1	PCMSD energy payback period	124
5.2.6.2	Carbon dioxide (CO ₂) emission	124
5.2.6.3	Carbon dioxide (CO ₂) mitigation	125
5.2.6.4	Carbon credit potential	125
5.3	Results and Discussions	125
5.3.1	Performance analysis of PCMSD	125-127

5.3.2	Drying analysis of tomato in PCMSD and open sun dry	127-129
5.3.3	Energy efficiency of PCMSD	129-132
5.3.4	Exergy efficiency of PCMSD	132
5.3.4.1	Exergy inflow and outflow of the PCMSD collector	132-135
5.3.5	Exergy efficiency of PCMSD drying section	136
5.3.5.1	Exergy inflow and outflow of PCMSD drying section	136-138
5.3.6	Economic analysis of PCMSD	138-140
5.3.7	Environmental analysis of PCMSD	140-142
5.4	Summary	142-144
	References	145-148
CHAPTER 6: SUMMARY AND CONCLUSIONS		149-151
6.1	Selection, thermal stability, and compatibility of PCM for solar drying application	149
6.2	Design, development, and performance assessment of PCMSAH	149-150
6.3	Performance assessment of PCMSD with energy, exergy, economic and environmental approaches	150-151
6.4	Limitations of the present research	151
6.4	Suggestions for future work	151
	Appendix 3A	152-154
	Appendix 4A	155
	List of Publications	156