

CONTENTS

	PAGE
Abstract	i
ACKNOWLEDGEMENTS	vi
List of Figures	x
List of Tables	xvii
Nomenclature	xix
CHAPTER I Introduction	1-5
CHAPTER II Literature Review	6-73
2.1: Ductile cast iron and evolution of austempered ductile iron	6
2.2: Development of ADI – an outline	11
2.3: Alloying elements in ADI	16
2.3.1: Influence of alloying elements on austemperability	17
2.3.2: Influence of alloying elements on austempering process	20
2.3.3: Alloying elements and segregation	24
2.4: Microstructure of ductile iron and development of ADI	27
2.5: Austenitization	28
2.5.1: Sequence of austenitization process	28
2.5.2: Austenitization kinetics	32
2.5.3: Austenite grain size	34
2.5.4: Carbon potential and austenitization	34
2.6: Austempering	35
2.6.1: Thermodynamics of austempering	35
2.6.2: Austempering transformations	41
2.6.3: Processing Window	42
2.6.4: Austempering Kinetics	44
2.7: Microstructure evolution in ADI	51
2.8: Variation of heat treatment and microstructure	52
2.8.1: Effect of austempering time	53
2.8.2: Effect of austempering temperature	53
2.8.3: Effect of austenitization temperature	54

2.8.4:Effect of austenitization time	55
2.9: Mechanical Properties	56
2.9.1:0.2 % Proof stress	56
2.9.2:Ultimate tensile strength	58
2.9.3:Percentage elongation	63
2.9.4:Quality index	65
2.9.5:Impact strength	66
2.9.6:Fracture of ADI	68
2.9.6.1:Fractographs of ADI	68
2.10: ADI and standards	69
2.11: Formulation of problem	71
CHAPTER III Experimental Procedure	74-88
3.1: Melting and casting of ductile irons	74
3.2: Base material characterization	74
3.3: Material Preparation	77
3.4: Heat treatment	77
3.4.1:Austenitization	77
3.4.2:Austempering	79
3.5: Study of austenitization process	81
3.6: Study of austempering process	81
3.7: Details of measurement procedures	82
3.7.1: Metallography	82
3.7.2: Hardness study	83
3.7.3: X-ray diffraction to study austenitization kinetics	83
3.7.4: X-ray diffraction study of austempering	84
3.7.5: Tensile testing	86
3.7.6: Impact testing	88
3.7.7: Fractographic study	88
CHAPTER IV Mathematical model for austenitization kinetics of ductile iron	89-105
4.1: Analysis of austenitization	89
CHAPTER V Structural Changes in ADI and heat treatment parameters	106-158

5.1:	Evolution of microstructure	106
5.2:	Structural changes and heat treatment parameters	117
5.3:	Structural changes and base iron composition	135
5.4:	Austempering kinetics	141
5.5:	Discussion	148
5.6:	Summary	158
CHAPTER VI	Mechanical properties and heat treatment	159-214
6.1:	Hardness	160
6.2:	0.2 percent Proof stress	163
6.3:	Ultimate tensile strength	170
6.4:	Ductility	172
6.5:	Quality index	174
6.6:	Strain hardening behaviour	176
6.7:	Impact strength	182
6.8:	Fracture study	186
6.9:	Comparison of mechanical properties	197
6.10:	Discussion	199
6.11:	Summary	212
CHAPTER VII	Mechanical properties of Cu-Ni alloyed ADI	215-233
7.1:	Hardness	216
7.2:	0.2% Proof stress	218
7.3:	Ultimate tensile strength	218
7.4:	Ductility	220
7.5:	Quality index	223
7.6:	Impact strength	223
7.7:	Discussion	225
7.8:	Summary	232
CHAPTER VIII	Conclusions	234-242
CHAPTER IX	Future scope of work	243
	References	244-251