

List of Figures	III
List of Tables	VII
Nomenclature	IX
1 Introduction	1
1.1 Transition of energy production in Germany	1
1.2 Objectives and outline of the current work	4
2 Background	7
2.1 Hall-Héroult process	7
2.1.1 Cell operation	11
2.1.2 Heat balance of the cell	13
2.1.3 Efficiency and Flexibility	14
2.1.4 Operational challenges	15
2.1.5 Approach to optimal cell operation	17
2.2 Literature survey	17
2.3 Contribution of this work	26
2.4 Closure	27
3 Solidification model	29
3.1 Introduction	29
3.2 Numerical model	30
3.3 Experimental set-up	35
3.4 Validation of the solidification model	40
3.5 Closure	53
4 Thermoelectric cell model	55
4.1 Multi-Region electric and thermal model	55

4.2	Modelling approach	55
4.2.1	Electric field model	58
4.2.2	Thermal field model	59
4.2.3	Multi-Region thermoelectric model	61
4.3	Material properties	67
4.4	Boundary conditions	70
4.4.1	Steel chamber and shell heat exchanger	72
4.4.2	Anode and cathode assembly	74
4.4.3	Summary of the boundary conditions	75
4.5	Cell parameters	75
4.6	Closure	79
5	Results and Discussion	81
5.1	Sensitivity Study	81
5.1.1	Augmented thermal conduction of the molten pool	83
5.1.2	Augmented thermal conduction of air	84
5.1.3	Ramming paste lining	86
5.1.4	Thermal boundary conditions	89
5.2	Validation of the thermoelectric cell model	90
5.3	Operational parameters	95
5.3.1	Height of bath and aluminium	98
5.3.2	Anode-to-cathode distance and cell current	100
5.3.3	Bath composition	104
5.3.4	Shell heat exchanger	107
5.4	Geometric parameters	108
5.4.1	Copper insert in cathode assembly	108
5.5	Discussion	110
5.6	Closure	114
6	Conclusions and future recommendations	117
6.1	Conclusions	117
6.2	Future recommendations	119
	Bibliography	121