# TABLE OF CONTENTS

Abstract vi

Thesis Structure x

List of Tables xv

List of Figures xvii

Acronyms, Symbols and Units xxii

1. Introduction 1
   1.1 Introduction to burnishing 3
      1.1.1 Principle of burnishing operation 5
      1.1.2 Types of burnishing 5
      1.1.3 Advantages and disadvantages 16
      1.1.4 Process parameters of burnishing 18
   1.2 Characteristics of burnished components 20
      1.2.1 Surface finish 20
      1.2.2 Surface hardness 21
      1.2.3 Compressive stresses 21
      1.2.4 Microstructure 23
      1.2.5 Corrosion resistance 23
      1.2.6 Wear resistance 24
      1.2.7 Fatigue Life 24
      1.2.8 Electrical Conductivity 25
      1.2.9 Bearing Ratio and Bearing Ratio Curve 26

2. Literature Survey 28
   2.1 Literature Survey 29
      2.1.1 Literature on various burnishing methods and tools 29
      2.1.2 Literature on optimization of process parameters 36
      2.1.3 Literature on study of process parameters 40
      2.1.4 Literature on study of improvement in surface properties 44
      2.1.5 Literature on theoretical modeling and simulation 50
      2.1.6 Literature on applications of burnishing 54
2.1.7 Miscellaneous literature 59
2.2 Gaps in the literature 63
2.3 Motivation 65
2.4 Research Objectives 81

3. Methodology 83
3.1 Experimental Approach 84
  3.1.1 Workpiece Materials 85
  3.1.2 Equipment 88
  3.1.3 Experimental procedure 94
  3.1.4 Surface roughness measurement 98
  3.1.5 X-ray Diffraction 100
  3.1.6 Microstructure analysis 105
  3.1.7 Corrosion resistance 109
  3.1.8 Wear resistance 120
  3.1.9 Electrical Conductivity 124
  3.1.10 Bearing Ratio and Bearing Ratio Curve 131
3.2 Optimization 138
  3.2.1 Design of experiments 139
3.3 Finite Element Analysis 147
  3.3.1 Introduction to finite element analysis 149
  3.3.2 Procedure for finite element analysis 150
  3.3.3 Advantages and disadvantages 153
  3.3.4 Application of FEA to Burnishing 154

4. Results and Discussions 158
4.1 Optimization of process parameters 160
  4.1.1 Optimization of tool related parameters for improved surface finish 161
  4.1.2 Optimization of process parameters for improved corrosion resistance 170
  4.1.3 Consolidated parameter values
4.2 Measurement of surface hardness and distribution 179
4.3 Measurement of induced compressive stresses 182
  4.3.1 X-ray diffraction 182
4.3.2 Finite element analysis 185
4.3.3 Comparison of results from XRD and FEA 186
4.3.4 Depth of stress affected zone 189
4.4 Analysis of microstructure 190
4.5 Study of improvement in corrosion resistance 194
  4.5.1 Corrosion in normal atmosphere 195
  4.5.2 Corrosion in brine solution 207
  4.5.3 Reasons for improvement in corrosion resistance 217
4.6 Study of improvement in wear resistance 219
  4.6.1 Weight loss in wear 219
  4.6.2 Dimensions of wear scar 225
4.7 Burnishing affected zone 228
4.8 Improvement in electrical conductivity 230
4.9 Bearing Ratio and Bearing Ratio Curve 231
  4.9.1 Bearing Ratio 232
  4.9.2 Bearing Ratio Curve 234
  4.9.3 Rk Parameters 236

5. Conclusions and Future Work 240
  5.1 Conclusions 241
  5.2 Significant research contributions 246
  5.3 Scope for future work 247

References 250
Appendix 272
Research Publications 283