Table of Contents

Abstract 11

Chapter 1  
Introduction 13  
1. Motivation 13  
2. Objectives and structure 14  
2.1 Objectives 14  
2.2 Structure 14

Chapter 2  
Literature Review 15  
1. Word Energy Scenario 15  
2. Overview of Organic Rankine Cycle 17  
3. ORC State of the art 20  
3.1 Overview of ORC market 20  
3.2 ORC architectures 23  
3.3 Working fluid selection 26  
3.4 Expander assessment 29  
3.5 Micro expanders 31  
4. The Tesla turbine 34  
4.1 Principle of operation 34  
4.2 Literature review 35

Chapter 3  
Methodology and Models 57  
1. Objectives and structure 59  
1.1 Nozzle Design 59  
1.2 Stator model 61  
1.3 Stator-rotor coupling model 65  
1.4 Rotor model 66
Micro turbo expander design for small scale ORC

1.5 Diffuser 76
1.6 Performance indicators 77

2. Mechanical Design 78
2.1 Static analysis 78
2.2 Dynamic analysis 80

3. Prototypes design: from thermodynamic considerations to realization 88
3.1 Air Tesla turbine 89
3.2 ORC Tesla turbine 98

4. 3D CFD Model 112
4.1 Air Tesla turbine 112
4.2 ORC Tesla turbine 114

5. Test benches setup 117
5.1 Air Tesla turbine 117
5.2 ORC Tesla turbine 119

Chapter 4
Analysis of Results 123
1. 2D model results 123
   1.1 Air Tesla turbine 123
   1.2 ORC Tesla turbine 127
      1.2.1 Component analysis 127
      1.2.2 Turbine geometric assessment 142
      1.2.3 Comparison with Volumetric expanders 154
2. Prototypes performance maps 156
   2.1 Air Tesla turbine 156
   2.2 ORC Tesla turbine 160
3. CFD analyses 173
   3.1 Air Tesla turbine 173
   3.2 ORC Tesla turbine 174
4. Experimental Campaigns 182
   4.1 Air Tesla turbine 182
   4.2 ORC Tesla turbine 184

Chapter 5
Conclusions and Recommendations 199
1. Conclusions 199
2. Recommendations 204