

Contents

| | |
|--|-------------|
| Contents | xiii |
| List of Figures | xv |
| List of Tables | xx |
| Nomenclature | xxi |
| 1 Introduction | 1 |
| 1.1 Background | 2 |
| 1.2 Motivation | 3 |
| 1.3 Objectives | 9 |
| 1.4 Methodology | 9 |
| 2 State of the Art | 11 |
| 2.1 Turbine Performance Data | 12 |
| 2.2 Radial Turbine Aerodynamics | 13 |
| 2.3 Measurements in Off-Design Condition | 14 |
| 2.4 1D Radial Turbine Modeling | 18 |
| 2.5 1D Tip Leakage Modeling | 21 |
| 2.6 CFD Modeling in Small Radial Turbomachinery | 23 |
| 3 Wide Range Turbine Map Measurement | 27 |
| 3.1 Introduction | 29 |
| 3.2 Theoretical Background | 29 |
| 3.3 Development of Methodology & Measurement of VGT Turbine | 32 |
| 3.4 Repetitiveness, Extension to Non-Adiabatic Condition & Measurement of Vaneless Turbine | 47 |
| 3.5 Conclusions | 64 |
| 4 Turbine CFD Simulation in a Wide Range | 67 |
| 4.1 Introduction | 68 |
| 4.2 Geometry & CFD Model | 68 |
| 4.3 Meshing & Mesh Convergence | 70 |
| 4.4 CFD Results vs. Experimental Data | 72 |
| 4.5 3D Flow in Extreme Off-design Condition | 78 |
| 5 1D Turbine Modeling | 107 |
| 5.1 Introduction | 109 |
| 5.2 Tip Leakage Loss Model & Flow Characterization Method | 109 |
| 5.3 Efficiency Extrapolation Model | 133 |
| 6 Conclusions and Future Works | 157 |
| 6.1 Conclusions | 158 |
| 6.2 Future Works | 161 |
| Bibliography | 165 |