A Parametric Approach to Turbine Tip Leakage Aerothermal Optmization for Helicopter Turbo-shaft Engines

Levent Kavurmacioglu, , Department of Mechanical Engineering, Technical University of Istanbul, Istanbul, Turkey

Hıdır Maral, Department of Mechanical Engineering, Technical University of Istanbul, Istanbul, Turkey

Cem Berk Senel, Department of Mechanical Engineering, TechnicaL University of Istanbul, Istanbul ,

Long Abstract

Introduction

The current paper deals with the development of a computational system dealing with parametric assessment of aerodynamic losses near the tip region of a high-pressure turbine blade. Performance of an axial flow turbine is strongly related to the flow structure in the gap between blade tip and casing. Aerodynamic losses related with the tip leakage flow is about one-third of the overall loss in the turbine rotor [1]. Thus, there have many studies on the tip leakage flow in the literature. Effect of the flow structure in the tip gap is going to be investigated parametrically in this study.

1. Methods

The current paper deals with the development of a computational system dealing with parametric assessment of aerodynamic losses near the tip region of a high-pressure turbine blade. Special emphasis is paid to developing a sufficiently accurate 3D RANS based loss estimation system for the optimization of tip section geometry in typical turbo-shaft engines used in helicopter propulsion systems up to 1500 HP. An HP turbine tip section will be optimized for minimum aerodynamic losses and also for minimized heat load. The present manuscript deals with a preliminary study of effective "parametric" grid generation, transitional and turbulent flow model implementation and assessment under realistically simulated turbine flow conditions. Initial development of this computational model is performed in a linear turbine cascade arrangement. Numerical experiments with parametrically generated block structured grids and unstructured grids pave the way for the 3D optimization of the HP blade tip region. The future efforts will include modified squealer tips, tip trenches and tip carving investigations in an effort to obtain optimal 3D tip shapes as far as aerodynamic losses and heat loads are concerned.

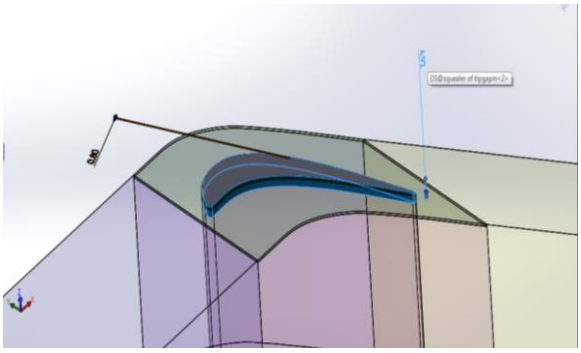

Figure 1. Parametrical approach for the tip leakage studies.

References

[1] B. Mischo, T. Behr and R. S. Ahbari. Flow physics and profiling of recessed blade tips: impact on performance and heat load. *Journal of Turbomachinery*, 130.