UNIVERSITI TEKNOLOGI MARA

NON-RADIAL FIBER TURBINE PERFORMANCE FOR LOW PRESSURE TURBINE VIA NUMERICAL ANALYSIS AND EXPERIMENTAL (COLD FLOW)

SITI NOR SYAZWANI BINTI RIDZUAN

MSc

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

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Name of Student	:	Siti Nor Syazwani binti Ridzuan
Student I.D. No.	:	2014913995
Programme	:	Master of Science (Mechanical Engineering) – EM750
Faculty	:	Mechanical Engineering
Thesis Title	:	Non-Radial Fiber Turbine Performance For Low Pressure Turbine Via Cfd And Experimental (Cold Flow)
Signature of Student	:	………………………………………………..
Date	:	May 2020

ABSTRACT

This thesis presents the evaluation of non-radial fiber turbine. The turbine adapted to an electrical turbo comporting (ETC) for recovering waste energy in the internal combustion engine. The ETC was designed to produce 1KW of power, rotate at 50000 rpm and expand the pressure ratio of 1.1. The pressure ratio for the off-design operations was limited between 1.05 and 1.25. The turbine cannot operate higher than 1.25 due to choking problem. Limitation of the current design caused the operation of the LPT to produce chocked flow at certain mass flow rate and the efficiency significant dropped when the turbine was operated at pressure ratio 1.25. The flow field of the non-radial fiber turbine (NRFT) was studied by adjusting the exit camberlines which were lean backward swept and forward swept from the base design of non-radial fiber element. The data were collected through numerical and experimental analyses by using cold flow testing facility. The low pressure turbine (LPT) analysis was done by using computational fluid dynamic (CFD) simulation for single passage. The three dimensional turbulence fluid flow motion is described by using the Reynolds-Averaged Navier-Stokes equations (RANS) in the CFD modelling. The k- turbulence model is used in this study to model the Reynolds stresses. The result for the numerical analysis was compared with the baseline design by analysing the performance of efficiency and swallow capacity of the LPT. The flow field analysis is discussed in order to investigate the entropy generated at different exit angles. According to the validation data that have been done using CFD baseline with the experimental it is shown that the efficiency data for the velocity ratio under 0.7 with Relative standard deviation of 0.37. The turbine performances for the backswept design has showed an increment of 2% for the total-to-static efficiency and higher swallow capacity at the PR=1.25. This shows that the backswept design has a better design than the baseline and forward swept design. Base on the current outcomes the backswept have shown the highest efficiency 0.787 at PR 1.05-1.11 but increased in entropy generated due to increase of the temperature and decreased of pressure at the outlet as it approaching the higher mass flow rate. The flow field analysis study shows at the mid-section of the blade which is 0.5 of the wise-span the flow were chocking as the flow intake for the backswept are higher compared to forward swept once it passes through the mid place the exit flow not constant and make the velocity curl are reduces that lead to entropy increased.

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