[Sondkar**et al.*, 5 (6): June, 2016]
IC™ Value: 3.00

ISSN: 2277-9655
Impact Factor: 4.116

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

THERMODYNAMIC DESIGN OF RADIAL TURBINE FOR TURBO-CHARGER

Sondkar Pratik [*], Siddiqui Qasim, Sonawane Shubham, Phirke Indraneel.

[*] Department of Mechanical Engineering, All India Shri Shivaji Memorial Society's College of Engineering, Pune, India.

DOI: 10.5281/zenodo.55789

ABSTRACT

This is a report for design process of radial turbine used in turbocharger. Input for design requirements are power, mass flow rate, inlet temperature, pressure and rotation speed. The design variables include rotor radius ratios, stator-exit angle and rotor-exit tangential velocity distribution. The geometry was tested using Computational Fluid Dynamics (CFD) where some modifications were introduced on the preliminary design to satisfy the design requirements. The turbine's design point rotational speed is 60000 rpm, stagnation inlet temperature and pressure are 1050K, 3.39 bar respectively and mass flow rate is 0.55kg/s. The turbine rotor has 15 blades with inlet and exit diameters 102mm and 36 mm.

KEYWORDS: Analytical design of turbine, circular arc method, Radial turbine, Turbocharger.

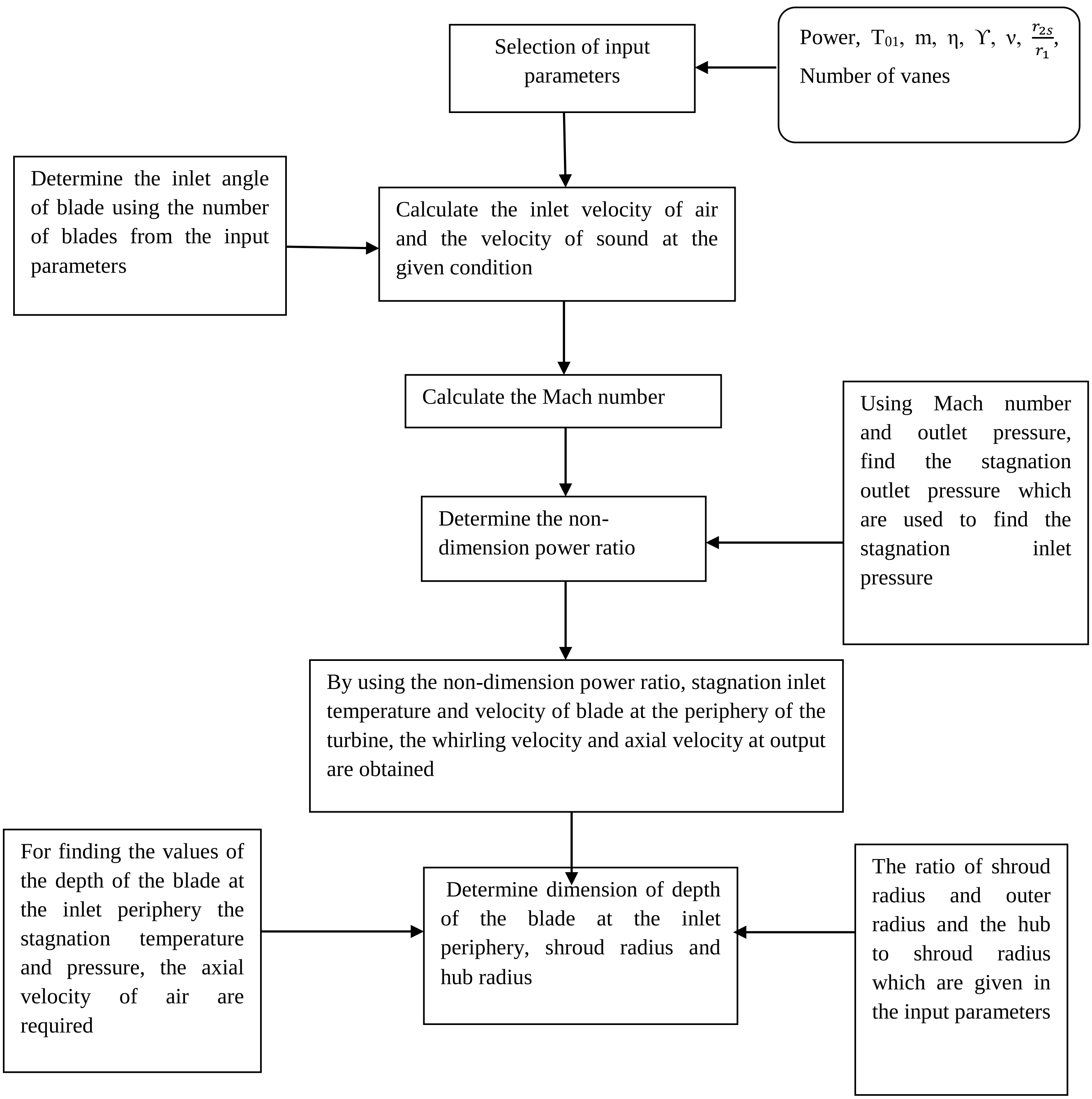
INTRODUCTION

There are basically two types of turbine which are radial flow and axial flow. A radial turbine appears similar to the centrifugal compressor but the diffuser vanes are replaced by a ring of nozzle guide vanes. A radial turbine is a turbine in which the working fluid enters radially i.e. radial to the shaft. There are two types of radial flow turbines which are inward flow radial turbines and outward flow radial turbines. The gas flow in radial flow turbine is tangential with high velocity and is directed inwards and leaves the rotor with a small whirl velocity near the axis of rotation. The radial turbine handles low mass flows more efficiently than the axial flow turbine. For this reason the radial flow turbines has been widely used in the cryogenic industry as turbo expander and also in turbochargers for reciprocating engines. The radial turbine which has variable-area stator can engage over a broad flow range at nearly constant pressure ratio, temperature and speed. If this can be achieved at high efficiency, the turbine can contribute to high engine performance over the entire operating range. But the stator-area variation along with the associated vane-end clearances affects the turbine performance and these effects must be taken into consideration for proper prediction of engine performance. In radial turbine larger pressure and temperature drops can be achieved in single stage compared to an axial turbine, so radial turbine can extract larger work in a single stage. A Turbine for a 75KW micro gas turbine has been designed as a part of the project. The analysis of the system involves many repetitive calculations of component performance and geometry over a range of conditions.

DESIGN METHODOLOGY

The descriptive process mentioned below are used for designing the radial turbine where the numbers of turbine blades are decided using trial and error method. The power required by the compressor in the turbocharger is produced in the radial turbine. The stagnation temperature and the mass flow rate are the values generally taken from a automobile engine. The standard values ratio of the shroud to inlet radius and exit hub to shroud radius are used.

ISSN: 2277-9655
Impact Factor: 4.116



ISSN: 2277-9655
Impact Factor: 4.116

Construction of vane profile

From thermodynamic design all dimensional parameter like inlet and outlet vane angle, radii at tip and root, blade height are obtained. For the vane profile work circular arc method has been used. Under circular arc method the circle is divided into number of circle having equal interval, starting with outermost circle with given angle found in the design a curve is drawn up to the internal circle. Both root and tip curves can be obtained by this method.

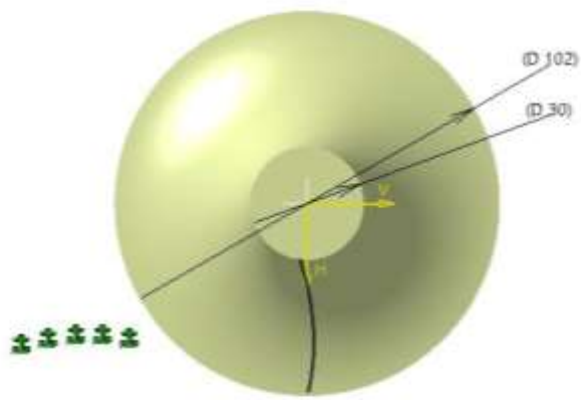
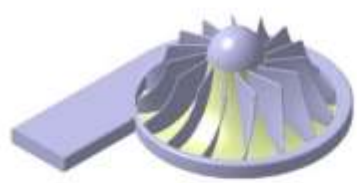


Figure 1 Profile by Circular Arc Method

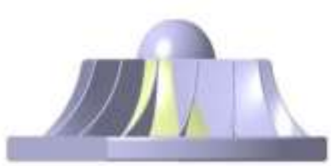
3D model

Now we can create the 3D model using CATIA software. Different view are shown below

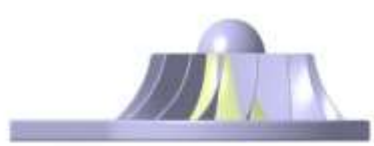
Top View



Isometric View



Front View



Side View

Figure 2 Various Views of Turbine

RESULTS AND DISCUSSION

Table 1 input and output parameters

Sr. No.	Input Parameters	Values	Sr. No.	Output Parameters	Values
1)	Input Power	75kW	1)	α_1	75.04^0
2)	Number of vanes	15	2)	β_1	29.92^0
3)	Inlet Temperature	1050 K	3)	Mach number at inlet	0.5106
4)	Mass Flow Rate	0.55 kg/s	4)	Axial velocity of air	215 m/s
5)	Volumetric efficiency	83%	5)	Whirling velocity of air	804.66 m/s
6)	ϒ	1.4	6)	Depth of blade at inlet	8.16 mm
7)	Exit hub to shroud radius ratio	0.4	7)	Radius of hub at outlet	15 mm
8)	Shroud to inlet radius ratio	0.7	8)	Radius of shroud at outlet	36 mm
9)	Rotation Speed of Turbine	60000 rpm			

CONCLUSION

The thermal analysis of turbine and the geometric parameter are calculated for geometric modeling. And this results can be use to analysis and manufacturing of turbocharger.

REFERENCES

[1]. Indraneel Phirke, Qasim Siddiqui, Shibham Sonawane, Pratik Sondkar,' A Review on Centrifugal Compressor Design Methods' IJIRST –International Journal for Innovative Research in Science & Technology, Volume 3, Issue 01, June 2016.
[2]. S. L. Dixon and C. A. Hall, "Fluid Mechanics and Thermodynamics of Turbo machinery", Seventh Edition.
[3]. Shalini Bharadwaj, " Computational Fluid Dynamics Analysis of Turbocharger System" volume: 3, Issue: 5, May 2014
[4]. R. Ragoth Singh, 'Design and Analysis of Pump Impeller using SWFS' world journal of modeling and simulation', vol. 10(2014) no. 2,pp. 152-160.
[5]. AshishBowade, CharuParashkar,*"A Review of Different Blade Design Methods for Radial Flow Centrifugal Pump",* International Journal of Scientific Engineering and Research (IJSER), Volume 3 Issue 7, July 2015
[6]. Graham Cox, "CHALLENGES IN THE DESIGN OF RADIAL TURBINES FOR SMALL GASOLINE ENGINES", PCA Engineers Limited, Lincoln, UK