STRUCTURAL AND THERMAL ANALYSIS ON GAS TURBINE BLADE USING SOLID WORKS

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ABSTRACT: Cooling of gas turbine blades is a major consideration because they are subjected to high temperature working conditions. Several methods have been suggested for the cooling of blades and one such technique is to have radial holes to pass high velocity cooling air along the blade span. The forced convection heat transfer from the blade to the cooling air will reduce the temperature of the blade to allowable limits. Finite element analysis is used in the present work to examine steady state thermal & structural performance for stainless steel. Four different models consisting of solid blade and blades with varying number of holes (7,8,9 & 10 holes) were analyzed in this project to find out the optimum number of cooling hole. It is observed that as the no.of holes increases the temperature distribution increase. The structural analysis is carried out after the thermal analysis in SOLID WORKS SIMULATION TOOL. Finally the blade with 9 holes has giving optimum performance.
KEYWORDS: Gas turbine blade, structural analysis, thermal analysis, solid works.

I.INTRODUCTION

A turbine is a rotary mechanical device that extracts energy from a fluid flow and converts it into useful work. A turbine is a turbo machine with at least one moving part called a rotor assembly, which is a shaft or drum with blades attached. Moving fluid acts on the blades so that they move and impart rotational energy to the rotor. The gas turbine is the most versatile item of turbo machinery today. It can be used in several different modes in critical industries such as power generation, oil and gas, process plants, aviation, as well domestic and smaller related industries. A gas turbine essentially brings together air that it compresses in its compressor module, and fuel, that are then ignited. Resulting gases are expanded through a turbine. That turbine's shaft continues to rotate and drive the compressor which is on the same shaft, and operation continues.A separator starter unit is used to provide the first rotor motion, until the turbine's rotation is up to design speed and can keep the entire unit running. The compressor module, combustor module and turbine module connected by one or more shafts are collectively called the gas generator.

II.PURPOSE OF THE STUDY

The main aim of the project is to analyze the structural and thermal behavior of gas turbine blade under extreme loading conditions by varying number of holes.

Methodology:

The geometric model is used to represent the gas turbine blade. The geometric model of the gas turbine bladeis carries out in the computer aided design and analysis software SOLID WORKS which is capable of producing precise solid surface geometry. After modeling meshing is done by defining boundary conditions with help of the **meshing tool and** analysis is done with help of the SOLIDWORKS SIMULATION TOOL.

Modelling Of Gas Turbine Blade

The orthographic views of gas turbine blade are as follows:

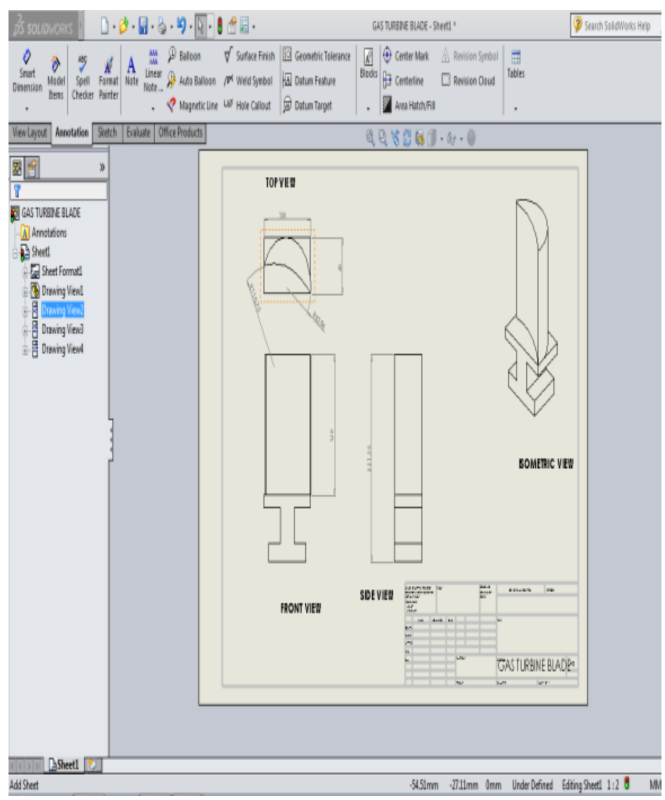

Fig.1.orthographic views of gas turbine blade

- By taking the dimensions from the drafting and drawing, we generated the part drawing of the gas turbine rotor blade in solid works.

3D Model Of Gas Turbine Blade

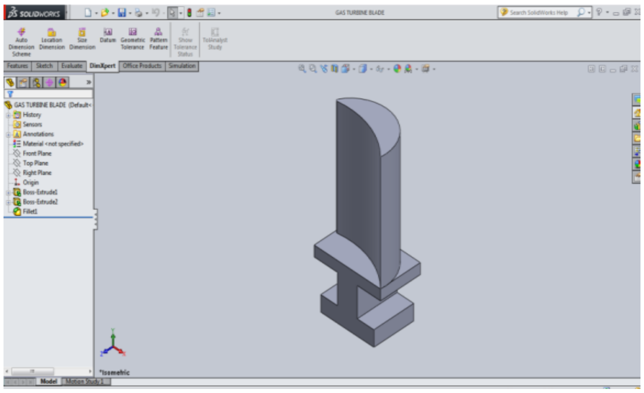

Fig.2.3D model of gas turbine blade

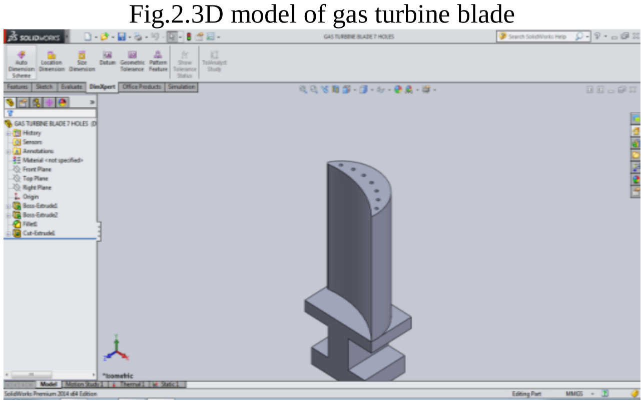

Fig .3. Gas turbine blade of 7 holes

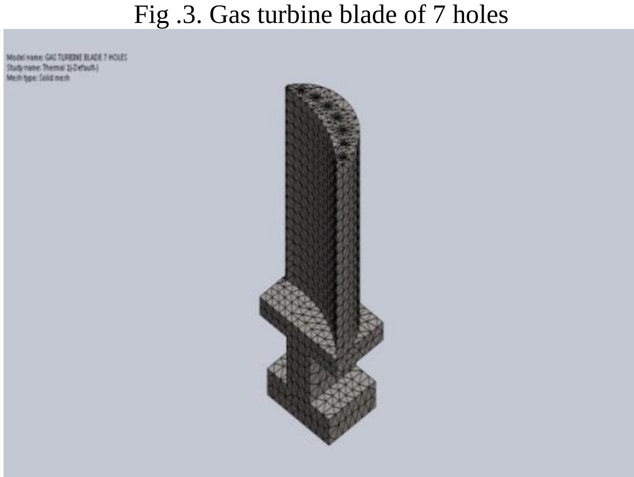

Fig.4.Meshing of gas turbine blade

THERMAL ANALYSIS:

A thermal analysis calculates the temperature distribution and related thermal quantities in a system or component. Typical thermal quantities of interest are

- The amount of heat lost or gained
- Thermal gradients
- Thermal fluxes.

Thermal Analysis Of Gas Turbine Blade :
Material : Titanium Alloy
Thermal Analysis of Gas Turbine Blade of 7 holes :

Name	Type	Min	Max
Thermal	TEMP: Temperature	300 Kelvin Node: 1	800 Kelvin Node: 792

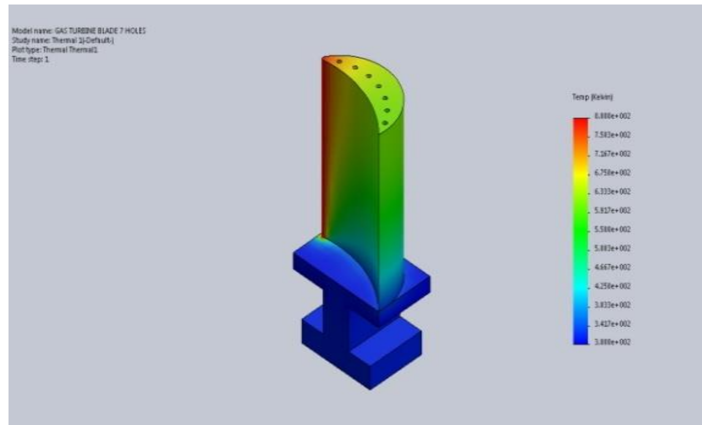

Fig.5.Temperature distribution in gas turbine blade 0f 7 holes

Thermal Analysis of Gas Turbine Blade of 8 holes:

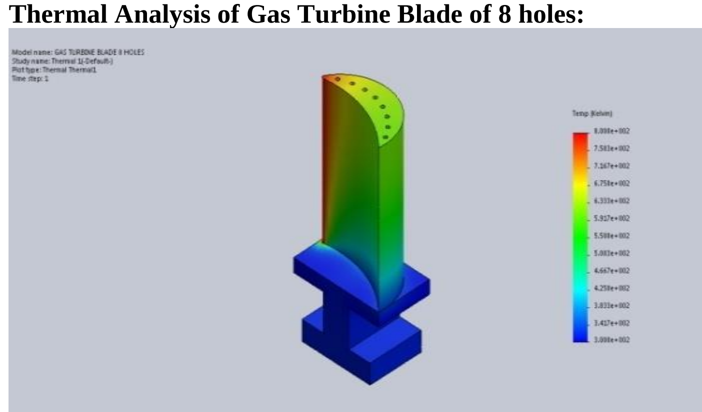

Fig.6.Temperature distribution of gas turbine blade with 8 holes

Thermal Analysis of Gas Turbine Blade of 9 holes:

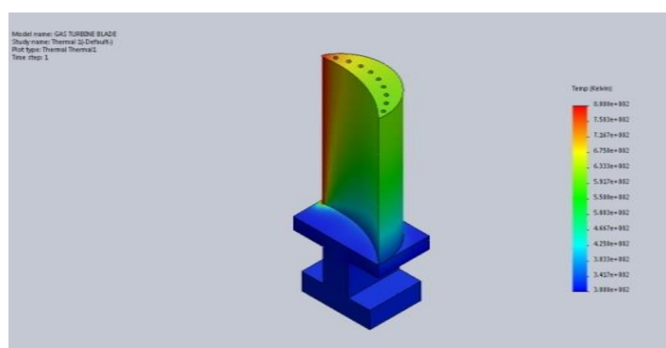

Fig .7.Temperature distribution of gas turbine blade with 9 holes

Thermal Analysis of Gas Turbine Blade of 10 holes:

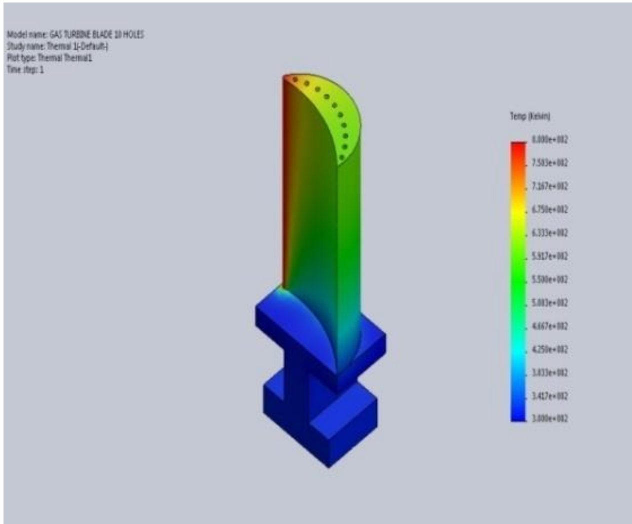

Fig.8 . Temperature distribution of gas turbine blade with 10 holes

Structural Analysis:

Structural analysis is probably the most common application of the finite element method. In this thesis displacement, stress and strain under different loading conditions are determined. The analysis results are shown in the following figures.

Structural Analysis of Gas Turbine Blade of 9 Holes:

Name	Type	Min	Max
Stress 1	VON: von Mises Stress	147.585 N/m^2 Node: 39087	1.77925e+007 N/m^2 Node: 38560

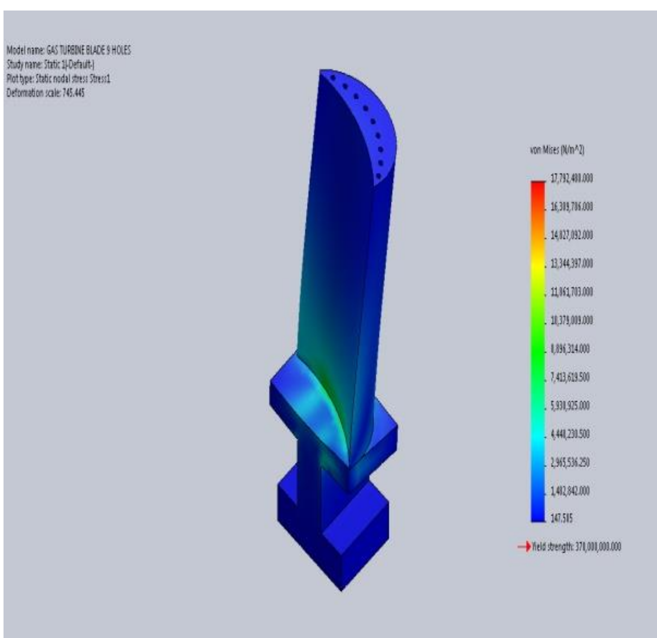

Fig .9. Von Misses Stress developed in blade of 9 holes

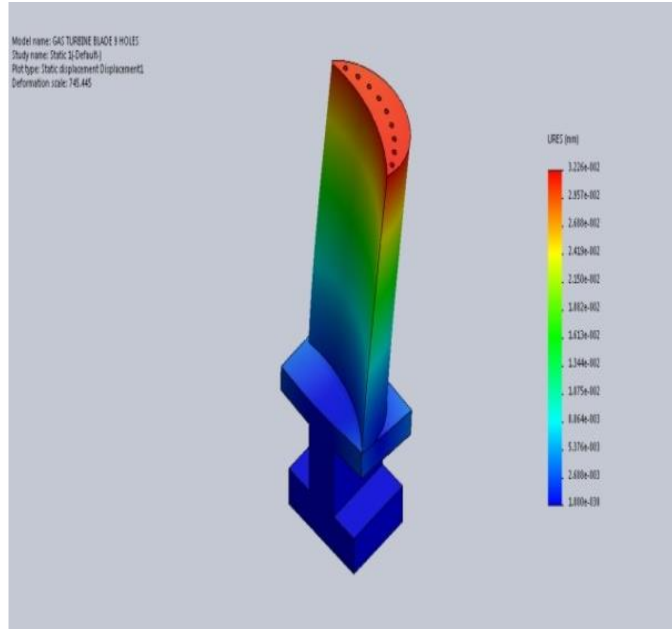

Fig. 10. Displacement developed in blade of 9 holes

Name	Type	Min	Max
Strain1	ESTRN: Equivalent Strain	1.83181e-009 Element: 18928	0.000145974 Element: 19623

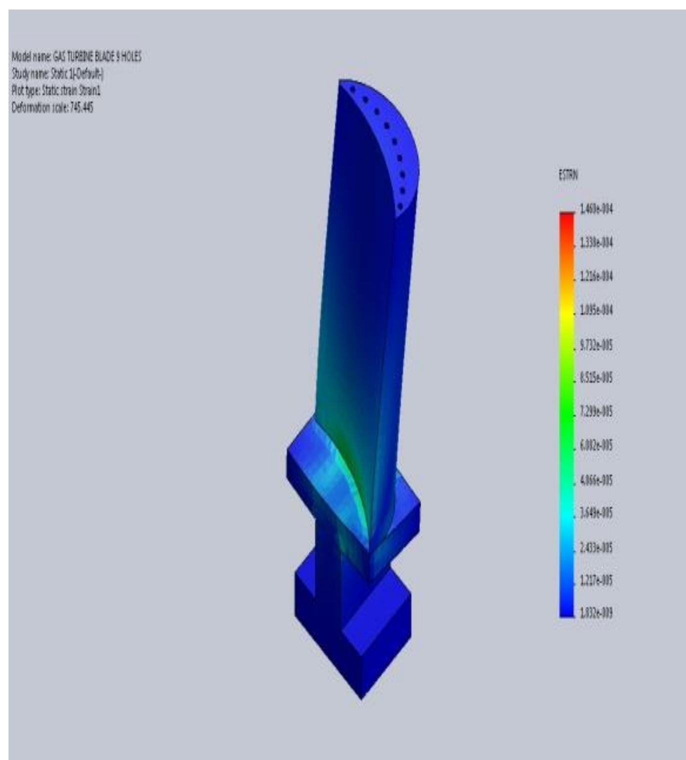

Fig.11. Strain developed in blade of 9 holes

III.RESULTS

Thermal Analysis:

TITANIUM ALLOY	
TURBINE BLADE WITH HOLES	AVERAGE TEMPERATURE VALUES (k)
7	516.12
8	515.12
9	514.1
10	513.2

Structural Analysis:

NO.OF HOLES	TITANIUM ALLOY		
	STRESS(N/mm^2)	Displacement(mm)	Strain
7	15.6	0.0321	0.001633
8	17.7	0.03223	0.001637
9	19.6	0.03226	0.001639
10	28.6	0.03235	0.001009

IV.CONCLUSION

In this project using finite element analysis as a tool, the thermal and structural analysis is carried out sequentially. The blade with different no. of holes 7, 8, 9and 10 were used for analysis.The gas turbine blade is modeled in a 3D cad tool called Solidworks 2014 by using extrude feature.Then gas turbine blade with different holes such as 7, 8, 9 and 10 has been modeled on the blade span.The blade with different no. of holes 7, 8, 9and 10 were used for thermal analysis in solidworks simulation tool. It is observed that as the no. of holes increases the temperature distribution increase.The structural analysis is carried out after the thermal analysis in SOLID WORKS SIMULATION TOOL. It is observed that blade with 10 holes has showing more stresses than the remaining blades.Finally the blade with 9 holes has giving optimum performance for prescribed loading conditions with average temperature of 514.1K at the trailing edge and von misses stresses as 17.7 Mpa.

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