



MODELLING AND ANALYSIS OF GAS TURBINE BLADES

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Abstract: The work is dealt with the modelling and analysis of gas turbine blades of a jet engine. The materials used for the modelling and analysis are severe temperature and pressure intolerant. In this work, turbine blade is modelled with two different materials i.e. Titanium T6 and Inconel 718. An attempt was made to investigate temperature, stresses, displacement and stress distribution for two materials considered on comparing the results it is concluded that Inconel 718 is the best material.

Keywords: Inconel 718, Titanium-T6, Stress Analysis, Strain Analysis, Thermal Analysis, Turbine Blade, Ansys.

1. Introduction

The blade is responsible for getting high temperature and high pressure for extracting energy. While working, the gas turbine blades are exposed to higher temperatures, directly resulting in the melting and shaping out from the original dimension, leading to the reduction in the overall output i.e., electricity generated. Therefore, a new, reliable material must be chosen to withstand the temperatures and pressures of higher order. Here, in this work, Inconel 718 and titanium T6 are considered for performing the stress, strain, displacement and thermal analysis on the ANSYS and solid works interfaces. Inconel 718 comprises of the metals like nickel, chromium, cobalt and steel in (+) proportions. Due to its distinct metallurgical composition and chemical arrangement, the material possesses higher melting points, which exactly comes into the perfect category of metals exclusively chosen for the turbine blade design. Due to its higher economy and rare availability, another material, Titanium T6 is also included for conducting the tests, by keeping dimension and other external factors remain same. At the end, a comparison is made

Amongst them, to decide which material is perfectly suitable considering all the factors. The mechanical properties of both the materials are taken from literature; the gas turbine blade is modelled in SOLIDWORKS interface. For simulation purposes, we used the airfoil AH 79-100C.

4. Literature Review:

AID--Airfoil Investigation Database [1] has done research on air foil turbine blades, his focus was on different turbine blade models. He had used different type of models for blades, of which AH79-100c air foil has the best Efficiency, Thickness and lower flatness.

V.Veeraragavan [2] has done research on aircraft turbine blades, and he has used conventional alloys such as titanium, molybdenum, and super alloys were chosen for the analysis. He analyzed the effect of temperature on different materials for number of times. He concluded that molybdenum has the best temperature resistance.

C.J.Manjunath [3] has done research on different types cooling techniques which has maintaining different temperature. He has done analysis on titanium and inconel .He concluded that Inconel has better efficiency and better thermal properties.

CAE Worldwide [4] has done a tutorial on YouTube making a muffler stress, strain and displacement analysis on the work bench by taking that in this project the analysis has been done.

5. METHODOLOGY:

First define the problem, then identify the dimensions of blade profile. After completing generate the required model, and finally analysis is to be done on model.

After obtaining the result meshing is to be done by determining the maximum stress, temperature distribution along the blade profile. Comment on the obtained result.

4. MODELLING IN SOLID WORKS:

By taking standard values, calculations are done to get the dimensions of the blade. The Modelling parameters are given in the table. 4.1.1. The turbine blade model is created in solid works software; it is depicted in the fig 4.1. After the turbine blade modelling, the obtained model was attached to a rotating shaft using the mirror extension option in the solid works GUI. It is performed by clicking on the shaft, giving 20 blades for the model turbine .Entire modelling is done in solid works software. The obtained outcome is depicted below in the fig 4.2.

5. ANALYSIS OF TURBINE BLADE:

The similar design is used for both the materials. The parameters like blade height, chord width etc included in the table 5.1.1. After completion of modelling, the model is imported to ANSYS 15.0

Open ANSYS workbench from the left column click on the steady state thermal analysis then a sub window occurs on main window now import the model into ANSYS. After importing the model apply temperature at end of the turbine blade. Apply convection to the

entire blade and de-select at end of the blade. At film coefficient right click; select the import option after this click on stagnant air-simplified case. Then solve by taking options as stress, strain and displacement analysis and it will show various results.

Meshing the Blade: For the meshing, the blade model is imported from the solid works to the ANSYS workbench for performing the analyses. For Meshing Ansys 15.0 workbench is used. The axis parameters are included in the table 6.1.1. The entire region was meshed and also a cross section was also taken so that we can see the meshed turbine blade inside the enclosure. Importing the designed gas turbine with its enclosure here can also see the entry and exit direction of the wind in the figure. Now after importing the design into the ANSYS fluent make sure that makes the energy equation in enabled condition. Now here the blade material as titanium T6.Now here we have taken the blade material as titanium T6.

6. RESULTS AND DISCUSSION:

In this work the stress analysis was maintained in Titanium-T6 is depicted in fig 6.2. The strain analysis performed and simulated is depicted in fig 6.3. The Displacement analysis performed is depicted in fig 6.4. The stress, Strain, Displacement analyses for Inconel 718 material to the existing model turbine is performed and depicted in the fig 6.5, fig 6.6 and fig 6.7 respectively. The thermal loading is also performed and the outcomes are depicted in the figures 6.8 and 6.9.The stress, strain, displacement, temperature tolerance values are depicted in the table 6.2.2.

7. CONCLUSION:

From the above results it can be observed that Titanium-T6 has lesser efficiency than Inconel 718. The Titanium-T6 has less stress, strain, displacement and strength where the Inconel 718 has better stress, strain and displacement. The Inconel 718 has high strength and deformation.

8. TABLES AND FIGURES:

Table No: 4.1.1 – Blade Dimensions

Parameter	Value	Unit
Blade height, h	0.081833	M
Chord width, c	0.02727	M
Pitch, s	0.02264	M
Blade inlet angle, β_2	18.3 ⁰	Deg
Blade inlet angle, β_3	54.56	Deg
Mean Radius	0.2457	M

Material properties

Properties	Unit	Inconel	Titanium
Young's modulus	MPa	2E5	1.06E5
Density	kg/m ³	8193.3	4420
Poisson's ratio		0.31	0.3
Tensile yield	MPa	1069	530
Allowable	MPa	641.8	318
Allowable Shear	MPa	385.08	190.8
Specific heat	J/kg-	556.85	527.5

X Axis	Y Axis	Z Axis
0.2 meters	0.2 meters	0.5 Meters

Parameters of the axes

Results of Titanium-T6 and Inconel 718:

Parameters	Titanium-T6		Inconel 718	
	MIN	MAX	MIN	MAX
Stress	10.34N/m ²	145570N/m ²	13.647N/m ²	174017N/m ²
Strain	1.24542e-010	5.73498e-007	1.1174e-010	3.6541e-007
Displacement	0mm	0.0115951mm	0mm	0.00744876mm

FIGURES

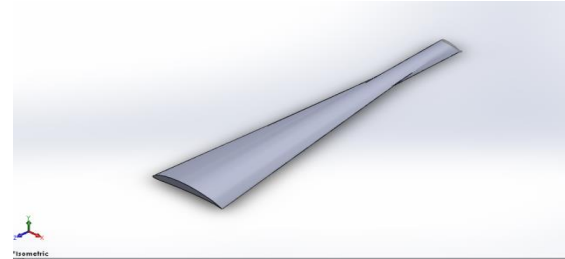


Fig: 4.1

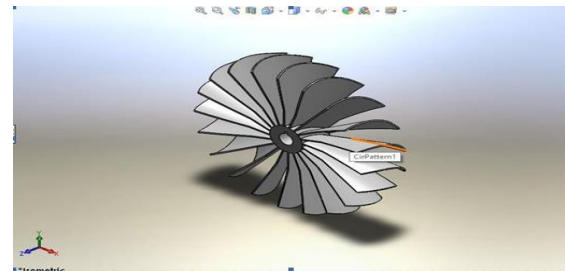


Fig: 4.2

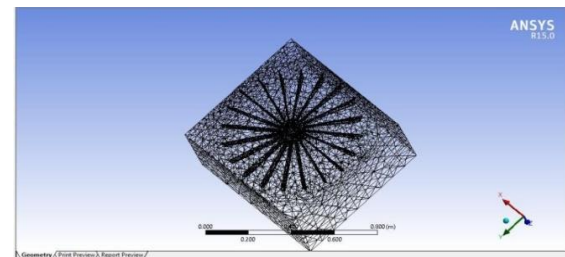


Fig: 5.1

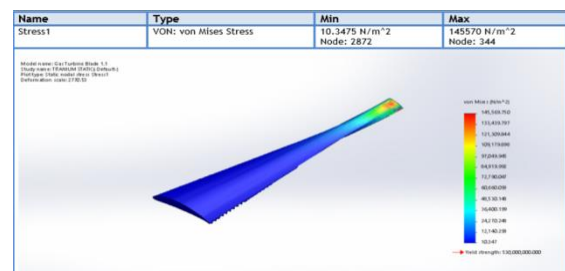


Fig: 6.2

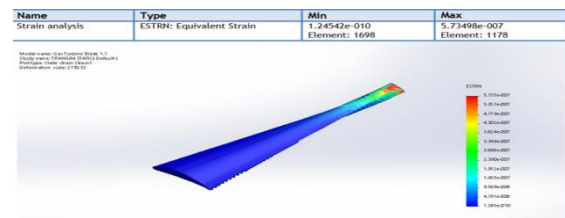


Fig: 6.3

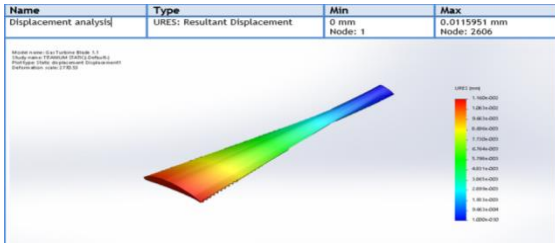


Fig: 6.4

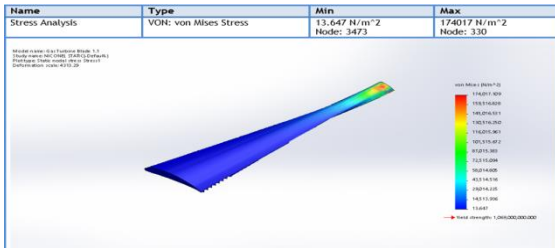


Fig: 6.5

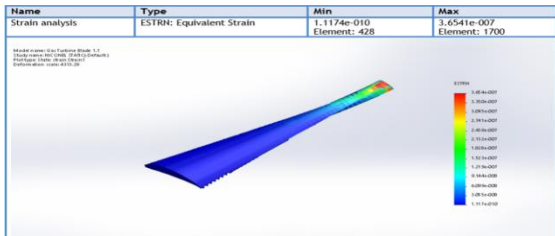


Fig: 6.6

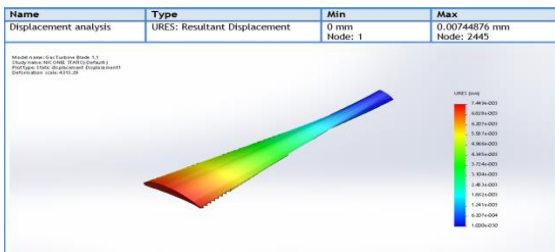


Fig: 6.7

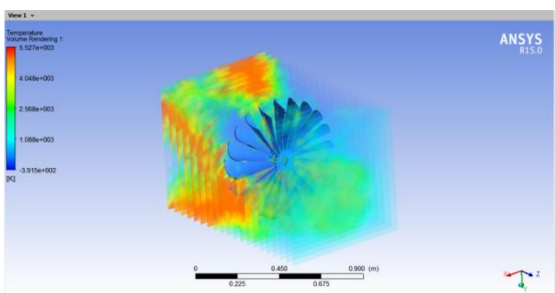


Fig: 6.8

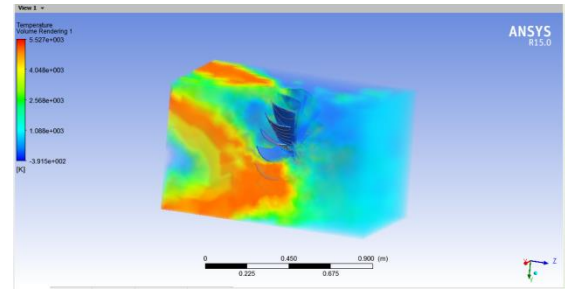


Fig: 6.9

9. References:

1. <http://www.airfoildb.com/airfoils/1494> in this the Gas turbine blade dimensions have been taken.
2. V.Veeraragavan Effect of Temperature Distribution in Gas Turbine Blade Model Using Finite Element Analysis.
3. www.ijirset.com C.J.Manjunath was done a research paper on turbine blade.
4. <https://www.youtube.com/watch?v=FIHV2CMC8Ok> was done a thermal analysis on stress, strain and displacement.

