Research Article Impact Factor: 4.226 ISSN: 2319-507X
Pateriya A, IJPRET, 2014; Volume 2 (12): 105-111 IJPRET

INTERNATIONAL JOURNAL OF PURE AND APPLIED RESEARCH IN ENGINEERING AND TECHNOLOGY

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DESIGN AND ANALYSIS OF TURBINE BLADE OF ENGINE

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Accepted Date: 29/07/2014; Published Date: 01/08/2014

Abstract: This paper summarizes the design and analysis of turbine blade, Pro-E is used for design of solid model and ANSYS software for analysis for model generated, by applying boundary condition, also includes specific post processing and life assessment of blade. How the program makes effective use of the ANSYS pre-processor to mesh complex turbine blade geometries and apply boundary conditions. Here we presented how Designing of a turbine blade is done in Pro-E. And to demonstrate the pre-processing capabilities, static and thermal analyses results, generation of Campbell and Interference diagrams and life assessment. This project specifies how the program makes effective use of the ANSYS pre-processor to analyze the complex turbine blade geometries and apply boundary conditions to examine steady state thermal & structural performance of the blade for La2Zr2O7 (Lanthanum zirconium oxide), Titanium Alloy & AlSi (Aluminum Silicate) materials. Finally stating the best suited material among the three from the report generated after analysis.

Keywords: Design, Pro-E, Turbine blade, Ansys

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PAPER-QR CODE

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How to Cite This Article:

Pateriya A, Narkhede SS; IJPRET, 2014; Volume 2 (12): 105-111

INTRODUCTION

The gas turbine obtains its power by utilizing the energy of burnt gases and the air which is at high temperature and pressure by expanding through the several rings of fixed and moving blades, to get a high pressure of working fluid which is essential for expansion a compressor is required. The quantity of working fluid and speed required are more, so generally a centrifugal or axial compressor is required. The turbine drive the compressor so it is coupled to the turbine shaft, If after compression the working fluid were to be expanded in a turbine, then assuming that there were no losses in either component, the power developed by the turbine can be increased by increasing the volume of working fluid at constant pressure or alternatively increasing the pressure at constant volume. To acquire a higher temperature of the working fluid a combustion chamber is essential where combustion of air and fuel takes place giving temperature rise to the working fluid. The turbine escapes energy from the exhaust gas. In each type the fast moving exhaust gas is sued to spin the turbine, since the turbine is attached to the same shaft as the compressor at the front of the engine, and the compressor will turn together, the turbine may extract just enough energy to turn the compressor. The rest of the exhaust gas is left to exit the rear of the engine to provide thrust as in a pure jet engine.

This paper deals with the first type is centrifugal stresses that act on the blade due to high angular speeds and second is thermal stresses that arise due to temperature gradient within the blade material. The analysis of turbine blade mainly consists of the following two parts: Structural and thermal analysis. The analysis is carried out under steady state conditions using Ansys software. The study has been conducted with three different materials i.e.La2Zr2O7 (Lanthanum zirconium oxide), Titanium Alloy & AlSi (Aluminum Silicate).

2.0 LITERATURE REVIEW:

Le- Chung shaiu and Teng- Yuan Wa (1), 1997 studied the free vibration behavior of buckled composite plates by using finite element method. Unlike beams or columns, plates can carry a much-increased load after buckling without failure. Here triangular plate element is taken for finite element analysis. This element is developed based on a simplified high order plate theory and large deformation assumptions. The nonlinear governing equations of motion for plates are linear zed into two sets of equations by assuming small amplitude vibration of the laminates about its buckled static equilibrium profile. In the post buckling region, the buckled plate may shift from are buckling mode to another. Due to this buckle pattern change, plate is also suddenly changed which in turn makes the natural frequencies of the plate to have sudden jump. The buckling mode of plates shifted from first to second. Then the stiffness of the plate is increased which makes a sudden increase in natural frequencies.

Hu.X.X and Tsuigi.T (2), 1999 had done free vibration analysis on curved and twisted cylindrical thin panels. Blades are part of turbo machinery rotating at high speed, so it is important to ensure safety while rotating. A turbo machinery blade is treated as a cylindrical thin panel twist, chord wise and span wise curvatures along lengthwise direction. The non-linear strain-displacement relations of the model are derived based on the general thin shell theory and a numerical method for analyzing the free vibrations of curved and twisted cylindrical thin panels is presented by means of the principle of virtual work for the free vibration using Raleigh-Ritz method. It is shown that the method is effective for analyzing the free vibrations of the turbo machinery blades, and can provide accurate results when the proper number of integrating points and terms of displacement functions are adopted. The effects of curvature and twist on the vibrations are studied. This method is adequate for evaluating the vibration characteristics even if the models have large curvatures and large twists.

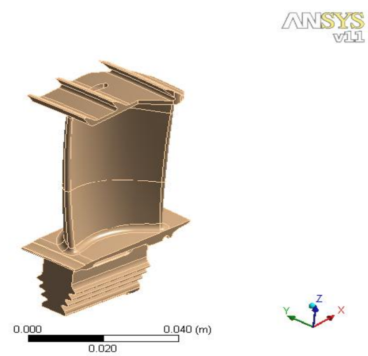
Rao J.S (3), 1974 made a two-dimensional analysis of free vibrations in the tangential direction. The first step is to develop the potential and kinetic energies for the tangential motion of the blades and shrouds. Second, Hamilton's principle is applied to derive the differential equation of motion and the boundary conditions.

Tsuiji and Sueoka (4), 1990 deal with the free vibration of cylindrical panels by using Raleigh-Ritz method. Blades of turbo machinery are twisted in axial direction and cambered in the chord wise direction. The blade has been idealized to a twisted cantilevered cylindrical panel and numerical methods have investigated its vibratory characteristics. The convergence of frequency parameters is studied with the increase of number of strip and of terms in assumed solution functions. To demonstrates the usefulness of the method, the frequency parameters obtained.

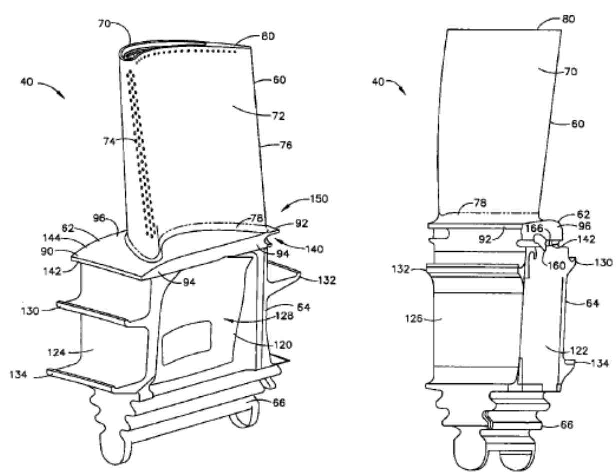
Leissa, MacBain and Kielb (5), 1984 made a comprehensive study of the numerous previous investigations on the free vibration of twisted cantilever plates of rectangular platform which are results of a joint industry, government and university effort. Theoretical results received from different FEM programs utilizing shell theory and beam theory were compared with two independent sets of data obtained from experiments.

3.0 COMPUTER AIDED ANALYSIS OF TURBINE BLADE:

The model is formed and analyzed using Pro-E and ANSYS. For automatic mesh generation and node selection is used. The structural, thermal modal modules of ANSYS 11.0 are used for the analysis of the turbine blade. The turbine blade was analyzed for mechanical stresses, temperature distribution, combined mechanical and thermal stresses and radial elongations, natural frequencies and mode shapes. The blade is then analyzed sequentially with thermal analysis preceding structural analysis.



3.1 Details of Turbine blade:



4.0 RESULTS AND DISCUSSIONS:

Properties	Suggested Material $La_2Zr_2O_7$ (Lanthanum zirconium oxide)	Titanium Alloy	AlSi *(Aluminum Silicate)*
Young's Modulus (Pa)	1.75E+11	9.60E+10	7.10E+10
Poisson's Ratio	0.2	0.36	0.33
Density (Kg/m3)	5740	4620	2770
Thermal Expansion (1/°C)	9.10E-06	9.40E-06	2.30E-05
Thermal Conductivity (W/m°C)	1.56	21.9	165
Specific Heat (J/Kg°C)	490	522	875

4.1 Thermal analysis:

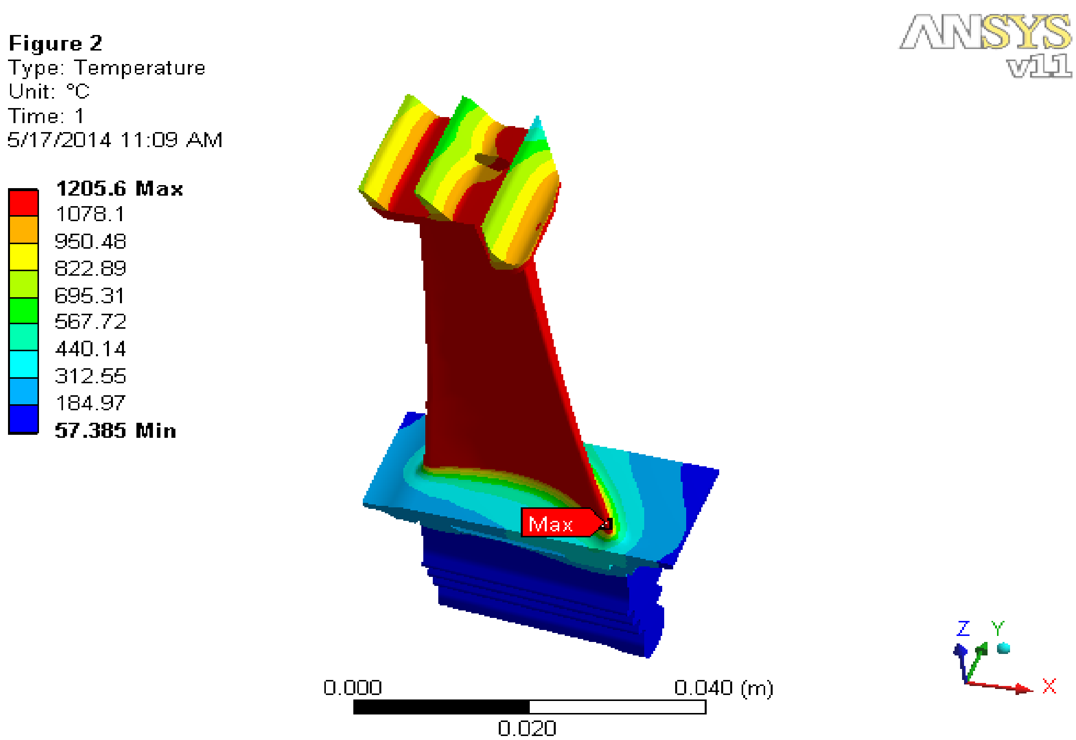


Figure 4.1 Temperature distributions in the blade geometry

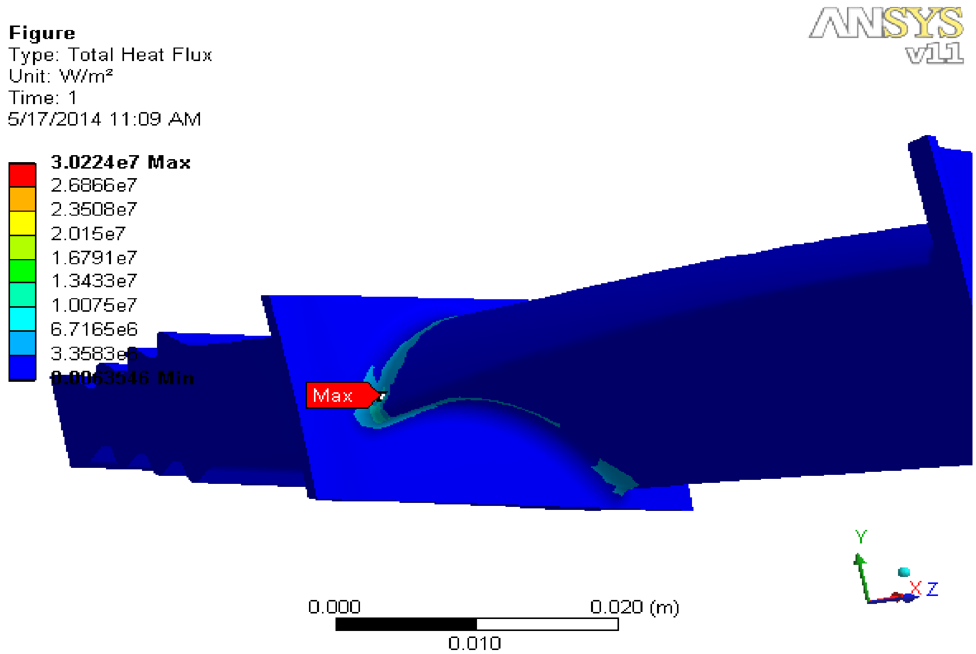


Figure 4.1 Total heat fluxes in the blade geometry

From the post processing, the temperature variation obtained as shown in fig. From figure, it is observed that the temperature variations from leading edge to the trailing edge on the blade profile are varying throughout the blade and the variation is linear along the path from both inside and outside of the blade.

5.0 CONCLUSION

In this paper, analyzed previous generals and designs of the gas turbine blade to do further optimization, Finite element results for free standing blades give a complete image of structural characteristics, which can utilized for the improvement in the design and the operating conditions.

6.0 REFERNCES

1. Le-chungshiau , Teng –yuan Wu, Free vibration of buckled laminated plates by finite element method, Transactions of the ASME ,journal of vibrations and Acoustics October 1997, volume 111, pp:635-644.

2. Hu, XX and T. Tsuiji free vibration analysis of curved and twisted cylindrical thin panels, journal of sound and vibration, Jan 7, 1999, vol-219(1), and pp: 63-68.

3. Rao.J.S; application of variational principle to shrouded turbine blades, proceedings of 19th cong. ISTAM, 1974, pp: 93-97.

4. Tsuneo Tsuji, Teisukesueoka, vibration analysis of twisted thin cylindrical panels by using Raleigh-Ritz method, JSME international Journal, Series iii, 1990, volume 33, pp: 501-505.

5. Leissa .A.W, Macbin.J.C and Keilb. R.E, Vibration of twisted cantilever plates summary of provisions; current studies, Journal of sound and vibration, 1984, vol-96(20), pp: 159-167.

6. Yoo.H.H, J. Y. Kwak & J.chung ,Vibration analysis of rotating pre twisted blades with a concentrated mass, Journal of sound and vibration, mar 2001,vol 240(5),pp:891-908.

7. Park ,Jung –yong; jung, Yong-keun; Park, Jong- jin,kang, yong-ho, Dynamic analysis method for prevention of failure in the 1st stage low pressure turbine blade with fingers root, Proceeding of SPIE- The International Society for Optical Engineering, 2001,vol.4537,pp:209-212.

8. A. H. Shah, G. S. Ramsekhar and Y. M. Desai, Natural vibration of laminated composites beams by using fixed finite element modeling , Journal of the sound & vibration,2002,vol:257,pp:635-651.

9. J. S. Rao, R. Bahree, A. M. Sharan, The design of rotor blades taking into account the combined effects of vibratory and thermal loads, transactions of ASME, Journal of Engineering gas turbines and Power,oct-1989,vol-111,pp:610-618.