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REVIEW PAPER ON STRESS DISTRIBUTION OVER THE BLADE OF COMPRESSOR OF MICRO TURBINE

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Abstract
A micro turbine can be used in refrigerator, generator; air drier. A micro turbine being small in size compared to large turbine has less weight which reflects on pressure ratio, low cost, easy maintenance In our paper we are going to analyse the compressor blade and shaft of a micro turbine under various loading condition and study the effect of stress distribution over the blade at various speed and shapes. Withstanding of compressor blades of gas turbine for the elongations is a major consideration in their design because they are subjected to high tangential, axial, centrifugal forces.There are several project summarizes the design and analysis of gas turbine compressor blade by using power full finite element software. There are many project specifies use of the different finite element software like ANSYS 11.0, ANSYA 9.0, CATIA V5, I-DEAS,CATIA V5R15 AND NASTRAN to analyse the compressor blade geometries and apply boundary condition to study structural performance on blade. And also study the structural performance on blade by considering various material like titanium alloy INCONEL 625, Al7075, S.S 310A.

KEYWORDS: FEM, FEA, Compressor, stress analysis.

1. INTRODUCTION

The purposes of gas turbine technology are extracting the maximum quantity of energy from the working fluid to convert into work with maximum efficiency at minimum cost. In general gas turbine obtains its power by utilizing the energy of burnt gases and the air which is at high temperature and pressure by expanding in gas turbine. The gas turbine drives the compressor so it is coupled to the turbine shaft. After compression the working fluid expanded in a turbine then the power generated is used for run the compressor and remaining power is used to generate electricity. 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 order of 4 to 10 bar of working fluid.

Turbine compressor usually sits at the front of the engine. There are two main type of compressor the centrifugal and axial compressor. In both types the of compressor rotates and it is driven by a shaft that passes through the engine and attached turbine compressor and generator. Blades may be considered to be the heart of the gas turbine compressor assembly and all other member exist for the sake of the blades. Without blades there would be no power and slightest damage would reduction in efficiency and costly repairs.

2. Simple gas turbine:

Gas turbine is the prime mover that uses gas or air as the working fluid to be use to move the turbine, the produced work is also use to drive the electric generator too. A simple gas turbine component consists of compressor, combustion chamber and the turbine as shown in the fig (1.1). Gas turbine deals with the Brayton Cycle for its work as its ideal work

Figure 1 – An Open Cycle Gas-Turbine Engine

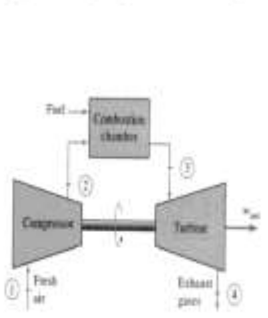
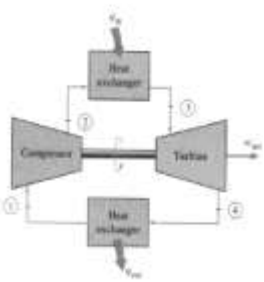


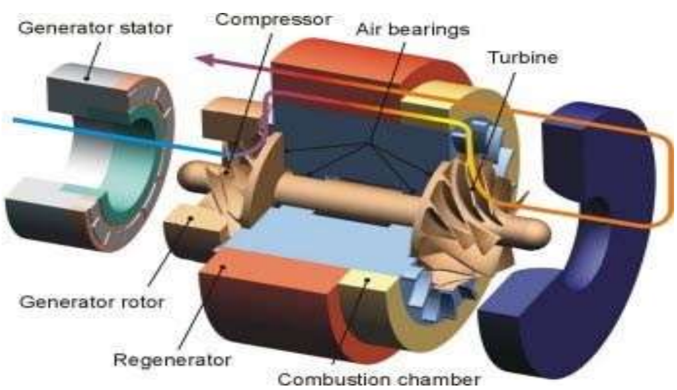
Figure 2 – A Closed Cycle Gas-Turbine Engine



3. **Micro turbine:**

The micro turbine took in place because of the emerging need of innovation to the existing large gas turbine power plant, especially for the application of remote and limited area to be placed.

In 1994, when a MIT turbine engineer named Alan Epstein found himself sitting in a jury pool and started to think about what it would take to build the smallest possible jet engine. Then conclusion made that in theory the device could be shrunk a lot. The idea was then started to make realization for a humungous application to appear



4.Scope of study:

The present paper deals with the various stresses that act on the blade due to high angular speed and the thermal stresses due to temperature gradient of blade material and a such type of studied is carried in various project with different material like Haste alloy X, Inconel,N155,S.S310A at different rotation speed. 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 by using powerful finite element analysis software.

The attachment of the compressor blade to the impeller is most critical aspect of gas turbine. The forces on the blade are many times its mass. It is therefore necessary to estimate the stresses in the attachment, but is difficult to get exact values. There is maximum possibility of stress concentration at the sharp corner and at the hub. Therefore selection of material is very important for safe guard from stress concentration.

5. LITERATURE SURVEY

G.Narendranath et.al (1) in 2012 studied on the first stage rotor blade of the gas turbine has been analysed thermal stresses and structural, modal analysis using ANSYS 9.0carried out which is a powerful finite element method software. For the mechanical and radial elongation resulting from the tangential and axial forces. The material of the blade was specified as N155 this material is an iron super bases alloy and the geometric model of blade profile is generated with splines and extruded to get solid model in CATIA V5R15 and analytical approach is used to estimate the tangential, radial and centrifugal force.

P.V.Krishnakanth et.al(2) in 2013 is studied on the structural and thermal analysis of gas turbine blade. CATIA V5 is used for design of solid model and ANSYS for analysis of model generated. This paper also includes how the program make effective use of ANSYS pre-processor to mesh complex turbine blade. Of sThe principal aim of this paper is to studied the effect of various speed on various material of impeller blade and select best material for impeller blade.

Kauthalkar et.al(3) studied the purpose of turbine technology is to extract maximum energy form fluid and produce maximum reliability, minimum cost and also improve efficiency of the turbine. A high pressure of order of order 4 to 10 bar for expansion , a compressor is required. For high speed generally centrifugal compressor is required. The turbine derived the compressor so it coupled the turbine shaft and same shaft connected to the generator.

J.B.Chaudhari et.al(4) in 2015 present work includes work the stress analysis of compressor radial impeller blade for small turbine. Application using solver I-DEAS 10NX. This is powerful finite element software. From the general study stresses analysis result it was found that for radial compressor impeller analyzed for different material peak stress are observed at inlet and mid hub section of impeller blade.

V.Raga Deepu et.al(4) Studied on a Gas turbine is a device designed to convert the heat energy of fuel in to useful work such as mechanical shaft power. Turbine Blades are most important components in a gas turbine power plant. A blade can be defined as the medium of transfer of energy from the gases to the turbine rotor. The turbine blades are mainly affected due to static loads. Also the temperature has significant effect on the blades. Therefore the coupled (static and thermal) analysis of turbine blades is carried out using finite element analysis software ANSYS.

Dr.R.Rajappan in 2013 present the work on analysis on number of blades of compressor an concluded that Compressor Efficiency mainly depends on the Compressor blades. Therefore, good improvement in the compressor blade is mandatory. To achieve high Compressor efficiency, we made a suggestion of increasing the number of blades in the compressor.

In this paper the first stage rotor blade of the gas turbine is created in CATIA V5 R15 Software. This model has been analysed using ANSYS11.0. The gas forces namely tangential, axial were determined by constructing velocity triangles at inlet and exist of rotor blades. After containing the heat transfer coefficients and gas forces, the rotor blade was then analysed using ANSYS 11.0 for the couple field (static and thermal) stresses.

6.COMPUTER AIDED ANALYSIS OF GAS TURBINE ROTOR BLADE

The model is created and analyzed using various FEA and FEM software (ANSYS, CATIA, NASTRAN etc). For automatic mesh generation and node sel0ection is used. The structural, thermal modal modules of FEA software are used for the analysis of the rotor blade. The rotor 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.

CONCLUSION

From the general study of stress analysis result it was found that the value of peak stresses are varies with material. Another point observed is that a higher rotational speed will result in greater stresses so we can find critical rotational speed for compressor to reduce stresses. Study also recommended that the stress variation also depend upon the shape and size of the impeller blade and material of the blade.The study also concluded that the analysis of compressor blade can be carried out in various FEM and FEA software like ANSYS, CATIA, Hyper mesh, Nastran program and CFD program

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