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IJIEMR Transactions, online available on 20th June 2023. Link

[:http://www.ijiemr.org/downloads.php?vol=Volume-12&issue=ISSUE-06](http://www.ijiemr.org/downloads.php?vol=Volume-12&issue=ISSUE-06)

**DOI: 10.48047/IJIEMR/V12/ISSUE 06/19**

Title **THERMAL ANALYSIS OF STEAM TURBINE**

Volume 12, Issue 06, Pages: 128-134

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## THERMAL ANALYSIS OF STEAM TURBINE

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### Abstract

Steam turbine improvements will improve the system's heat rate, thereby improving efficiency of operations, as well as decreasing maintenance costs. In addition, greater steam turbine efficiency also reduces or eliminates greenhouse gas emissions. Figure 3.1 FlowChart Process in the below chart the approach to obtain the final expected output as accurate as possible. A three-dimensional model of blade was developed using a computer-aided design software. All materials were assumed linear, homogenous, elastic and isotropic. A 5 N widespread force was applied to the blade. The results of this study showed that longer blades are experienced higher maximum Von Mises stress and strain than shorter ones. The blade with the length of 400 mm and thickness of 20 mm experienced the lowest maximum Von Mises stress at 51 kPa. Furthermore, blade with the length of 400 mm and 600 mm experienced the lowest and highest strain at  $3.07 \times 10^{-6}$  and  $4.3 \times 10^{-6}$  respectively. In addition, thicker blades were undergone less maximum Von Mises stress and strain than thinner ones. Understanding stress and strain pattern in turbine blades provides useful knowledge which can be useful to estimate the fatigue in turbine blades.

### 1. 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. Early turbine examples are windmills and waterwheels. The first turbines to be used were the steam turbines but now on the basis of the fluid from which energy is extracted Use up

high pressure steam to produce energy. These turbines are not used for producing electricity but they are used to propel jet engines. Steam turbines are the latest types of turbines. Their structure is advanced but the principle is the same.

### How Do Steam Turbines Work?

Steam turbines are composed of three primary sections mounted on the same shaft: the compressor, the combustion chamber (or combustor) and the turbine. The compressor can

be either axial flow or centrifugal flow. Axial flow compressors are more common in power generation because they have higher flow rates and efficiencies. Axial flow compressors are composed of multiple stages of rotating and stationary blades (or stators) through which air is drawn in parallel to the axis of rotation and incrementally compressed as it passes through each stage. The acceleration of the air through the rotating blades and diffusion by the stators increases the pressure and reduces the volume of the air. Although no heat is added, the compression of the air also causes the temperature to increase. The compressed air is mixed with fuel injected through nozzles. The fuel and compressed air can be pre-mixed or the compressed air can be introduced directly into the combustor. The fuel-air mixture ignites under constant pressure conditions and the hot combustion products (steames) are directed through the turbine where it expands rapidly and imparts rotation to the shaft. The turbine is also comprised of stages, each with a row of stationary blades (or nozzles) to direct the expanding steames followed by a row of moving blades. The rotation of the shaft drives the compressor to draw in and compress more air to sustain continuous combustion. The remaining shaft power is used to drive a generator which produces electricity. Approximately 55 to 65 percent of the power produced by the turbine is used to drive the

compressor

## Existing Steam Turbines:

In order to match steam production to heat demand, there are three types of steam turbine in common use for CHP plants. The figure 1.4 depicts the Standard Blade and 1.5 shows The Turbine hub, These three are called a back pressure steam turbine, an extraction steam turbine and a condensing steam turbine. Each type will suit a different configuration of plant.

## 2. PROBLEM IDENTIFICATION & SOLUTION

### Problem Definition:

Steam turbine blade design technology has become an important research field. The level of design is one of the most important factors restricting the performance of steam turbines, which is related to the working efficiency of the steam turbine.

### Objective :

Hence to overcome this issue we are trying and performing experiments on the existing Steam turbine blade, by changing the blade dimensions, blade angle and the material composition of the blade considering the factors affecting, acting on the blade and performing thermal analysis in order to find out and compare the efficiency to the existing and most widely used blade. By making changes in CATIA V5 software, where the change in dimensions and change of blade angle is noted and the later the figure is subjected to ANSYS where the stresses are calculated before and after the work

done , energy generated are noted down and later compared with the existing solution to provide a complete overview concluding our work.

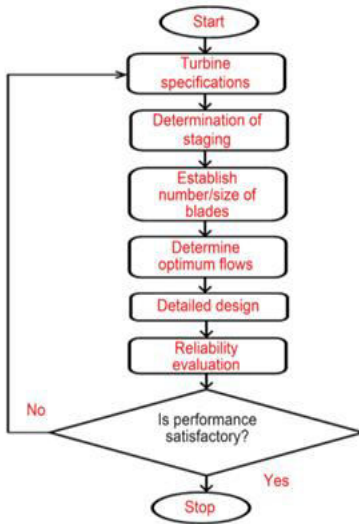


Figure 1 FlowChart Process

### 3. DESIGNING OF DIFFERENT PARTS OF TURBINE BLADE

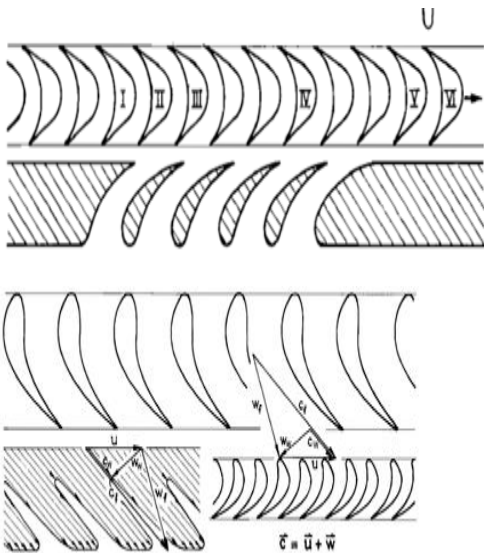


Figure 2 DESIGN OF SIDE PROFILE VIEW OF TURBINE BLADE

The above figure 2 shows the side profile 2D view of the Turbine. The breadth and

thickness of the blade are shown and the angles are depicted in the figure.

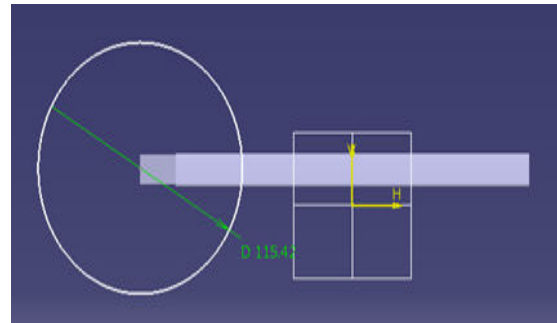


Figure 3 Sketch the circle

After pocket cut, Figure 3 Sketch the circle is shown go to plane in reference and select front plane as a reference and specify offset distance 0.45metre.

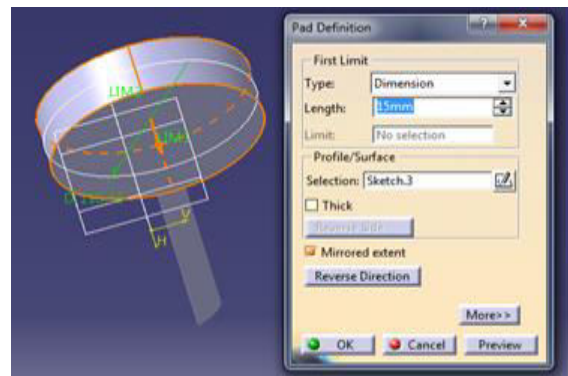


Figure 4 Extrude

On part module go to sketch. And select sketch, then create sketch as shown in figure in below Later select on exit sketcher

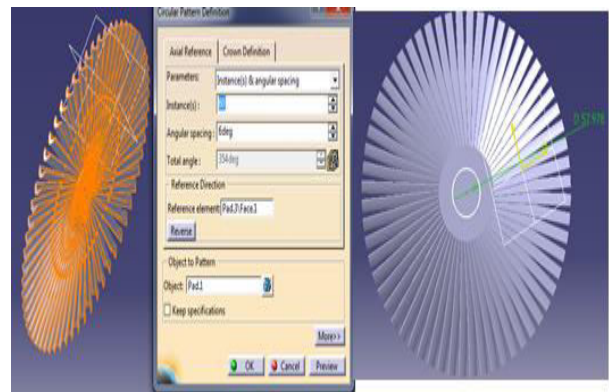
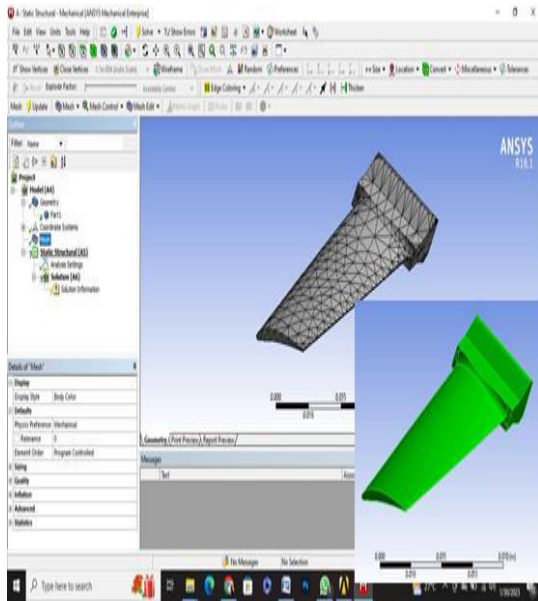
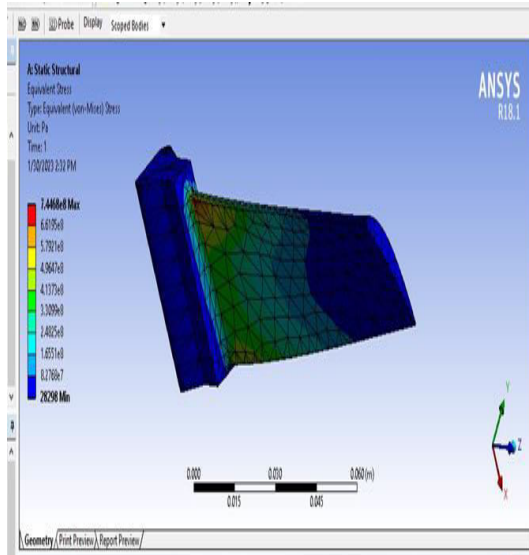


Figure 5 Sketch the circle

After sketch. Go to features and select extrude cut boss/base .In extrude cut boss, sketch above profile as a object to depth and specify direction Then click ok or click on right mark. As shown in Figure 5 Sketch the circle is formed and the turbine hub is created.



**Figure 6 Mesh Generated With Default Mesh Controls**



**Figure: 7 Total Equivalent Stress**

## 4. RESULTS

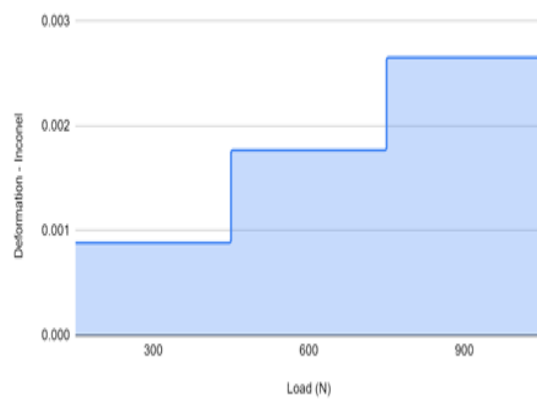
The final resultant values obtained for the turbine blades for various materials at various

loads in the form of;

**Table 1 Results for Inconel**

INCONEL 600 Load	Stress (Min- Max)	Equivalent Strain (Min-Max)	Total Deformation
300 N	$2.417 \times 10^8$ pa - 13584	0.001163 - $1.6933 \times 10^{-7}$	0.00088467 m
600 N	$4.8339 \times 10^8$ pa - 27168	0.002326 - $3.3867 \times 10^{-7}$	0.0017693 m
900 N	$7.2509 \times 10^8$ pa - 40752	0.0034889 - $5.08 \times 10^{-7}$	0.002654 m

**Deformation - Inconel vs. Load (N)**



**Figure 8 Deformation v/s Load graph for Inconel**

**Table 2 Results for Titanium**

Titanium Load	Stress (Min- Max)	Equivalent Strain (Min- Max)	Total Deformation
300 N	$2.399 \times 10^8$ pa 16395	0.0025252 $3.7559 \times 10^{-7}$	0.0019301 m
600 N	$4.7981 \times 10^8$ pa 32791	0.0050504 $7.511 \times 10^{-7}$	0.0038602 m
900 N	$7.1972 \times 10^8$ pa 49186	0.0075756 $1.268 \times 10^{-6}$	0.0057903 m

## 5. CONCLUSION

We have successfully made a change and followed an approach “ Design and Optimization of Steam Turbine Blades” . In this task I here consider a Standard Stream turbine blade which is made with the proper existing turbine blade dimensions and thereby reduced and adjusted the dimensions of the existing turbine blade. In this project we have combined the specifically designed turbine blade which is made by using CATIA V5 and combined it with various materials like in this report we have chosen 3 materials 1. Inconel 600, 2. Titanium, 3. Stainless Steel. Consequently, finding out the stresses induced on a turbine blade at a normal load and at higher loads can be helpful to find out and determine the maximum deformation and conclude the suitable material which can be used to manufacture the turbine blade. Initially the blade is designed in CATIA V5 and later the designed blade is transferred to ANSYS for the further process, Static Analysis and Structural

Analysis is done on the turbine blade at various loads where the blade is made of various materials. The total deformation, Stress and Strain is calculated so that the behavior of the blade is found out, finally a Stress vs Strain graph is plotted for all the materials to show the deformation of the blade. We can say that Titanium material is more suitable for high Pressure Turbines. And Inconel for Low and Intermediate Turbines,

## 6. REFERENCES

1. A microturbine for electric power generation Jan Peirs, Dominiek Reynaerts\*, Filip Verplaetsen Department of Mechanical Engineering, Katholieke Universiteit Leuven, Celestijnenlaan 300B, Leuven 3001, Belgium Received 15 September 2002; received in revised form 25 July 2003; accepted 11 January 2004 Available online 25 February 2004
2. A Microturbine Made by Micro-Electro-Discharge Machining Jan Peirs, Dominiek Reynaerts, Filip Verplaetsen, Michael Poesen, Pieterjan Renier Katholieke Universiteit Leuven, Department of Mechanical Engineering, Celestijnenlaan 300B, 3001 Leuven, Belgium, Dominiek.Reynaerts@mech.kuleuven.ac .be  
The 16th European Conference on

- Solid-State Transducers | September  
1518, 2002, Prague, Czech Republic
3. Experimental and Computational Studies on Cryogenic Turbo expander – S. K. Ghosh and Sarangi
  4. Hou J F, Bryon J, Wicks, Ross A. Antonion. An Investigation of Fatigue Failures of Turbine Blades in a Gas Turbine Engine by Mechanical Analysis[J]. Engineering Failure Analysis, 2002(9):201–211.
  5. Ren Tao. Analysis and Optimization of Blade Blade Root Strength of Steam Turbines[j]. Turbine Technology, 2012, 54 (4): 267-272
  6. Sun Weimin, Li Liuxuan. Analysis and treatment of turbine blade adjustment stage rotor blade fracture accident[j]. Turbine Technology, 2006(6): 458-459.
  7. Zhang Xingshun, Zhang Shihai, Sun Gengsheng, et al. Fracture analysis of multi-speed blade of extraction steam turbine[J]. General Machinery, 2009(9): 69-70.
  8. Yun Y II, Park Y II, Song S J. Performance degradation due to blade surface roughness in a single-stage axial turbine[J]. Journal of Turbomachinery, 2005, 127(1): 137-143.
  9. Liu Xiongzheng, Li Luping, Zhang Shihai, et al. Modeling and Modal Analysis of Turbine Rotor Blades [j]. Turbine Technology Surgery, 2015, 57(5): 329 - 332. Kreimeier F, Greim R, Congiu F, et al. Experimental and numerical analyses of relaxation processes in LP steam turbines[J]. Proceedings
  10. Karuppusamy, L., Ravi, J., Dabhu, M., Lakshmanan, S., “Chronological salp swarm algorithm based deep belief network for intrusion detection in cloud using fuzzy entropy”, International Journal of Numerical Modelling: Electronic Networks, Devices and Fields, 2021, Vol. Issue, PP.
  11. Nayak, S.C., Nayak, S.K., Panda, S.K., “Assessing compressive strength of concrete with extreme learning machine”, Journal of Soft Computing in Civil Engineering, 2021, Vol. 5-Issue 2, PP-68-85.
  12. Thalluri, L.N., Srinivasa Rao, K., Venkata Hari Prasad, G., Kiran, S.S., Guha, K., Kanakala, A.R., Bose Babu, P., “Reconfigurable Antennas for RFID/GPS/WiMAX/WLAN Applications Using RF MEMS Switches”, Lecture Notes in Electrical Engineering, 2021, Vol. 755-Issue , PP-225-231.
  13. Rama Raju, V., Anji Reddy, D., Narsimha, D., Srinivas, K., Kavitha Rani, B., “Adaptive Closed-Loop Deep Brain Stimulator Coding Techniques for Target Detections in Parkinson’s”, IETE Journal of Research, 2021, Vol. Issue, PP.
  14. Nayak, S.C., Satyanarayana, B., Kar, B.P., Karthik, J., “An Extreme Learning Machine-Based Model for Cryptocurrencies Prediction”, Smart



Innovation, Systems and Technologies,  
2021, Vol. 225-Issue-, PP-127-136.

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