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STRUCTURAL AND THERMAL ANALYSIS OF THE ROTOR BLADE OF THE STEAM TURBINE IN ANSYS

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Abstract: The steam turbine is one of the most excellent prime movers in to the mechanical energy due the essential forsteam turbine blades, the many multifunction used and for themore applications. the reduction the stresses and increasing the fatigue of life in major concern is high temperature, various technic has used for the increasing the fatigue that isone technic has the axial hole along with blade spam. The thermal using ANSYS 16.2 workbench this software is popularity of the finite element analysis in different types of loading with based material properties modules with differentholes in turbine blades. The rotor blade of the Steam turbine has been analyzed for the static and thermal stresses resulting from the tangential, axial and centrifugal forces. Reducing the stresses and increasing fatigue life is the major concern since they are in a high-temperature environment.

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 there are four major types of turbines:

- Steam turbines

- Water turbines
- Wind turbines
- Gas turbine

2. Steam Turbine

Steam turbines 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 same.

3. How Do Steam Turbine Work?

Steam turbines are comprised 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 comprised 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

4. Types of Steam Turbine

Steam turbines are classified based on many parameters and there are many types in this. The types to be discussed are as follows:

4.1. Based on the Steam Movement:

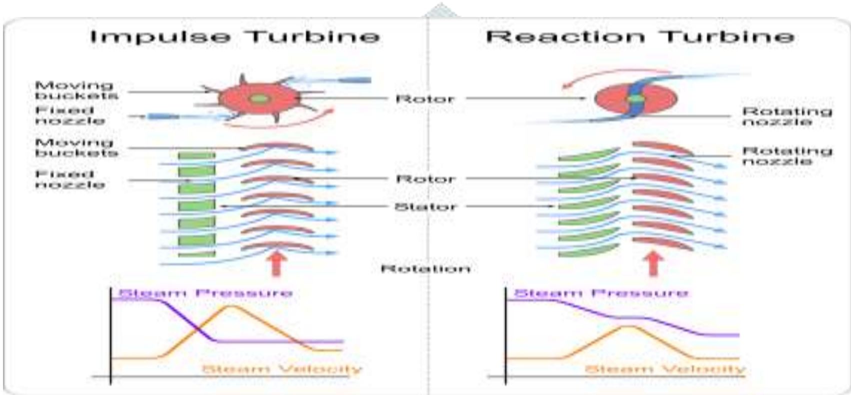
Based on the steam movement, these are classified into different types which include the following.

4.2. Impulse Turbine

Here, the extreme speed steam that flows out from the nozzle hits the rotating blades which are placed on the rotor periphery section. As because of striking, the blades alter their rotating direction having no change in the pressure values. The pressure caused because of momentum develops the rotation of the shaft. Examples of this kind are Rateau and Curtis turbines.

4.3. Reaction Turbine

Here, the expansion of steam will be there in both the moving and constant blades when the stream flows across these. There will be a continuous pressure drop across these blades.



5. Specification of steam turbine blade with holes

D=1300.5 mm, N=7600 rpm, L=116mm, d=12mm,

Holes Dia 0.5mm

- The steam turbine rotor blade inlet temperature is 16200/ 900°C
- Rotor blade outlet temperature is 1478°C.
- Total thermal heat flux for copper is 2.6453MW/ m^2
- Total thermal heat flux for titanium is 0.9927MW/m^2
- Total thermal heat flux for nickel is 1.9559 MW/m^2.

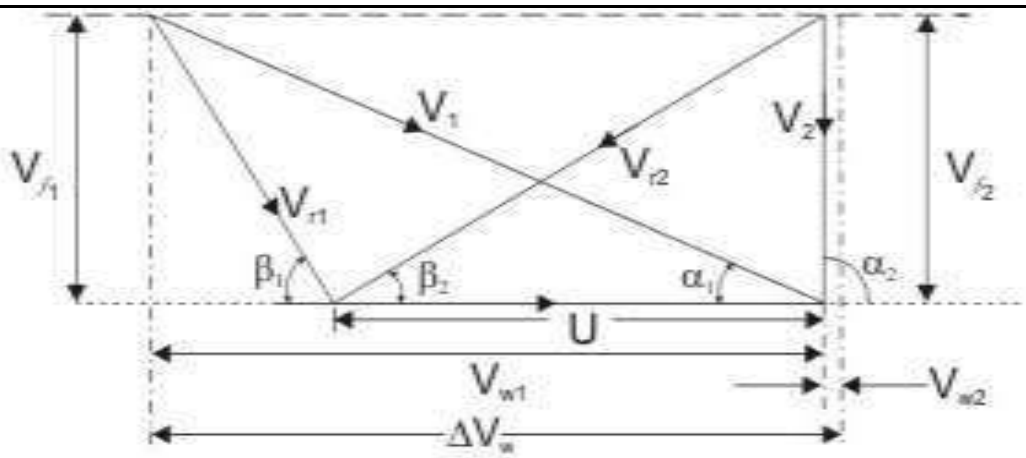


Figure 1.velocity profile of steam turbine blade with hole

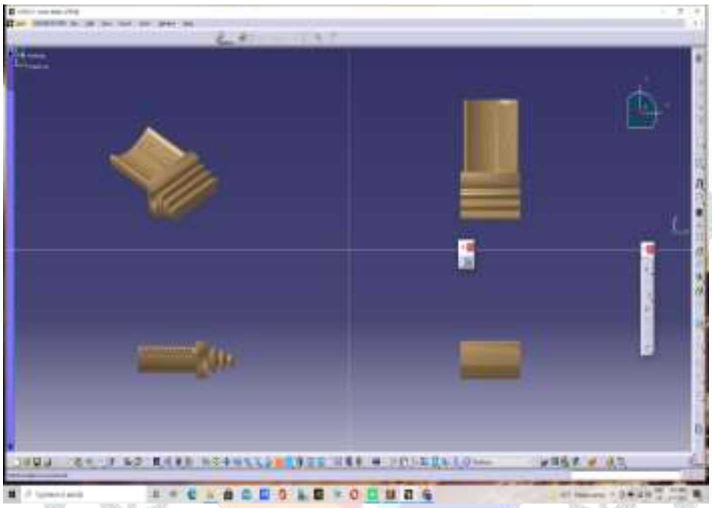


Figure 2. Catia module steam turbine blade inlet heat with holes

6. Results

Table 1. theoretically result of titanium, nickel and aluminum alloys

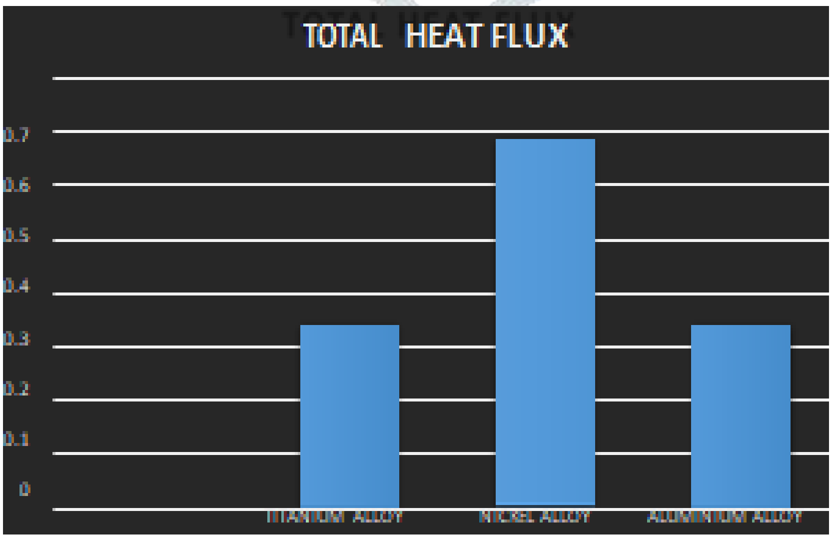
Material	Total Heat Flux	Directional Heat Flux	Temperature
Titanium Alloy	0.3399	0.16114	900
Nickel Alloy	0.68853	0.32634	1800
Aluminum Alloy	0.3400	0.16115	2200

Table 2. **blade specification with and without holes**

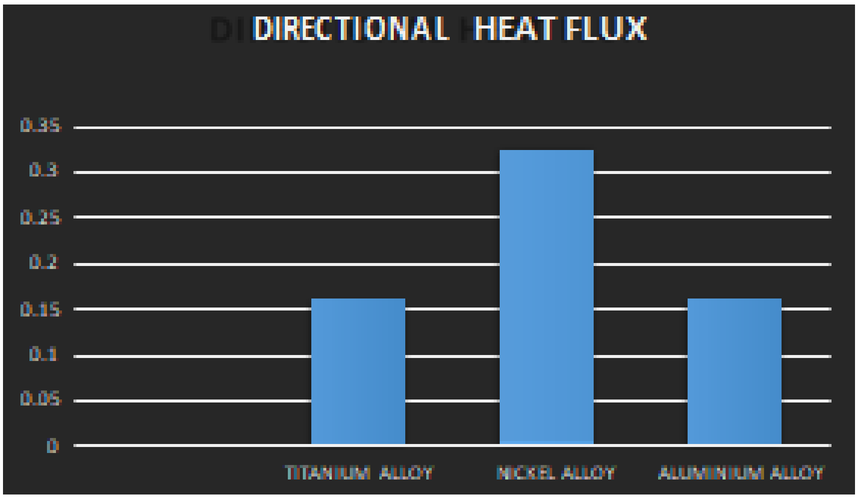
Blade specification	Equivalent stress	Cycliclife	Damage	Sensitivity
Blade Without holes	209.48 N/mm²	6.53E5	46234	3.26E5
Blade with 2mm holes	159.18 N/mm²	7.30E5	16884	1E5
Blades with 4mm holes	164.19 N/mm²	6.214E5	3654	1E6
Blades with 5mm holes	134,15 N /mm²	5.703E5	39456	4.76E5

Graphical Results

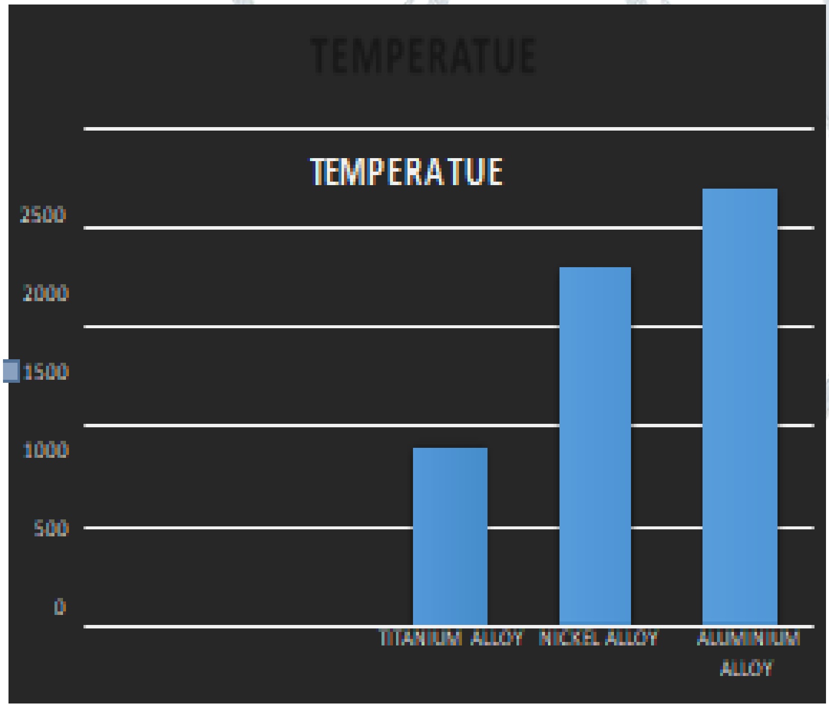
Graph 1. **graph of directional for total heat flux**



Graph 2. **graph of directional for directional heat flux**



GRAPH 3. graph of directional for temperature



7. CONCLUSION

From the applied data it is found that titanium alloy is found to show that considering the Total heat flux the value is stable when compared with the remaining applied material. The dissipated heat temperature is comparably low when compared with other parameters and hence a stable performance is achieved the holes created supposed to show good response, in reducing the heat and also overcome the creep in edges that creates blow holes. Nickel is found to be the second choice and bit non-economical but the temperature is low when compared to aluminum alloy material. The blade design of Triveni Turbine Company is found to be used titanium as the main blade material as per also the results show the supportive performance.

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