Transient Thermal Analysis of Blades of Steam Turbine using ANSYS WORKBENCH 16.0

Pranav P Kulkarni[1]

[1]Pranav P Kulkarni, Dept., of Mechanical Engineering, SVIT, Nashik, Maharashtra, India

---***---

Abstract – *Steam turbines convert energy of high pressure and high temperature steam into mechanical power. Fixed blades are fixed to casing and moving blades are fixed to turbine rotor. In this research paper the analysis of moving blades of steam turbine is done using ANSYS WORKBENCH 16.0. ANSYS is a simulation software using which we can test durability, temperature distribution, fluid movements, electromagnetic properties of a component/product.*

***Key Words*: Steam Turbine, ANSYS, ANSYS WORKBENCH 16.0, Simulation**

1. INTRODUCTION

A steam turbine is a rotary machine which is designed to convert the energy of high pressure and high temperature steam into mechanical power. The operation of steam turbine wholly depends upon dynamic action of the steam. In the steam turbines steam is first expanded in a set of nozzles or passages up to exit pressure where in the pressure energy of the steam is converted into kinetic energy. When the high velocity steam is passed over blades, the steam changes its direction. Due to this there is a change in momentum and it will exert a resultant force on the blades. If, these blades are attached to a disc on a rotor or shaft which is free to rotate, the resultant force would cause the rotor to rotate. This is how motive power is developed.

2. ANALYSIS

For this analysis we have used the simulating software ANSYS. We performed the analysis in ANSYS WORKBENCH 16.0. ANSYS is simulation software used for checking product's durability, temperature distribution, fluid movements, and electromagnetic properties. The steps followed during analysis are as follows.

2.1 ENGINEERING DATA

In this analysis material we have used is Titanium alloy – Ti6Al4V (Grade 5). This alpha-beta alloy is the workhorse alloy of the titanium industry.
Properties of material:
Density – 4512 kg/m^3
Young's modulus – 190GPa
Poisson's ratio – 0.37
Isotropic thermal conductivity – 7.3 W/Mk
Specific heat – 570 J/Kgk

2.2 GEOMETRY

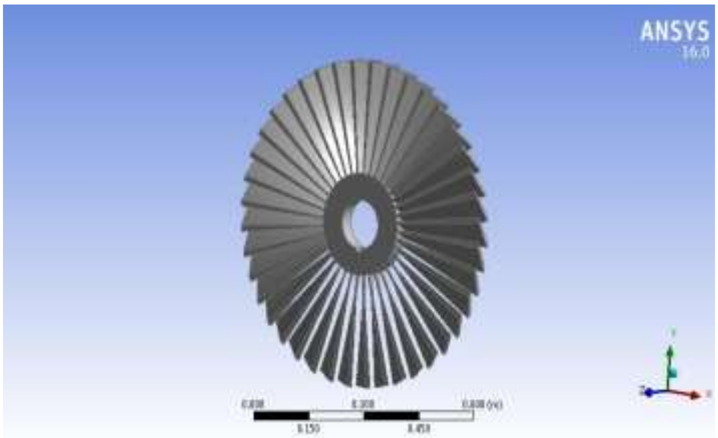

Fig -1: Blades of Steam Turbine

The CAD model of blades of steam turbine is shown in the figure above. It is prepared in Solidworks. The CAD has 40 blades, 1 hole for shaft and a keyway.

2.3 MESHING

In Meshing, Relevance is kept 100. Sizing of mesh is kept fine.

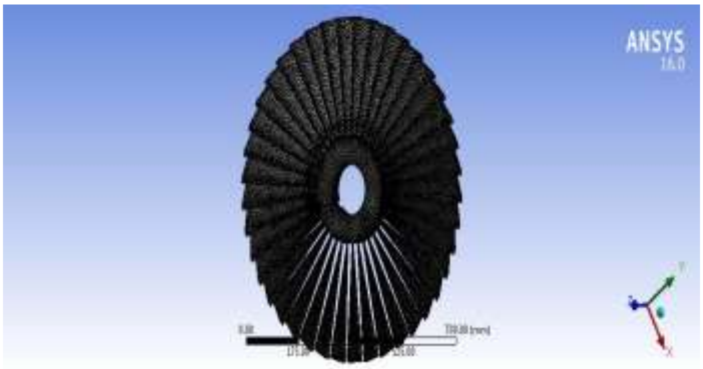

Fig -2: Meshing of Blades of Steam turbine

Refinement of the whole geometry is performed. The total number of nodes is 213183 and total number of elements is 100580.

2.4 TRANSIENT THERMAL

Initial temperature of the geometry is 22^{0}C.

2.4.1 BOUNDARY CONDITION

The steam turbine generally operates between 200 – 400^{0}C. In this case we have considered temperature as 330^{0}C.

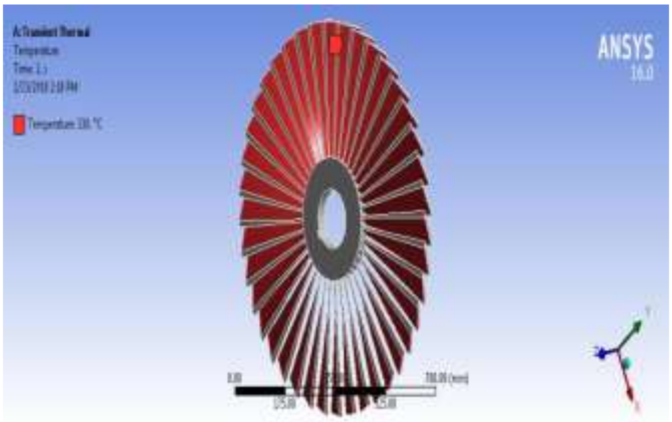

Fig -3: Temperature Boundary Condition

2.4.2 SOLUTION

In this analysis we have calculated the Total Heat Flux. The chart for total heat flux obtained is as shown below:

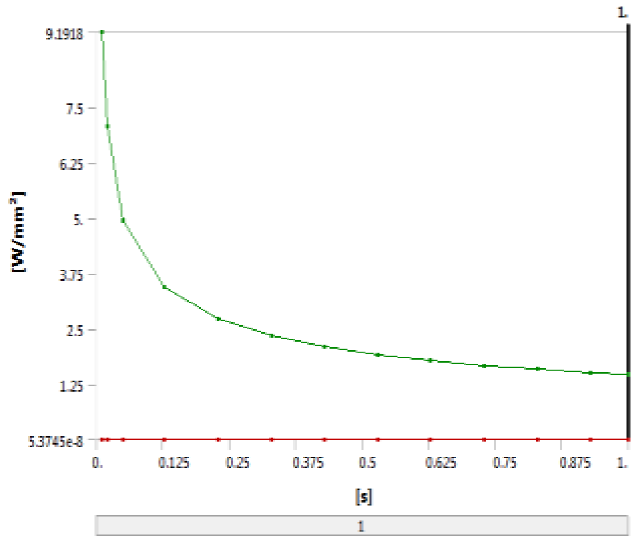

Chart -1: Total Heat Flux

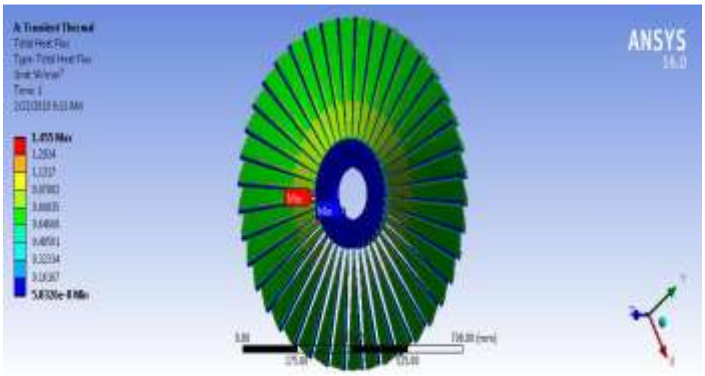

Fig -4: Total Heat Flux

The Minimum and Maximum values of Total heat flux are as follows:

Time [s]	Minimum [W/mm^2]	Maximum [W/mm^2]
1.e-002	9.9134e-007	9.1918
2.e-002	1.2756e-006	7.0716
5.e-002	3.5685e-007	4.9478
0.12893	1.5326e-007	3.4491
0.22893	5.3745e-008	2.7273
0.32893	1.4719e-007	2.3417
0.42893	2.4085e-007	2.0932
0.52893	1.9358e-007	1.9151
0.62893	8.8333e-008	1.7789
0.72893	6.0227e-008	1.6701
0.82893	9.3753e-008	1.5802
0.92893	6.4343e-008	1.5038
1	5.8326e-008	1.455

3. CONCLUSION

Using the ANSYS WORKBENCH 16.0 we performed the Transient Thermal Analysis of Blades of Steam Turbine. We obtained the values of Total Heat Flux. Minimum value for Total Heat Flux is 5.8326e-8 W/mm^2 and maximum value for Total Heat Flux is 1.455 W/mm^2.

REFERENCES

[1] Power System Dynamics and Simulation by Abhijit Chakrabarti

[2] Power System Dynamics by R Ramanuja

[3] Working with ANSYS a tutorial approach by Divya Zindani, Apurba Kumar Roy, Kaushik Kumar

[4] Introduction to ANSYS 16.0 by R.B. Choudary

[5] Steam Turbines, Practice and Theory by Lester G French

BIOGRAPHIES

Pranav P Kulkarni, Mechanical Engineering student at Sir Visvesvaraya Institute of Technology, Nashik, Maharashtra, India.