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Design and Analysis of Micro Steam Turbine Using Catia and Ansys

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ABSTRACT

Micro turbines are becoming widely used for combined power generation and heat applications. Micro turbines have many advantages over piston generators such as low emissions less moving parts, accepts commercial fuels. Steam turbine cycle and operation of micro turbine was studied and reported. Different parts (Inlet. Storage, Nozzle, Rotor, coupling, outlet, clip, housing) of turbine are designed with the help of CATIA software. The turbine is of Axial input and axial output type. ANSYS is used for thermal analysis of a steam turbine and those results are extracted and following values are shown by applying known temperature when it is in working condition.

***Key words**: Steam turbine, CATIA, Rapid Prototype, parts of turbine, nozzle, and rotor.*

I. INTRODUCTION TO STEAM TURBINE

A Steam turbine is a rotating engine that extracts energy from a flow of combustion Steams that result from the ignition of compressed air and a fuel (either a Steam or liquid, most commonly natural Steam). A Steam turbine is a rotating engine that extracts energy from a flow of combustion Steams that result from the ignition of compressed air and a fuel (either a Steam or liquid, most commonly natural Steam). The simplest Steam turbine follows the Brayton cycle .Closed cycle (i.e., the working fluid is not released to the atmosphere), air is compressed isentropically, combustion occurs at constant pressure, and expansion over the turbine occurs isentropically back to the starting pressure. As with all heat engine cycles, higher combustion temperature (the common industry reference is turbine inlet temperature) means greater efficiency.

II. LITERATURE SURVEY

Extensive work has been reported in the literature on analysis of steam turbines. Charles F and Orrin J Crommett [1] have considered Steam was to be admitted to the turbine wheel by a pair of nozzles, but it was specified that any desired numbers of nozzle could be used. R. K. Sahoo, S. K. Sarangi et.al. [2] Have considered focuses on design and development of turbo expander.The paper briefly discuses the design methodology and the fabrication drawings for the whole system, which includes the turbine wheel, nozzle, diffuser, shaft, brake compressor, two types of bearing, and appropriate housing. Charles Lang's team et.al.[3] performed including Donald Welbourn and A.R.Forrest, at Cambridge University's Computing Laboratory began serious research into 3D modeling CAD software.. Avions Marcel Dassault et.al.[4] purchased a source-code license of CADAM from Lockheed and in 1977 began developing a 3D CAD software program named CATIA (Computer Aided Three Dimensional Interactive Application) which survives to this day as the most commercially successful CAD software program in current use.

III. INTRODUCTION TO CAD/CAM/CAE:

The Possible basic way to industries is to have high quality products at low costs is by using the computer Aided Engineering (CAE), Computer Aided Design (CAD) And Computer Aided Manufacturing (CAM) set up. Further many tools is been introduced to simplify & serve the requirement CATIA, PRO-E, UG are some among many.

CATIA is a robust application that enables you to create rich and complex designs. The goals of the CATIA course are to teach you how to build parts and assemblies in CATIA, and how to make simple drawings of those parts and assemblies.

IV. MODELING, MESHING AND ANALYSIS OF MICRO STEAM TURBINE BLADE

The blade model is generated by using CATIA AND ANSYS software. Blade profile key points are imported through icem input. The points are joined by using Nurbs operation. And by using the face command create the edges as face, by selecting the extrude face and mention magnitude finally volume is created. Using volume command and select brick it creates the blade boundary. And varying number of blades are created by selecting volume command cylinder and subtracts real volumes. And import file in to ANSYS, then define model is discretised using solid element (solid 20 node90), and mention the boundary conditions. Meshing is done in ANSYS for accurate meshing. By selecting the tetra elements then compute mesh it creates number of elements and nodes. In ANSYS the blade is analysed sequentially with thermal analysis preceding structural analysis.. And apply the temperature and convection loads on surface elements. The thermal flux of the blade is determined by thermal analysis.

V.NOMENCLATURE

E Young’s Modulus
μ Poisson’s ratio
L Length of blade
K Thermal conductivity
ρ Density
Cp Specific heat

VI. RESULTS & DISCUSSIONS

The total heat transfer rate and temperature distribution of the blades depends on the heat transfer coefficient for gases and thermal conductivity of material. The ANSYS analysis is carried out. It is observed that the maximum heat flux is attained at the temperature of 120°C at trailing edges of the blades ant the minimum temperature is attained 119.22 °C at the leading edges of the blades. However the temperature distribution is very less in the blade is expected during the time interval. It I observed for the temperature is shown by fig1,. It is observing that fig2 is thermal heat flux.

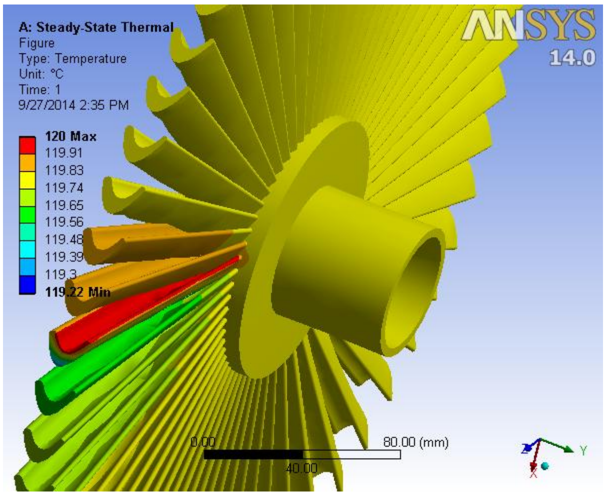


Fig 1. Model (A4) > Steady-State Thermal (A5) > Solution (A6) > Temperature

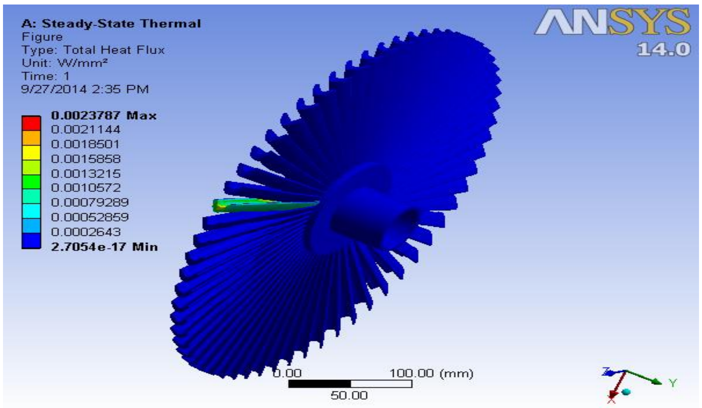


Fig 2. Model (A4) > Steady-State Thermal (A5) > Solution (A6) > Total Heat Flux

TABLE 1
Model (A4) > Analysis

Object Name	*Steady-State Thermal (A5)*
State	Solved
Definition	
Physics Type	Thermal
Analysis Type	Steady-State
Solver Target	Mechanical APDL
Options	
Generate Input Only	No

TABLE 2
Model (A4) > Steady-State Thermal (A5) > Initial Condition

Object Name	*Initial Temperature*
State	Fully Defined
Definition	
Initial Temperature	Uniform Temperature
Initial Temperature Value	22. °C

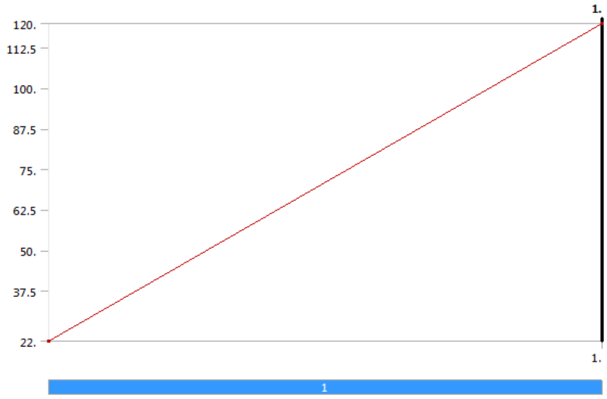
Model (A4) > Steady-State Thermal (A5) > Loads

Object Name	*Temperature*	*Radiation*
State	Fully Defined	
Scope		
Scoping Method	Geometry Selection	
Geometry	1 Face	
Definition		
Type	Temperature	Radiation
Magnitude	120. °C (ramped)	
Suppressed	No	
Correlation		To Ambient
Emissivity		1. (step applied)
Ambient Temperature		32. °C (ramped)

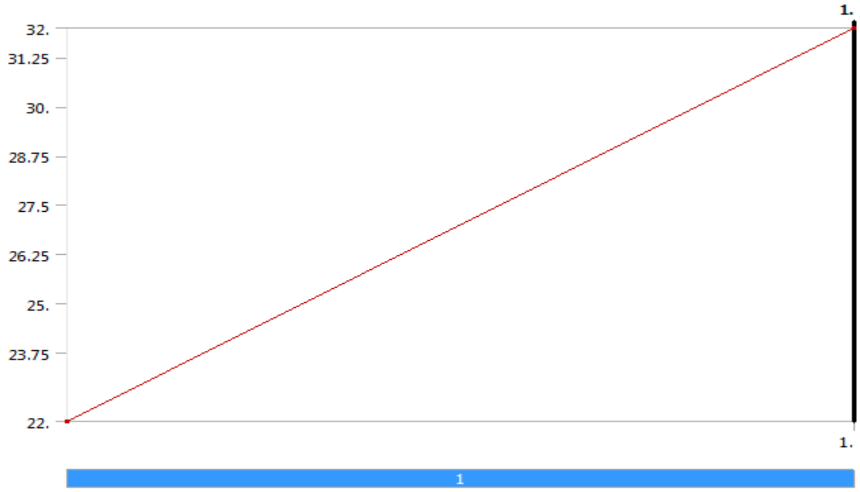
TABLE 12
Model (A4) > Steady-State Thermal (A5) > Solution (A6) > Results

Object Name	*Temperature*	*Total Heat Flux*
State	Solved	
Scope		
Scoping Method	Geometry Selection	
Geometry	All Bodies	
Definition		
Type	Temperature	Total Heat Flux
By	Time	
Display Time	Last	
Calculate Time History	Yes	
Identifier		
Suppressed	No	
Results		
Minimum	119.22 °C	2.7054e-017 W/mm²
Maximum	120. °C	2.3787e-003 W/mm²

Information		
Time	1. s	
Load Step	1	
Substep	1	
Iteration Number	2	
Integration Point Results		
Display Option		Averaged



Model (A4) > Steady-State Thermal (A5) > Temperature



Model (A4) > Steady-State Thermal (A5) > Radiation

VII. CONCLUSION

Micro turbines are relatively new in the market and are attracting wide attention due to their varied applications. Development of a sophisticated engineering product like micro turbine is a continuous process. A lot of work is yet to be done on the design aspects before the micro turbine can be readied for market consumption. The design procedure has to take into various other parameters to make it suitable for practical applications. Also, manufacturing of such complex shapes of minute size is another ongoing research work. Further research into the design and manufacture process would result in production of even better micro turbines.

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