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Modeling and Thermal Analysis of Steam Turbine

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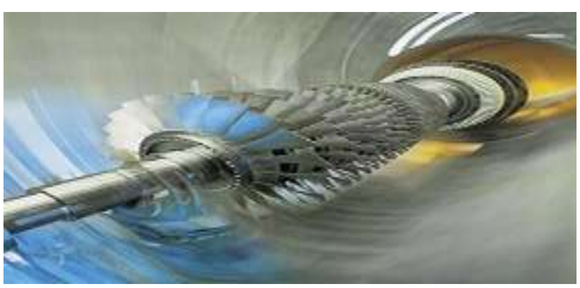
ABSTRACT

A steam turbine is mechanical device which converts thermal energy in steam into mechanical work. The steam turbine gives the better thermodynamic efficiency by using multiple stages in the expansion of steam. The stages are characterized by the way of energy extraction from the miss considered as impulse or reaction turbines. In this thesis the parameters of steam turbine blade varied and analysis is done for strength, life and heat transfer rates. The varied parameters are the ratio of X-axis distance of blade profile by chord length and ratio of ma imam height of blade profile in Y-direction to the chord length. The 3D model ling is done by using catia. The ANSYS software is used for static, thermal and fatigue analysis.

1. INTRODUCTION

TURBINE:- 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.



Turbine

Gas, steam, and water turbines have a casing around the blades that contains and controls the working fluid. Credit for invention of the steam turbine is given both to the British engineer Sir Charles Parsons (1854–1931), for invention of the reaction turbine and to Swedish engineer Gusted de Laval (1845–1913), for invention of the impulse turbine. Modern steam

TYPES OF TURBINE:-Steam turbines Gas turbines transonic turbine. Contra-rotating turbines Stator turbine Ceramic turbine Shrouded turbine Water turbines Wind turbine

USES OF TURBINES; - Almost all electrical power on Earth is generated with a turbine of some type. Very high efficiency steam turbines harness around 40% of the thermal energy, with the rest exhausted as waste heat. Most jet engines rely on turbines to supply mechanical work from their working fluid and fuel as do all nuclear ships and power plants. Turbines are often part of a larger machine. A gas turbine, for example, may refer to an internal combustion machine that contains a turbine, ducts, compressor, combustor, heat-exchanger, fan and (in the case of one designed to produce electricity) an alternator. Combustion turbines and steam turbines may be connected to machinery such as pumps and compressors, or may be used for propulsion of ships, usually through an intermediate gearbox to reduce rotary speed.

2. CAD/CAE

Introduction to CATIA:-CATIA also known as **Computer Aided Three-dimensional Interactive Application** and it is software suit that developed by the French company call Das salt Systems.

CATIA is a process-centric computer-aided design/computer-assisted manufacturing/computer-aided engineering (CAD/CAM/CAE) system that fully uses next generation object technologies and leading edge industry standards. CATIA is integrated with Dassult Systems Product Lifecycle Management (PLM) solutions. It allows the users to simulate their

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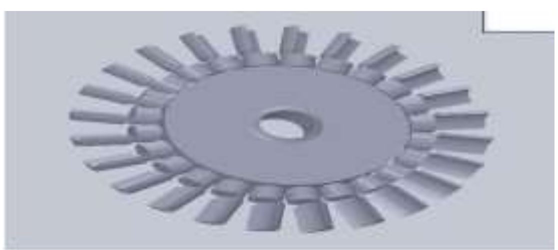
industrial design processes from initial concept to product design, analysis, assembly and also maintenance. In this software, it includes mechanical, and shape design, styling, product synthesis, equipment and systems engineering, NC manufacturing, analysis and simulation, and industrial plant design. It is very user friendly software because CATIA Knowledge ware allows broad communities of user to easily capture and share know-how, rules, and other intellectual property assets.

Engineering Design:-CATIA V5 offers a range of tools to enable the generation of a complete digital representation of the product being designed. In addition to the general geometry tools there is also the ability to generate geometry of other integrated design disciplines such as industrial and standard pipe work and complete wiring definitions. Tools are also available to support collaborative development.

Different Modules in CATIA 5

Sketcher Part Modeling Surfacing Sheet Metal Drafting Manufacturing Shape designs

DESIGN OF MODIFIED MODEL



INTRODUCTION TO ANSYS:-ANSYS is general-purpose finite element analysis (FEA) software package. Finite Element Analysis is a numerical method of deconstructing a complex system into very small pieces (of user-designated size) called elements. The software implements equations that govern the behavior of these elements and solves them all; creating a comprehensive explanation of how the system acts as a whole. These results then can be presented in tabulated or graphical forms. This type of analysis is typically used for the design and optimization of a system far too complex to analyze by hand. Systems that may fit into this category are too complex due to their geometry, scale, or governing equations.

Generic Steps to solving any Problem in ANSYS:- Like solving any problem analytically, you need to define (1) your solution domain, (2) the physical model, (3) boundary conditions and (4) the physical properties. You then solve the problem and present the results. In numerical methods, the main difference is an extra step called mesh generation. This is the step that divides the complex model into small elements that become solvable in an otherwise too complex situation. Below describes the processes in terminology slightly more attune to the software.

Build Geometry:-Construct a two or three dimensional representation of the object to be modeled and tested using the work plane coordinates system within ANSYS.

Define Material Properties:-Now that the part exists, define a library of the necessary materials that compose the object (or project) being modeled. This includes thermal and mechanical properties.

Generate Mesh:-At this point ANSYS understands the makeup of the part. Now define how the modeled system should be broken down into finite pieces.

Apply Loads:-Once the system is fully designed, the last task is to burden the system with constraints, such as physical loadings or boundary conditions.

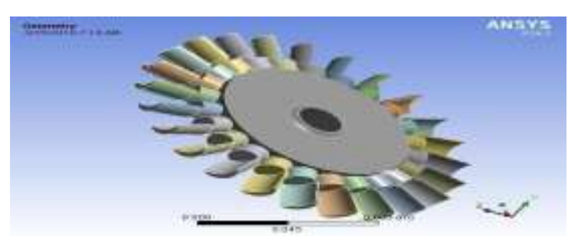
Obtain Solution:-This is actually a step, because ANSYS needs to understand within what state (steady state, transient… etc.) the problem must be solved.

Present the Results:-After the solution has been obtained, there are many ways to present ANSYS' results, choosing from many options such as tables, graphs, and contour plots.

3. ANALYSIS

THERMAL ANALYSIS OF STEAM TUBINE WITH AL2024

Model (A4) Geometry



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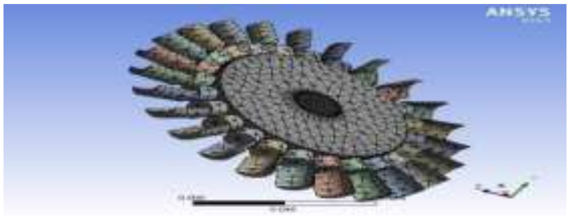
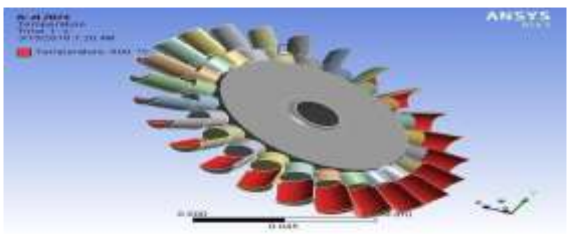
Mesh

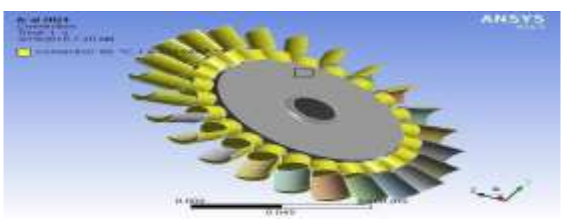


4. CONDITONS

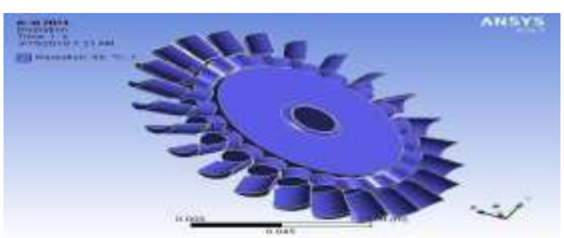
TEMPERATURE



COONVECTION



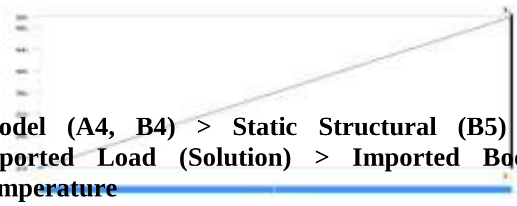
RADIATION



Model (A4, B4) > Steady-State Thermal (A5) > Temperature

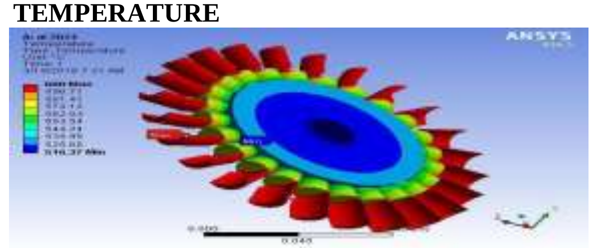
Model (A4, B4) > Steady-State Thermal (A5) > Convection

Model (A4, B4) > Steady-State Thermal (A5) > Radiation Solution (A6)

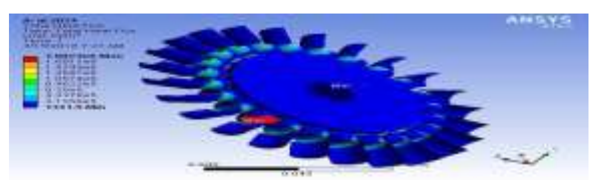


Model (A4, B4) > Static Structural (B5) > Imported Load (Solution) > Imported Body Temperature

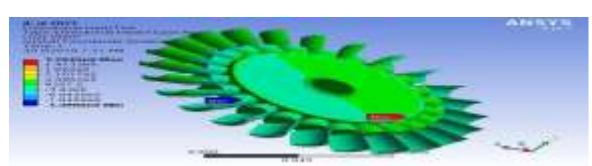
TEMPERATURE



TOTAL HEAT FLUX



DIRECTIONAL HEAT FLUX



THERMAL ERROR

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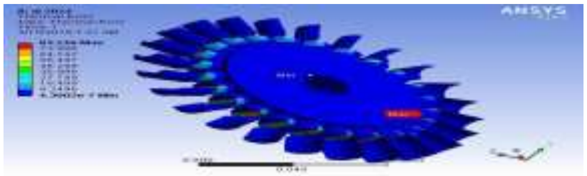
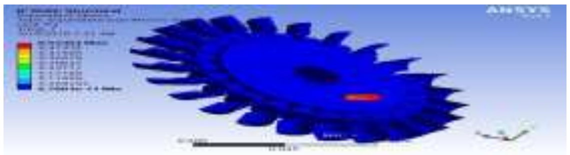
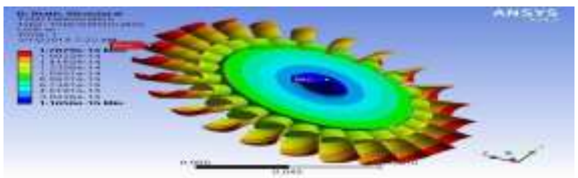


THERMAL STRESS

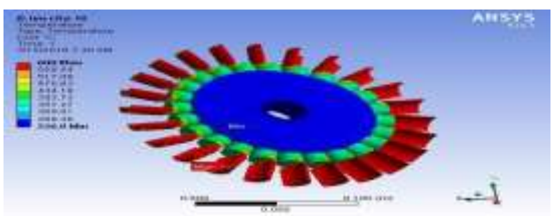


THERMAL DEFORMATION

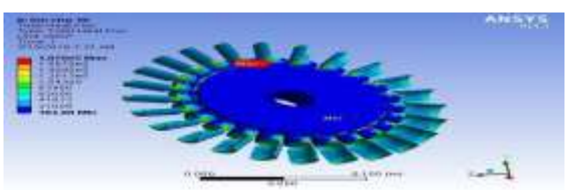


THERMAL ANALYSIS STEAM TURBINE WITH HM-CFRP 10%

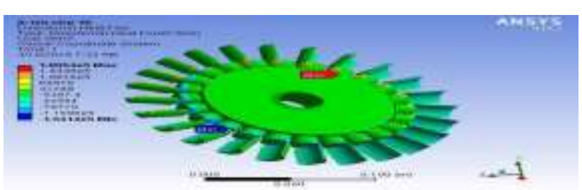
TEMPERATURE



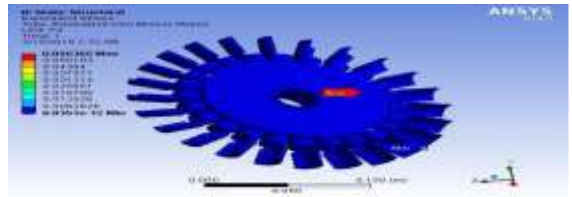
TOTAL HEAT FLUX



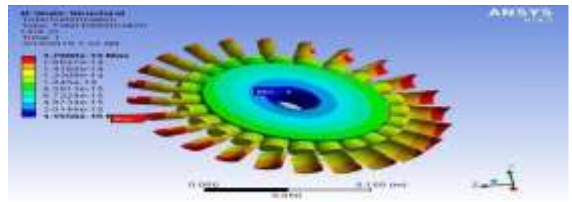
DIRECTIONAL HEAT FLUX



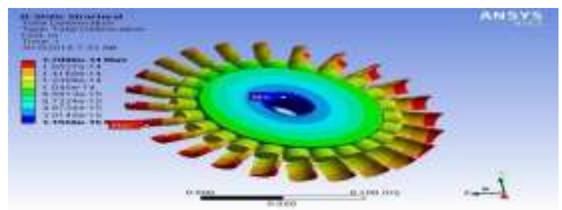
THERMAL ERROR



THERMAL STRESS



THERMAL DEFORMATION



5. COMPARISONRESULT GRAPHS: GRAPHS:

TEMPERATURE

MINIMUM

MAXIMUM

TOTAL HEAT FLUX

MINIMUM

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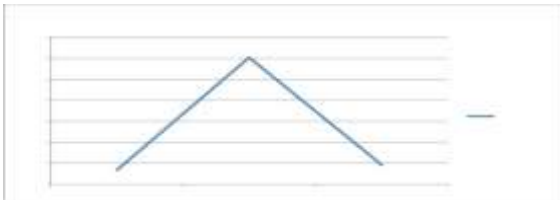
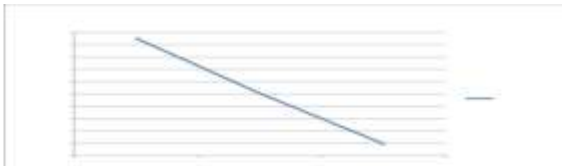


MAXIMUM



DIRECTIONAL HEAT FLUX

MINIMUM

MAXIMUM

THERMAL ERROR

MINIMUM

MAXIMUM

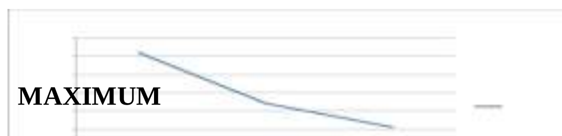
THERMAL STRESS

MINIMUM

MAXIMUM

THERMAL DEFORMATION

MINIMUM



MAXIMUM

6. CONCLUSION

Here we have done thermal analysis and structural analysis on the steam turbine blade. the materials are used al2024, c-c composite and hf-cfrp 10%, as if we compare the results total heat flux is higher than the other materials. and directional heat flux, thermal error and thermal stress is less than the other materials. As we observe here all the results which are obtained here are plotted in to tabular and graph form, as we can observe in all the variants here the al2024 is considered as the best material.

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