Computer Aided Designing of Steam Turbine Blade to Improve Its Performance

Ashish kumar patel[1] , Mukesh Kumar Solanki[2]

[1]*Research Scholar, Mechanical Engineering Department, Guru Ramdas Khalsa Institution Of Science & Technology*,**JABALPUR**, *INDIA E-mail id:* ashishpateljabalpur@gmail.com, *Ph: +918989140893*

[2]*Professor and Head, Mechanical Engineering Department, Guru Ramdas Khalsa Institution Of Science & Technology*,**JABALPUR**, *INDIA E-mail id:* solanki3011@rediffmail.com

ABSTRACT:-In modern power generation, we have required the modern power generation technology to improve the better performance in power generating system. Here mainly purpose of modernization of steam power plant to reduce the fuel cost of plant. In this report to use of latest technology in steam turbines like as advanced shaft sealing, advanced balding technology and condenser optimization in primary mechanism for realizing saving is in the improvement of turbine efficiency. In this article we are provide the advanced shaft sealing technology for reduction of waste, heat recovery losses in power generation plant. This article describes the steam turbine modernization to improve its performance. In engineers most challenges is the design of ultra super critical and advanced ultra super critical steam turbines presenting. Also refurbished old blades of steam turbine with new turbine blades to get additional power to beginnings thermal power plant demand for best design of turbine blades for ideal performance. Here the major design problem in chosen for the design of super critical steam turbine blades for pressure drop in given.

Keywords: Steam Turbine, Modernization, Performance and efficiency, Curve, Design Of steam turbine blade.

1.Introduction

The process of power generating depends on energy conversion processes is chemical energy in fossil fuels or nuclear fuel energy used in boiler as well as steam generator as give heat .this heat energy is transferred converted to thermal energy, which is to be transferred to the working steam. This steam converted to mechanical energy; this energy may be used in electrical generator in the electrical power-generation system. In this section, we focus on the electrical power system, but is also relevant to other applications such as ship propulsion. The rate of heat improvement in turbine cycle heat rate is decreasing. Thermal power plant and steam turbine manufacture engineers are working hard to achieve small improvements both in new designs and in refurbished and re-powering programs tailored to spot units. Considering the worth of energy, then are our options leading to thermal efficiency improvements, performance and the management of our energy and pecuniary resources. Other energy-conversion processes are possibilities: magneto hydrodynamic (MHD) generator, geothermal power plant, solar thermal power plant, breeder reactor, and nuclear fusion reactor are some of the future possibilities. A more near possibilities is through the improvement (increase) of steam generating process. The effect of improved steam conditions on turbine cycle where heat rate is high as a function of more pressure with high parameters of steam temperature level. The positive point indicates the placement of the power generating unit.

2.Literature Review

a) A study on improve the efficiency and performance of steam turbine

Here importance of steam turbine blade efficiency has been much highlighted in addition to its reliability/Credibility with drastic change increase in fuel cost. Siemens Power Generation has improved the efficiency and availability of its steam turbine blade by decreasing the steam flow energy losses in each of the steam turbine part, here the cost of materials and fuel is largely beyond the control of steam turbine operators, and the primary mechanism for realizing savings is in the improvement of turbine blade efficiency.

An innovative program has been developed to evaluate, appraise and restore steam turbine efficiency in few modifications to steam turbine main parts and components. New steam turbine seal and packaging technology coupled with improved repairing process can enhance efficiency gains. This paper describes improved steam turbine efficiency and turbine blade performance.

The steam turbine converts the thermal energy of high pressure steam generate useful mechanical energy, this energy used into the electrical generator to generate electricity; therefore its efficiency has a measure role on the amount of electricity production and in the end on overall steam power plant efficiency. As increased energy demand rises constantly over the last few years, energy efficiency is an important aspect of modern economy in every industry and household. High efficiency of steam power plant electricity generation can reduce the primary energy consumption. Steam turbines are one of the many-sided and oldest prime mover technologies, hitherto in general electricity production used to drive generator mechanical machinery like as generator. Steam power plant as power generation using steam turbine has been in used for about more than 100 years; here they replaced reciprocating steam engines due to their lower costs and higher efficiencies. Most of the electricity produced in all country today is generate electricity by conventional steam turbine power plants. Here the capacity of steam turbines can range from 50KW to 100 mws for large power plants. Steam turbines are most widely used for power generation applications. in the actual steam turbine efficiency level is vital, and the author emphasizes that the nucleus of a turbine maintenance has improved working process should be centered on the inspection and repair /improvement activities.

b) Energy Optimization of Steam Turbines by Audit

Here is basically focused at optimizing the steam turbine efficiency and steam heat rate. These techniques can be used them of solution capital cost and finance involved. Typical design of steam turbine, the efficiencies of steam turbine are in the range of 40 to 44.0%.While the operating efficiencies of steam turbine are in the range of 34.0-42.0%. New technological of steam turbine solutions give improvements of as much as 2.5 % in steam turbine efficiency or more than 6.6 % in heat rate or 14 MW for a 210 MW unit. The aspects of energy audit of steam turbines power plant as are this article.

Basic aspects of steam turbines as Efficiency of components, Maximum efficiency and Losses in turbines; Performance calculation and evaluation of steam turbines through acceptance routine tests. Evaluation of component/part of steam turbine efficiencies, Willan’s line of a steam turbine diagnostics- Pressure, temperature and flow profiles in steam turbines ttechnological improvements in steam turbines and Energy conservation measures. The power stations auditors are decide the dates for energy audit steam turbine efficiency. This data help to analysis and processing is done at plant. The auditor is working report prepared taking into consideration the realistic economic cost factors associated with modifications, repairs and if any problem solution.The auditors submitted auditing draft report. This released within 1-2 weeks has been conducting the observing energy audit. After interaction manangment and auditors with the sponsors, a jointly agreed final audit report is prepared and released.

The efficiency of individual circuit and equipment like water circuit pump, steam turbine piping, steam turbine, condenser and generator is evaluated and compared the final valuation and calculation with the design value. The divergence in efficiency is diagnostic ate using the overhaul data provided by the steam power plant and reported. The performance increases and decreases in equipment are computed and presented of turbine and its important parts. The extend the efficiency can be improved by implementing various energy conserving measures is discussed along with the economic cost of steam turbine plant implications considering the present level of interest rate on the capital. The savings envisaged will be also be quantified.

3. Applying Computer Aided Designing for Steam Turbine Blade

Modern manufacturing industries are using Computer Aided Design based model for the accurately representation of geometry for manufacturing and designing of steam turbines. The Computer Aided Design based design model are provide a more realistic analysis and better performance of the product this included dimensional design measurement and geometric modeling this chapter presented the application process for how to obtain Computer Aided Design model of steam turbine blade. The Computer Aided Design method discussed here is the latest steam turbine profile developed for blades invoices Computer Aided Design Steam Turbine blade is absorbing the energy form the dynamics of fluid and modified into mechanical energy. These Blades are prepared in the desired size and shape and assembled in a straight line or angular according to the designing of computer aided designee is based on the database, which contains a set of turbine computer aided designs with their operational and geometry conditions. In generally, there are two methods for blade profile design is faster because it based on the 2-dimensional flow analysis to from the airfoil according to the airfoil pressure profile.

However, the position of the framework control points is difficult to control and numbers of arcs are generally large. This makes it arduous to use the same curve opinion routine for design and manufacturing. On the other hand, direct design may demand more time in the aerodynamic creation procedure, but can generate more accurate designs in the manufacturing process. In turbulent flow process and analysis, is expecting to rate the steam turbine blade performance.

3.1 Blade Profile

A turbo machine, blade is ordinarily a bracket beam or plate is twisted and tapered with an airfoil cross-section. Typically, a turbo machine has many stages, to every stage with a stator and rotor. The function of stator is to guide the flow medium at a suitable entry angle into rotor blades. The rotor blades are mounted on a disc at a stagger angle to the machine axis and they transformed to the thermal energy into mechanical energy in steam turbine.

In turbine steam enters at high temperature and pressure in the first stage and diffuse while passing through the several stages before it is let out from the Stages with low temperature and pressure after extracting as much as thermal energy as possible. Shape of the steam turbine is frustum acuminate type, small size blades assembled in first stage the size of blade increases progressively. Hence, the small size blades in high pressure have high frequency, to as progressively lower up to the last stage long size blades. The initial stages of the steam turbine blades designed with a mutable degree of reaction. The design of these integrally shrouded blades result in an elastically pre-stressed blade ring after assembly that characterized by an excellent damping behavior during operation. This robust and proven blades construction through long experience converts highly efficient three- dimensional airfoil designs.

Within the steam turbine blade path section, interlocking labyrinth seals are applied. Since the overall efficiency of steam turbine power plants is very strongly, related to the steam turbine blade performance, it is necessary to design each steam turbine blade path individually. It is burdensome method of design and can be easily achieved through application of Computer Aided Design.

Computer Aided Design is very popular among the manufactures, due to many advantages like Computer Aided Design. It has ability to create fast designing to meet today's poky design lead times. We can do fast modification in developed part in order to match the required efficiency and performance levels in each particular application. Developing the blades with Computer Aided Design facilitate a most standardized and flexible bladeing technology. This essentially based upon the latest generation of highly efficient fully 3-dimensional balding with compound lean and variable stage reaction. However, since not only the technology but also the quality and speed of the design process decide whether the overall performance and lead-time requirements are met. The entire steam turbine blade path design process has been automated within a very powerful design system.

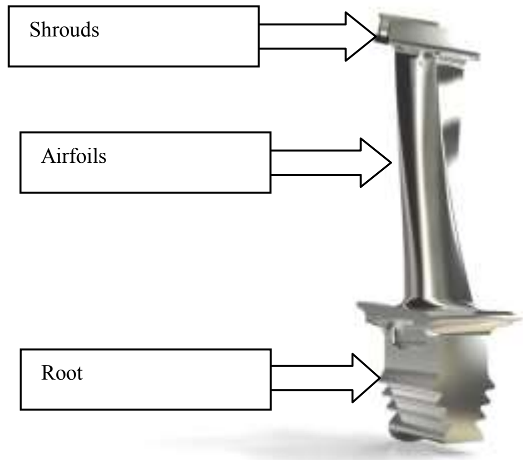

Fig.1 :- cross section of steam turbine blade.

Design automation enables more design cycles in a given time and hence leads to a much more efficient design process reaching a better optimum design in a shorter period. Thus, from this automation significant cost and time savings, due to accelerated, okay processes can be achieved, while at the same time a contract specific blade path design, with best efficiencies is delivered to the customer. Different to the other elements of the steam turbine the primary goal of standardization, with regard to HP/IP blaedeing has been to standardize the " way to the product" instead of the product itself by using Computer Aided Design. We can create modular concept of blade path construction from standard and proven elements (e.g. airfoils, roots, grooves, shrouds, extraction, locking devices). The Composition of a single blade from root, shroud and airfoil is demonstrated.

By assembly of each element with different types of other elements, exist for the various applications, so we may analysis of each type to measure advantages and disadvantages with respect to performance, mechanics and costs. Within the modular concept all these different types may be combined freely to give an optimum blade for the specific design boundary conditions such as aerodynamics, forces, material and temperature. Hence, cylindrical, twisted or bowed airfoils can be assembled with any of the roots or shrouds.

3.2 Shape of blade profile

The shape of a blade profile is function of a velocity triangle and an aerodynamic calculation. The shape of the blade profile must be defined through a suitable method with considering manufacturing point of view. It is very conveniently obtained through computer aided design systems by using vector graphic, because machine tools are able to work with these inputs directly. Before determining computer aided design procedure for blade let, we understand the geometry of the blade profile. The blade position inside the blade row is described by a few geometrically and aerodynamically angels, the geometrically parameters of the blades row has variable influence on their function. When we change the angle of blade profile inside blade row in the steam turbine it will affect the changes of momentum of a jet of stream flowing over a curved vane. The steam jet, in moving over the curved surface of the blade, exerts a pressure on the blade owing to its centrifugal force. This centrifugal pressure is exerted normal to the blade surface and acts along the whole length of the blade. The resultant of these centrifugal pressure, plus the effect of change of velocity, is the motive force on the blade. Blade profile is made airfoil by using aerodynamic properties and shape defined by mean camber line.

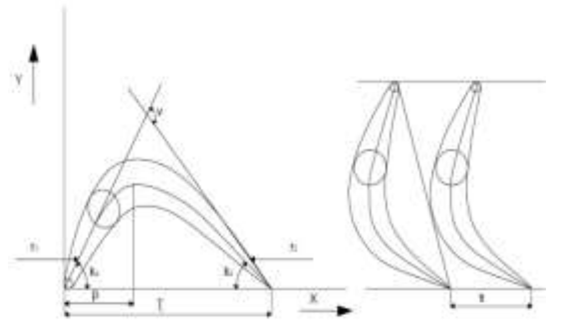

Fig.2 :- Description of the profile curves are shown in the figure.

As indicated in the figure m is the maximum camber; p is the position of maximum camber; k1 , k2 are the angles of the mean camber line (on the leading edge and the trailing edge the camber); c is the length of the chord line; s is the pitch. The blade profiles are generated by performing experiments on various blades profiles by changing their angles. The shape of the mean chamber line usually has a shape of the circle, parabolic, others geometric fundamentals curves or combination of two curves connected in the maximum camber point through tangent. The terms and the signs of the blade profiles geometry can be various. It depends on convention applied in the country. Therefore it is necessary wrote this convention with the descriptions of the shape of the blade profile. Here are used the terms and the signs by that are usually Fundamental geometric and aerodynamic angles of blade profiles are mentioned these are as shown in following figure

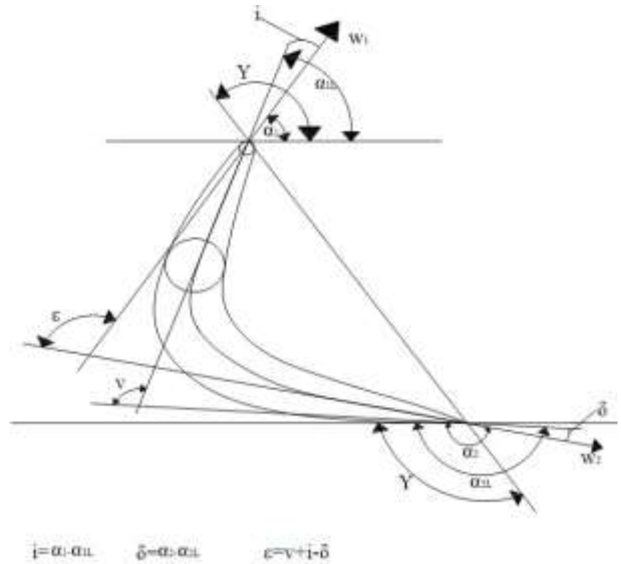

Fig. 3 : Geometry And Aerodynamic Characteristics Of Blade Rows

Y is angle of blade profile inside a blade row; α1L is the blade inlet angle; α2L is the blade exit angle; i is the angle of attack (incidence); δ is the angle of deviation ; ε is the angle of chamber of flow; w1 the velocity of attack; w2 others system of the angles be can use, for example the systems, which are shown in leaving velocity parameters (total pressure loss coefficient , exit flow angle, deviation angle). The pitch of a blade computer aided design is design from an appropriate density of the blade rows: Density of the blade row and competitive pitch.

Creating Geometry and aerodynamic characteristics of blade rows the design approach is based on the definition of the computer aided design by the parameters with their geometry and operating condition. That forms the artificial intelligence technique. For the geometrical representation of a turbo machinery computer aided design a Bezier curve, based approach has been used. The geometry of the Turbo machinery computer aided design is then completed by adding the pitch / chord ratio. The independent variables that define the computer aided design geometry are sixteen in total. These quantities will be the output values for the computer-aided design. For each turbine computer aided design the database contains the above set of quantities for the geometrical representation, the operating conditions (inlet flow angle, exit mach number) and the performance B- spline representation for heterogeneous representation for homogeneous object :sensor product solid representation has been widely used in computer aided design geometry design community.

3.3 Blade Geometry

The geometry of a turbine profile with specified performance is generated with an innovate inverse design technique or direct design, based on total sixteen independent variables and are in a computer aided design . These variables are many dependent and independent variables. Important variables are Reynolds no., mach no., Pitch chord ratio, Aspect ratio, Blade geometry and profile , boundary layer and degree of turbulence , incidence. All these parameters have a broad range of variation, so a finite test program is obvious impossible. in the development or design of blade row some parameter are fixed by the given conditions and others parameters have marginal effect. Therefore, the variables involved can be reduced to a more practical and manageable member. In this paper our main focus will be concentrate on the blade geometry and profile. in the development of the blade mainly study the effect of blade profiles is important for the performance. in the profile effects of leading and trailing edge shapes are important in designing of blades shapes because of high stresses in the blades are influenced by these factors.

The computer aided design is using the data stored in the database and then developed computer aided design geometry based on sixteen output values with a given in performance (total pressure loss coefficient, exit flow angle) during operating conditions.

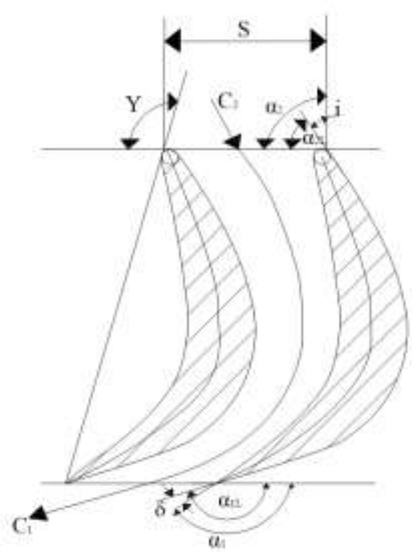

Fig.4:- Blade Geometry Of Steam Turbine Blade.

In order to grantee a homogeneous set of performance data in the database, the aerodynamic performance stored in the database for all the computer aided design configurations have been computed using the same Navier-stokes method (with the mesh density) that was also implemented into the optimization procedure.

The additional set of computer-aided design from the open literature have been geometrically parameter using the same bezier approach previously described. In order to obtained the set of geometrical parameters (fifteen) for the aerodynamic profile from the Cartesian co-ordinates available, an optimization technique has been set up as sketched the set of variables for the Bezier representation of a given reference co- ordinates. In the reference co-ordinates and the Bezier representation of the staggered turbine.

To improve internal efficiency of steam turbines, reduced root diameter and increased number of stages is one of the important strategies for design. In order to accomplish this, optimization of parameters such as the degree of reaction are required. After careful selection of optimized points, the combination of stage number and the degree of reaction that gives highest turbine efficiency is used for design.

Contour lines represent the distribution of turbine efficiency and it is clear that peak of efficiency exists at certain combinations of stage number and degree of reaction. To maximize efficiency, it is important that as many stages as possible are used in retrofit turbine within the limited bearing span. Deciding stages in the turbine efficiently is very easy by using computer aided design technology as an example before retrofit; the HP section was comprised of 6 stage. Because of applying the improved design with the help of computer-aided design, number of stages in HP section is increased to 11 stages after retrofit.

The IP section was comprised of stages before retrofit. Due to the midpoint extraction, there was some restriction to increase the number of stages. However, by applying the latest computer aided design Technology and improved design it is possible to add two additional stages. In this case, one stage upstream and one stage downstream are added to maintain extraction pressure. Hence, after retrofit, number of stages in IP section is increased to 6 stages.

Because of the optimized steam path design, following features are achieved for performance improvement:

1)Increased number of stages with increased stage reaction, reduced nozzle exit velocity and blade turning angle, 2)Higher aspect ratio Blade and reduced root diameter resulting in reduced end-wall and leakage loss. 3)Axial enter dovetail design reduces the blade axial length to allow increased number of stages.

3.4 Videsign Optimization

3D blade design using computer aided design has been introduced to improve efficiency and minimize incident losses. We can develop steam turbine blade of optimized size base on the analysis using computer aided design software. An optimization of reaction blade design in the turbine stages is to make blade lengths comparatively smaller and to optimize degree of reaction, number of stages and blade root diameters. At the last stages upstream of fixed design LP stages. When the blade becomes longer and longer, the difference in ratio between flow velocity and blade rotating speed at hub and tip diameter respectively, becomes larger and larger. Thus, the velocity vectors over the blade length change dramatically and it is no longer possible to find an optimized blade with a straight profile.

With twisted 3D profile over the length of the blade, incident angles can kept constant, thus avoiding the corresponding incident losses. Additional effects are achieved in the shroud sealing, where the twisted blade profile gives a stronger support for the integral shroud plate, and an additional number of seal strips can be used to decrease the leakage losses still further. In addition, robust design on the bucket leading edge configuration based on statistical theory of design of experiment was carried out. As a result, it observed that by optimizing the pitch-chord ratio, number of moving blade could be reduced by three-dimensional stage flow analysis. It can be observed that total pressure loss of casket for optimized reaction blade decreases along almost the entire floe path also, it can be seen that the optimized profile reduced total pressure loss downstream from the tiling blade in general have a Bezier or a B-spline curve representation.. B-spline curve applied for the blade simply to shorten the computational time. There is no technical difficulty to extend the methodology to nubs volume.

3.5 Variation Geometry Shape After Applying Loads And Fem Using AnsysStructrual analysis

Material	Stainless Steel
Stress	340.0
Displacement	0.15
Thermal analysis	533
Temperature	715.04
Thermal gradient	5
Thermal flux	11.727

Table no.1

Finite element result for free standing blades give a complete picture of structural characteristics, which can utilized for the improvement in the design and optimization of the operating conditions. Initially a study on different materials performed to choose best for the optimized turbine blade.

The result testing of different material for turbine blade suggested best material as using cast iron with partially stabilized zirconium coating is more beneficial than previous materials, due to low stress displacement, good thermal strength, low cost and easy to manufacture.

The blade with complicated airfoil construction is benefited designed by computer aided design technology which is allow the airfoil shape to be enhanced to the varying steam conditions between the base and tip of the blade. This design is a considerable advantage over the previous generation of the typical parallel-sided airfoil. In shorter blades, relatively large end-wall losses occur at the hub and shroud (secondary losses). Bowing the blades at the hub and shroud boundary improve the flow conditions at the end walls and minimizes losses. longer blades are of twisted design depending on the hub-to-tip ratio, where by each profile section is adopted to suit the local inlet and exit angle conditions. The blade profile themselves have also been improved using numerical optimization methods to provide better flow and strength properties.

4. **RESULT AND DISCUSSION**

After a presentation of the functionality of steam turbines of thermal power plants, we present the method of enthalpy difference used for the calculation of the steam turbine efficiency. This is why we present a stratification survey by circuit, by equipment and by organ. The objective is to determine the possible reasons for the deterioration of the heat rate of a thermal power plant at the level of a steam turbine. This survey concerns particularly the application of the causal analysis for determining the different losses at the level of a steam turbine.

The results from the present investigation are summarized as follows

1. Reduced startup vibration, and quicker startups
2. Decreased shaft packing leakage
3. Decreased tip (or shroud) leakage
4. Reduced first stage shell pressure, and consequent increased Effective control stage efficiency
5. Reduction of excess turbine flow capacity
6. Significantly longer packing life
7. Significantly longer tip seal life
8. Reduced boiler emissions
9. Reduced fuel handling costs
10. Reduced waste handling costs
11. Reduced unknowns in LP section deduced efficiency

5.CONCLUSIONS

Comparative study of the steam turbine blade to improve its performance, solutions are the application of the latest steam turbine blade technology to a current steam turbine blade to maximize their efficiency, reliability, and reduce life cycle costs. The discussion of this performance, solutions focused on the technology and application of these options, which can range from replacing seals with upgraded designs at a scheduled maintenance outage, up through major component replacement and the alternatives in between. All options provide a definite payback period that in most cases "pays for itself". In many cases, these can be considered investments rather than expenses associated with traditional maintenance work.

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