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Design and Analysis of a High Pressure Steam Turbine

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ABSTARCT:

Pressure contact and do as it has done in the analysis of the easiest bolts in recent years due to the availability of high computing capacity and flexibility in the methods of calculation using finite element analysis. In this paper, is one such analysis of the mixture of manual calculations and finite element analysis to evaluate steady contact pressure in the casing of the steam turbine high pressure state. The work involves design considerations and controls design, validation and sensitivity analysis to achieve a design to meet the structural requirements for mechanical safety standards. In recent years fundamental changes focused on the design of the steam turbine to improve efficiency, reliability and reduced operating costs. Siemens power generation, for example, the efficiency and availability of steam turbines by reducing energy losses have improved vapor flow in each of the components of steam turbines. The steam turbine unit greatly affects the efficiency and reliability of the power plants. Any improvement in the design of steam turbine may be a more efficient use of fuel and results in cost reduction. The high pressure steam at 565 ° C and 156 bar pressure passes through the high pressure turbine. The exhaust steam of this section is returned to the boiler to heat before use. To exit heating boilers and redo, and enters turbines medium pressure steam at 565 ° C and 40.2 bar pressure. Turbine medium pressure steam expansion still in three low-pressure turbines. The steam entering the turbine is 306 ° C and 6,32 bar. For the most jobs steam remains in the exhaust pressure is too low. Thus, witnesses, and turned the envelope of steam power at work in stages HP and IP. Therefore, the cover design is a very important aspect.

INTRODUCTION:

Stage turbine housing casings single stage turbine parts are covered. The cover consists of the top half and the bottom half of the lower half of the housing houses both inlet and exhaust. Either cast bearing cans integrated with or retreated to less than half of the cover. All frames of step and with the exception of a type of ag and ae steam turbine has a tie mold integrated with the cover means that the material needed to ring the steam is also necessary to cover. In cases that do not deliver the steam loop as part of the housing, housing materials different steam ring can be used. And he brought the two elements together.

A turbine housing multistage:

It is the turbine casing multistage be divided horizontally cover through and can be used to divide the head as well. And he asked the point of vertical and horizontal divisions juncture means the four c, which is the most difficult area in gathering all the turbine to seal against vapor pressure because of this maxwatt working to build so-called construction barrels in normal steam loop construction is a housing section of high pressure and the intermediate portions and the exhaust housing is screwed directly. This puts the quad division in the first phase, which is the case in the face of higher pressure in a multistage turbine. Turbine blades vapor major components of power plants which convert the linear movement of high temperature and high pressure steam flowing through the pressure gradient in the rotation axis turbines. As the steam enters the turbine boiler, it passes through different stages such as high pressure (hp), medium pressure (ip) and regions (lp) low pressure. Statistics show that the lp turbine blades are generally more likely to fail than those of hp and intellectual property. There are several mechanisms by which the lp blades fail faults related to corrosion and fatigue cracking and corrosion fatigue. It fatigue failure occurs as a result of vibration caused by the bending stress due to the asymmetric steam once initiated component could not supposed crack crack growth occurs rapidly. Even fatigue failure and this could be due to corrosion. Creep damage is not important for the lp blades. It is reported that the fault starts from different parts of the leaf, and this is the cover \ skin of a hole in the region of aerofoil and annex battery get so \ failure mechanism varies along the blades and public assembly blades lp steam turbine designed to last for 29 years, but faces many cases of early blade failure in practice. A recent study suggests that the cause could not be determined damn fault. To reduce the incidence of failure is necessary to consider all important aspects of the performance of the blade. Therefore, it is necessary to understand the minerals opcode physical pressure and ergonomics and design of the blades of the physical state complexes tension is very complicated, but if the design conditions are not diverted to serve the state of tension in the sheet should not cause any concern and pressure acting on the blades arise mainly from the central expelling charge and vibratory response of the blades. Vibrating pressure are maintained usually is at a low level through the frequencies to ensure we reach the narrow limits, thus avoiding the resonant vibration and reduce steam bending stresses. And the total number of sheets in a certain stage of the groups is divided. The blades are connected in each group of skin rods passing through the holes of the outer and inner skin. Preserve the strength of the group to join the leather bars with copper sheets on the edges of the hole. As materials impurities and surface defects to reduce the tendency to fatigue are minimized. Regarding the environment \ pay attention to the quality of steam so that fatigue does not occur by corrosion. We are carrying out a lot of investment to achieve the best turbine design with clean steel and have the right microstructure and mechanical properties. Failures that still face are mainly related to the maintenance conditions and improper operation. Knowledge of failure because of these reasons often go a long way in preventing failures and greatly improves the economics of power generation. This paper presents the results of the analysis unit blades of the lp turbine failed 109 megawatts of thermal power station and one was repaired and the unit after years of implementation within the nearly two years of work are presented after repairing the unit was forced to close because it has found a high level of noise and vibration in the lp region during the operation to open the housing of the turbine blades four stages of the break 18. Turbines in this case, the stage where the failure took place there in college blades and divides this to the presence of eight sheets of each group. And dened stage because the position of the wheel containing the blades, which is calculated from the area position hp along the axis towards the turbine-generator. In the current drive it contains the steps of hp and ip 01 and 00 zones, while the lp area there are stages eight stages 13, including 14 of the 18 stages, also known as stages bowman are likely much vibration arising out of steam during the operation. A number of start-ups 214 times and 168 times a cold start hot start. The turbines were carried out mostly at 49 hz, but for a certain period of time that was previously run: without this level. Is extended to 0749 hours these operations with a frequency of 40.3 hz range. It was observed that due to some problems in the organization of the network has been operating in units of 34 hz for 02 s for two days before the failure frequency.

LITERATURE REVIEW:

The Is used to provide an overview of the published work that is relevant to the current investigation. Given the scope of the present research, a comprehensive review of all of the contributing research is not possible. With a brief discussion of the loss generation mechanisms and secondary flow development in turbine blades, the present chapter focuses on the detailed unsteady phenomena in turbo machines. This chapter discusses the sources of unsteady flow, unsteady loss generation mechanisms and provides an insight into the mechanisms of interaction between the stator and the rotor of a modern high-pressure turbine. Unsteady flow calculations form an important part of the current investigation. A brief summary of the steady and unsteady multi blade row prediction methods is given in this chapter. This chapter also discusses briefly the use of lean and sweep in designing modern steam turbine blades and reviews the analytical models for the wake-blade and vortex blade interactions in turbo machinery.

Loss Mechanisms

The principal aim of the current investigation is to achieve a greater level of understanding of the complex flows in high-pressure turbines with particular emphasis on loss generating mechanisms in unsteady flow. Denton (1993) gave an extensive review of the loss generating mechanisms in turbo machinery. He stressed the importance of the physical understanding of the origins of loss within the turbo machinery flows and argued against the continued use of non-physical correlations in the design process. He identified three principal sources of loss in a turbo machinery environment:

(a) Viscous shear in boundary layers, shear layers and mixing processes

(b) Non-equilibrium processes such as shock waves

(c) Heat transfer across the finite temperature differences

Entropy is chosen as the most suitable measure of irreversibility or loss in the present investigation because its value is independent of the frame of reference and it is a 7 convected quantity. Entropy, which is created during an irreversible process, may be compared to smoke as it diffuses into the surrounding fluid and convected downstream. These sources of loss generation are described briefly in the following section.

Losses in Boundary Layers

Boundary layers are regions of steep velocity gradients and large shear stresses. These highly viscous regions are responsible for much of the loss created in a turbo machine, with a high proportion of this loss being created in the inner part of the boundary layer where the velocity gradients are the steepest as shown by Dawes (1990a). Denton (1993) derived an expression for the entropy production rate per unit surface area 'Sa ' in a two-dimensional boundary layer and showed it to be a strong function of the velocity at the edge of the boundary layer 'Vδ'. The entropy production rate can be non-dimensionalised to give a dissipation coefficient 'Cd' and is given as

$$C_d = \frac{T\dot{S}_a}{\rho V_\delta^3}$$

The value of Cd depends upon the state of the boundary layer and the Reynolds number based on the local boundary layer thickness. Figure 2.1 compares the dissipation coefficients for laminar and turbulent boundary layers following the work of Schlichting (1966). For turbulent boundary layers, the value of dissipation coefficient does not vary greatly. The large difference in dissipation coefficients for laminar and turbulent boundary layers with Reynolds numbers in the range 300 <Reθ< 1000 highlights the importance of transition prediction in the assessment of loss production in the turbomachinery boundary layers. A large amount of research is currently being undertaken in the field of transition prediction with particular emphasis on the effect of unsteady wake passing on the transition process.

METHODOLOGY:

For the power range from 100MW to 700 MW, Siemens provides two optimized two-cylinder steam turbine designs with single and double flow low pressure sections. For applications with lower power output or high back pressures, the HE product line with single flow LP is used. The flat floor mounted HE steam turbine set consists of a high pressure turbine module (H) and a single flow combined intermediate/low pressure module (E) with axial exhaust.The H-turbine is a single-flow, full-arc admission machine. The steam enters through one combined control and stop valve. The H-turbine casing uses the proven barrel-type design, which does not have horizontal flanges at the outer casing to ensure a homogenous distribution of the forces regarding main steam pressure and thermal load. Additionally, the design improves thesymmetrical expansion behavior of the turbine. Thus, small radial clearances between stationary and moving blades are realizedThe KN turbine series consists of a combined HP and IP section (K-turbine) and a double flow LP section (N-turbine). It is typically applied with a power range of 250 MW and 700 MW. Combinations of both modules (K and N) in different sizes are available and may be configured in different arrangements (with down, side and single-side exhaust) to tailor exactly to customer requirements.

The combined HP/IP module, termed K-turbine, is a compact, double shell design with horizontally-split inner and outer casings. The cast inner casing is centered within the cast outer casing via support brackets. This design minimizes the differential expansion between rotor and casing to prevent from any changes in turbine alignment. The main steam is admitted close to the center of the combined HP/IP turbine through a thermal sleeve. After passing the HP blading the steam is routed into the reheater. The steam re-enters the IP-section of the K-turbine again close to the center of the machine and then flows towards the LP turbine. A spring-backed shaft gland seal separates the two single-flow HP and IP expansion sections. Additionally, abradable coatings can be applied to the spring-backed seal segments to improve the sealing efficiency further more.The double-flow LP turbine section (N-Turbine) consists of a welded inner and outer casing. The horizontally-split inner casing includes the admission section with stationary blade carriers. Again, the design has been optimized to minimize the impact of thermal expansion on the sealing arrangements. The inner casing is provided with the support arms and a thrust rod connection to the outer casing of the K-turbine. These thrust rods cause the LP inner casing to be displaced towards the generator, allowing it to follow thermal expansion of the shaft. The exhaust diffuser of the N-turbine has been carefully optimized by means of extensive fluid analyses in order to improve turbine efficiency.Both the HE and KN product lines are applicable to combined cycle and steam power plants in 50Hz and 60Hz regimes respectively. Additionally, in CCPPs both steam turbines have beensuccessfully operated in multi-shaft and single-shaft configurations. In the design of the turbine trains, special emphasis has been placed on an optimized transient operation in order to meet market requirements on short start-up times and operational flexibility. At the same time much care has been taken to maintain the high level of reliability by utilizing well proven components from Siemens technology.

Through-out the development of both two-casing steam turbine product lines, much effort has been made in implementing a modular concept as a basis for the design. Taking into account the independent variables affecting the design, a large number of variants are required even for the major components:

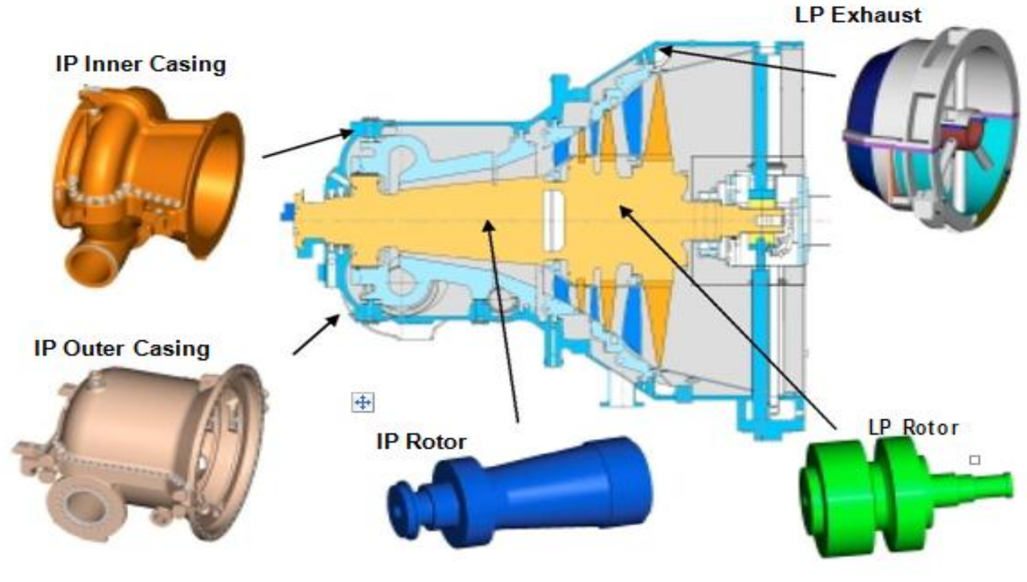
1. The power output affects the basic size of each component.

2. Different main steam conditions require different materials at the concerned areas.
3. The ambient temperature and cooling system affects the size of the low pressure end of the steam turbine.

These are well known effects. But the number of variants resulting from the possible combinations of the independent parameters strongly affects the product costs. Therefore special care has been taken to derive a modular concept which drastically reduces the number of variants in major steam turbine components and hence ensures short lead times, moderate prices and proven reliability over the complete range of applications. In the following, details on the concept will be outlined for the three major parameters power output, temperature and condenser pressure.

Sub-Modules

The turbine modules are furthermore divided into sub-modules of different sizes, which may be combined as required. This approach has been especially favorable for the E-turbine, since size of the IP part is mainly linked to the main steam flow, whereas the size of the LP part also strongly depends on the ambient temperature. Therefore the modular concept consists of a standardized axial separation plane between the IP and LP casings and of a welded rotor module. The five main components of the E turbine are shown in Fig.

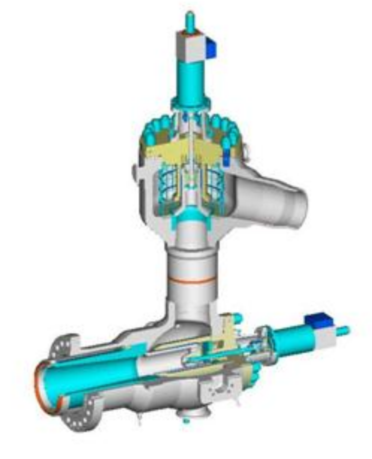


Modular Concept of the new E-Turbine for CCPP Application

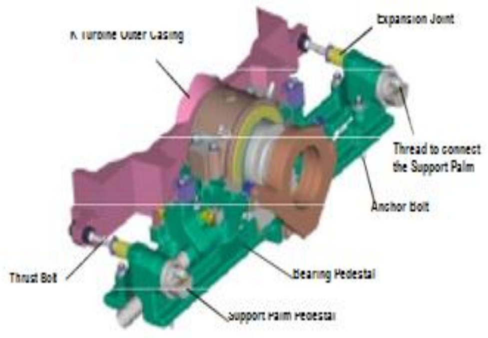
The modular concept yields an optimum number of required components to cover a wide range of applications for both CCPP and SPP. For the latter, an additional set of casing components is available with steam extractions. Again, the main benefits from the modular concept are reduced prices and delivery times due to the standardized long lead time items – while at the same time a very high performance level is maintained.

Valves

The HP, IP and LP admission valves comprise stop and control valves arranged at right angles to each other and combined in a single casing (Fig. 4). For both the E andthe K turbines, the valve assembly is provided with a flange connection at the bottom of the outer casing of the turbine.The modular valve concept consists of a standardized connection to the turbine casings for different sizes. Thus different valve sizes can be assembled to a single turbine size, and a single valve fits to different turbine types. Hence an optimum valve arrangement with respect to flow velocities can always be applied to achieve maximum element efficiency.



Stop and Control Valve

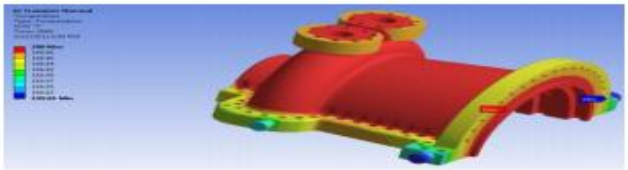


Standard Bearing

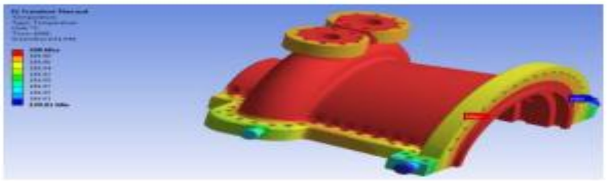
Bearings

The HE and the KN steam turbine arrangements both consist of three bearings. All three bearing pedestals are separated from the turbine casings and are supported directly on the foundation. Only one bearing is locatedbetween the turbine sections to minimize the effect of foundationdeformation on loads to bearingsand shaft journals. Axial thermal expansion of the entire rotor train starts at the combined journal and thrust bearing as the fixed point. If required, the bearing pedestal cansupport the thrust rod arrangement allowing the LP-inner casing to follow thermal expansion of the shafts .A shaft turning gear (mainly comprising a hydraulic motor and an overrunning clutch) is used for intermittent rotation of the shafts.

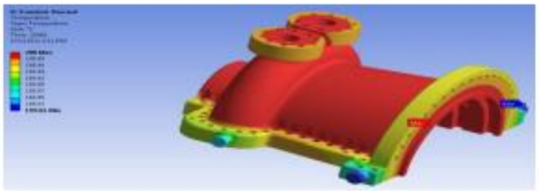
RESULTS:



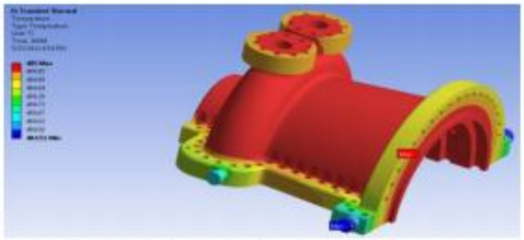
Temperature Distribution in inner casing in unsteady (Transient) state condition after 2000s



Temperature Distribution in inner casing in unsteady (Transient) state condition after 6000s



Temperature Distribution in inner casing in unsteady (Transient) state condition after 12000s



Temperature Distribution in inner casing in unsteady (Transient) state condition after 36000s

Conclusion:

To maintain a high level of availability and reliability in a fossil power plant, substantial consideration of failure by repeated thermal loading should be carried out.

- In this study, the transient temperatures and stresses distributions within a turbine inner casing were achieved from actualoperation data during cold start-up.
- The maximum deformations are calculate in transient state condition within inner casing.

- Equivalent (von-Misses) Stress distribution in Transient condition.
- Total deformation and stress values are compared with analytical results calculated for 2D geometry.

If the thermal gradient is great enough, the stress at the bottom of the threads may be high enough to cause the carking. The result shows the casing develops higher stress levels in startup condition.

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