International Journal of Applied Engineering Research ISSN 0973-4562 Volume 13, Number 6 (2018) pp. 386-395
© Research India Publications. http://www.ripublication.com

Studies and Analysis of Effect of Foreign Particles on the Parts of Steam Turbine

Karunesh Kumar Yadav
Research Scholar, Department of Mechanical Engineering Research,
Dr. K. N. Modi Institute of Engineering and Technology
Kapda Mill, opposite SBI Main Branch, Modinagar, Uttar Pradesh. India.

Raju Giri*
Assistant Professor, Department of Mechanical Engineering Research,
Dr. K. N. Modi Institute of Engineering and Technology
Kapda Mill, opposite SBI Main Branch, Modinagar, Uttar Pradesh. India.

Dharmendra singh[a], Piyush Priyadarshi [a], Monu Kumar [a],
Vijay Kumar [a], P. K. Sharma[b], I. D. Sharma[b].
[a]Dr. K. N. Modi Institute of Engineering and Technology, Modinagar,
Kapda Mill, opposite SBI Main Branch, Uttar Pradesh India.
[b]Supreme Turbo Tech., Shastri Nagar Modinagar, India

Abstract

This paper is reported on the investigation of industrial turbine's fault, its detection method & take the challenging and strategic task to diagnosis the fault. This paper describes the study conducted on steam turbine parts like rotor, bearing, thrust pad, gear pump turbine gear (reduction gear), throttle valve, emergency stop valve, and analysis of failure mode during the operation. The faults that come during operation are breaking of blade, failure of gear pump, damage of bearing's Babbitt material, thrust pad, chocking of steam inlet valve, clogging of pores of oil filter and strainer due to dust particles. Vibration may arise due to bearing defect, rotor unbalance which is corrected by balance the rotor by removing the weight of unbalance portion of turbine by grinding of rotor disc. Other cause of vibration is improper impact of steam on blade, bearing crack, less lubrication of bearing. White metal deposited on bearing then we match the face of bearing with rotor and precisely measure the clearance of the bearing. Turbine surface degradation is due to the deposits, corrosion, solid particle erosion, mechanical damage etc. Turbine surface roughness up to 0.05mm, decreases the efficiency by 4% and increases the steam consumption. Operating the turbine is considerably different from parameter given in turbine manufacturer manual. Other reasons of fault are use of poor quality water in boiler for producing steam and improper assembly of parts after maintenance. Major causes of failure are fatigue, stress corrosion, cracking and corrosion fatigue. So many faults are introduced after the continued operation of the turbine by unskilled operator. The remedies of many faults are replacing the parts like defected blades, oil filter, labyrinth gland seal by using the new spare parts of turbine which are strongly recommended to keep in store. Some defect can be removed by polishing surface, open clogged holes, clean drains etc. For repairing the defected parts, we use foundry shop, rotor balancing machine, brasso, and blue paste, emery paper, compressed air, lubrication, diesel, sponge, siling rope, mobile cranes, chain blocks for lifting heavy parts, Filler gauge, Dial gauge, Welding Machine etc.

Key word: babbitt metal, corrosion, clearance.

Introduction

Today in competitive generation the requirement of the electricity increases. To meet this requirement many power plants are working in our world. These are so many different types on the basis of capacity operation, application and desired performance. In 1882 the first commercial central electric generation station in New York, London also used reciprocating steam engine. As generation size increased, eventually turbine came into use because of its high efficiency & lower construction cost. After 1920's maximum power generation station was larger than few kilowatts and were using a turbine prime mover. The modern manifestation was invented by Sir Charles parson in 1884. In 1996 the 90% generation of electricity in United States was use of steam turbine. In our India about 68% of total electricity generation is from thermal power plant the steam turbine is necessary to extract thermal energy from pressurized steam and convert it into rotating shaft which is coupled with generator to generate electricity. [3] Now day's steam turbines are most important machine for electricity production worldwide due to their higher efficiency and low cost. There is a great impact of steam turbine on power plant economy. Today's demand for electricity is fulfilling with less cost is very important.

* Corresponding author. Tel.: +91 9639242066,7888307760
E-mail address: raju.k.giri@knmiet.edu (R. K. GIRI),. karuneshyadav17@gmail.com (Karunesh Kumar yadav)
Address: Dr. KNMIET MODINAGAR, INDIA 201 204, India

Generally, steam turbine has multistage steam expansion which helps to increase the efficiency by proper utilization of the thermal energy of steam, these stages are the combination of blades having equal size in a particular row. This blade plays an important role to convert the kinetic energy of steam into mechanical work. Each turbine section has a set of moving blades and set of stationary vanes. From inlet of steam into turbine to the exhaust of steam from turbine and enter to the condenser of steam. So many governing and monitoring devices are installed for proper operation and prevent turbine from serious damage to machine as well as operation. There are many types of tripping devices used as safety devices into turbine to stop the turbine inlet steam and reducing RPM of rotor during any error which is unhygienic for safety tripping devices are over speed tripping, vibration tripping, thrust wear trip, low pressure, high temp, sensor (RTD), ESV and steam inlet control valve mechanism are very important for proper operation. No adjustment and maintenance are carried out on a running STG unless it is approved by manufacturer and outmost care should be taken to avoid any untoward incident. Necessary firefighting equipment should be available next to the STG. Steam should be superheated. There must be provision to remove moisture and condensate from the steam supply system to avoid damage the turbine. Safety instruction and warning placed on the machine itself are not removed and are clearly readable.

Literature Review

This study is concerned with the assessment of the fatigue life of cracked steam turbine blades which operate under cyclic loading conditions. The turbine blades fatigue life estimation approach includes numerical stress-strain analysis of real rotor components, experimental study of fatigue and fracture resistance material properties and determination of crack growth rate characteristics on the round bar specimens with the single edge notch. Static and cyclic tests were performed to obtain the main mechanical properties and the fatigue life characteristics of blade's material after loading history. Both specimens with the initial surface state and specimens with high velocity air fuel (HVAF) coating were tested. As a result the fatigue life characteristics of blade's material were determined as a function of operating time. The fatigue crack growth study of surface flow was performed for round bar specimens with different initial single edge notch depth. Experimental constants describing the linear parts of the fatigue fracture diagrams were determined. [6]

A steam turbine from a thermoelectric central was Ut into maintenance due to a forced outage for high vibrations. Visual inspection of the steam turbine of 300 MW showed blades fractured at the last stage, L-0 and these affected other blades. Some operating parameters demonstrated to be out of range such as flow steam, low vacuum, and several areas in blade result to be damaged by the implosions particle. Three blades were fractured and others with a considerable crack presence were detected. The damage and fracture in the blades joints are attributed to high vibrations stresses combined with high cycle fatigue. A metallographic study revealed that the fracture was initiated from a cavity due to particle erosion. Numerical calculation results have shown that stubs blades group are disconnected as a result of the firstly vibratory stresses during startup and shutdown of the turbine. Resonance phenomena are present in the first blade when this is a detachment of the group initializing a crack propagation process. Number cycles before crack propagation in the blades of the last stage of a steam turbine of 300 MW were calculated [7] Steam turbines for power generation installed on vessels are designed to operate for over 30 years. However, there are some cases of untimely failures. In this paper, we are reporting a case of a deeply damaged turbogenerator, with several visible corrosion/erosion attacks, such as 'pit-shaped' defects, rust, and drains. While significantly widespread, they were almost only observed on the inlet steam flow side. Also, their extension and size were not such as to affect the integrity of the failed rotor, especially if we consider the size of its blades and discs. Some chemical elements not included in the alloy composition of the turbogenerator are detectable on the surface of the turbine components. Their presence could be due to passivation layers and/or material oxidation, in the case of oxygen, or, in the case of other elements detected in very low amounts and contained in the steam, to their deposition during standard turbine operations. However, turbogenerator storage conditions at the shipyard workshop before analysis might also be involved. Based on our data, we would rule out that a damage such as detachment of all blades from the sixth disc in the intermediate-pressure stage was caused by material corrosion/erosion. This conclusion was further supported by reports by the crew on how the failure had occurred. Other turbogenerators similar to the one described in our paper are currently operating on vessels. Therefore, this paper can be useful to better manage steam turbines for power generation and prevent corrosion/erosion damage. [8]

Cracks were analyzed at the root of the third blade row of low-pressure steam turbine blades of different natural frequencies. The root cause of the fatigue crack initiation was pitting corrosion of the forged ferritic/martensitic X20Cr13 material. Metallographic investigations, finite element analysis and fracture mechanics analysis combined with experimental data from the literature are used to evaluate crack propagating stresses to discuss the operating conditions. The calculations show that corrosion pits at the root of the turbine blade increase the local stresses above yield

strength. Excitation of natural frequencies by changing the rotor speed is not responsible for the crack propagation. The centrifugal load and superimposed bending load caused by unsteady steam forces are responsible for the crack propagation. [9]

Journal bearings as so sensitive parts of steam turbines are very susceptible to failure through different mechanisms of wear, fatigue and crush during service conditions. Failure occurring through these mechanisms lead to turbine completely shut down as a result of interfering in working conditions of bearing different parts. In this research, failed interfered part of a journal bearing related to a 320,000 kW steam turbine was examined. Failure analysis investigations were performed by utilizing of stereographic, optical microscopy, scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDS) analysis and hardness test. Surface crush, large amounts of surface cracks, no noticeable changes of failed surface chemical composition and microstructure with significant hardness improvement were the main obtained results. The studies were revealed that the bearing part loosing and inappropriate clearance can produce relative displacements under cyclic gradient loading. This condition was detrimental for the service life of turbine journal bearing via failure through fretting fatigue mechanism. [10]

Problem definition

Bearing

if lubrication oil pressure in bearing is not maintained between 1.5kg/cm2 to 2 kg/cm2, the bearing is defected and the clearance between them increases. [4] Clearance between the rotor and bearing is adequate approximately 1 thou per one inch of the diameter of the rotor plus 0.003mm for lubrication oil. In the condition of increasing clearance, white metal casting is done on the bearing to decrease the clearance. Apply blue paste on rotor and take impression on bearing to match the face of bearing and rotor. Maintaining clearance of bearing by scrubbing of white metal with scrubber should be very careful. Even a single mistake damages the clearance of all over the bearing.

Figure 1: Bearing with blue paste impression

To maintain clearance, remove metal by scrubber very precisely. Marks of scrubber on bearing should not be acceptable. During witness marks, the metal should not be cut because it destroys the uniformity of face. Size of lead wire is used to check the clearance of the bearing, should be slightly greater than calculated clearance.

Balance of rotor

Vibration is occurred in the casing of turbine which is serious problem for turbine as well as operator’s life. The vibration is occurred due to the sagging of the turbine. In this the rotor centre line is slightly buckled at the axis of the rotation of turbine rotor. Rotor balancing machine is used to identify the weight deflection of rotor, mark on rotor to machine the portion of unbalance weight to balance the weight of rotor. Balance marking of unbalance portion of rotor is done properly. Deflection is occurred due to unbalance weight of rotor, should be removed. Metal should be removed very slowly by grinding because fast removing metal process may chance to over grinding the disc of rotor. Axial clearance and radial clearance of rotor and gear should be measured after assembly of bearing, because without bearing cover, the radial clearance should not have observed and observation of axial clearance should be greater than actual clearance. Tighten the studs and bolts properly for exact observation.

Figure 2 : Metal removed to balance the rotor

Labyrinth

Leakage of steam is occurred due to rubbing of the teeth of the labyrinth strip to the rotor and clearance increases. Sometimes the clearance of the rotor and labyrinth increases due to loss of stiffness by the leaf spring of the labyrinth seal.

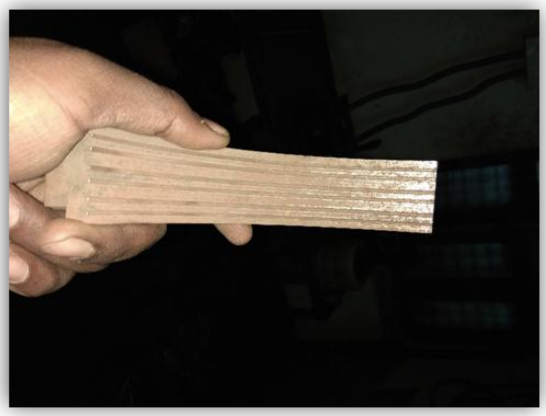


Figure 3: Rusted and defective labyrinth

After long interval of time the labyrinth strip becomes rusted. These rust and dust particle is removed with the help of emery paper. After polishing the labyrinth, it should not rub the edges of strip very hardly with emery paper. It may increase the thickness of the labyrinth teeth which may rub and damage the smoothness of the rotor's shaft. So, the thickness of edges of the labyrinth should be very fine.

Gear

Gear box with turbine which is reduction gear of ratio 5.45: 1 to 5.50: 1. The main defect of the gear is backlash clearance, which increases due to the meshing of teeth of gear and pinion. These defects increase the noise in gear box and don't transfer the torque properly to the alternator.

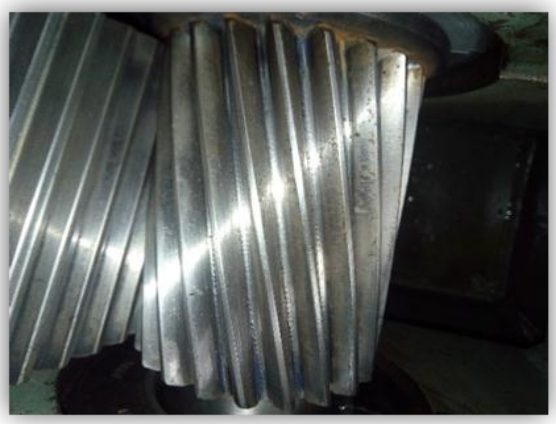


Figure 4 : teeth with removed nickel coating on some portion of teeth

In this defect the teeth of the gear don't mesh with teeth of pinion properly. Then teeth are not completely meshed to each other and nickel coating of the gears are removed due to high load on small portion of the teeth which may arise the chances of breaking of the teeth. To prevent these types of defects, regular check the meshing of the teeth by taking blue paste impression. These defects decrease the life of the gear and increase the axial thrust and overhauled condition may arise. Complete gear box is change for proper operation which is very costly. Axial clearance should not exceed +/-0.1mm and backless clearance is not exceeding +/-0.1mm

Experimental Setup: -

Magnetic base dial gauge----it is used to measuring the shaft axial alignment, gear backlash, axial movement of gear.

Vernier calliper -it is used to measuring the diameter of rotor shaft and another inner and outer diameter of the pipeline and orifice diameter.

Measuring scale – it is used to measuring the length of the pipeline.

Tri square ---- it is used to check the joints of right angle.

Thread gauge – it is used t measuring the thread of the bolt and studs used in assembly of the turbine.

Filler gauge---- it is used to measuring the clearance of the nozzle and collar of thrust wear trip and to measure the clearance of the thrust pad and collar.

Chain block – heavy parts of the turbine like gear, rotor, casing of turbine etc are lifted with the help of the chain block.

Governor setting machine: - this machine is used to set the governor rpm set point.

Welding machine: - welding machine is used to joint making in pipe line.

10. Sling /wire rope- sling and wire rope are used to hold the heavy part and tie with chain of chain block.

RESULT ANALYSIS:

Vibration

The Turbine get vibrated due to misalignment of assembled part and improper working and rotation of the rotor. If vibration increases above set point, the turbine gets tripped. There are many causes of increasing vibration but some of frequent detected reasons are following.

Bearing defect: -

1) Increase clearance and improper alignment during assembly.
2) Lack of lubrication, Crack in bearing

Method to find the crack defect in bearing should be examined with ultrasonic testing method and X-ray testing method.

Unbalancing of rotor*:* -Mainly rotor is unbalanced when we stop the rotation of rotor at high temperature, due to this sagging occurs.

To avoid this defect, rotate the rotor with the help of barring gear, until the temperature of rotor come near to the ambient temperature or prescribed by the manufacturer provided manual of turbine.

Figure 5: Rotor after balancing

Remedies: - Rotor should be balanced with the help of balancing machine. Rotor is subjected to nearly 20% overspeed test and is balanced at 5000 rpm. Mark the portion of rotor with chalk on disc which is machined to balance the rotor. Balance the rotor to every fine degree of precision. Machining of unbalance load on rotor is shown in fig-5.

Steam path: - Improper path of steam from nozzle to blade i: e incomplete impact of steam on blade, the remaining steam is striking on disc & casing of the turbine.

Oil pressure control valve: -

Oil pressure control valve helps to control the flow of lube oil. Generally, desired pressure of controlling oil is 20 kg/cm2 to 24 kg/cm2 and lube oil is 1.5 to 2 kg/cm2. Seat of valve opens and closes to control the pressure of oil. [4]

Defect in OPCV: -

The seat of the valve gets scratched. Oil gets leaked even after fully closed. this defect makes difficult to rise the pressure of controlling oil. Due to this defect the load on oil pump increases. The defect mark is shown in fig-6.

Causes: -

This scratch is obtained due to dust particle get trapped between valve seat and housing. The dust particle may be iron pieces or babbitt material powder come with oil and they trapped between seat and housing, produce mark on valve seat. Due to improper working of oil filter, it is unable to filter dust particle.

Figure 6: Defect of OPCV seat defect mark

Remedies: -

Apply the paste on scratched area and gently rubbing to remove the strain and surface scratched of the valve gets smooth by putting the valve in housing then rotate axially in clockwise and anticlockwise until the marks are removed. Now see carefully there should be no marks left. Then examine smoothness by penetration method (NDT method). After satisfactory result apply blue past and taking impression in housing. if impression is obtained proper on all around the seat then it should be fine that seat is ready to use with its proper function. If these scratches is more deep then seat is required to be changed

Turbine Blade

Turbine blades convert the impact of the steam into shaft work. Steam from nozzle increases the velocity in the expense of pressure and strikes on the blades.

Defects: -

In old turbines the edge of the blade of rotor is eroded and nozzles attack trailing edges. Edges chipped off and erosion blow holes are occurred, deep dent marks are occurred due to impact of foreign particle as shown in fig-7. Impact on blade and nozzle of turbine get some particles eroded from blades. solid particle is generally iron from steam line and super heater of boiler. These particles get strikes on the blades and get eroded. The effect of poor quality steam is considerable, that dissolves salt of boiler heater. These salts come with superheated steam and sticks to the blades. Generally, solid gets deposited on the blades and results in decrease of the steam flow area due to reduction in the flow area. Therefore, the stage pressure increases in turbines, axial thrust increases and turbine is unable to wear desired load on the basis of steam consumption. The Increase in axial thrust and tripping is occurred via thrust wear trip.

Figure 7: Show the pitting on blades of rotor

Consequences: -

The gap between nozzle and blade gets increase, then more steam is required to operate the turbine at same load as the designing of turbine. Thus, increases steam consumption and the temperature of the exhaust steam increases. Then estimated design which leads to the many defect such as bearing high temp trip and many other.

Remedies: -

Replace the defected blade with new blade with the dimension according to the manual of turbine with better composition of material.

Properly treated water should be used in boiler for making steam.

Balancing the pH of feed water according to the requirement of the turbine.

Periodically check the quality of steam.

Install the monitoring devices to check the inlet and outlet steam quality.

The blade clearance of active side is 5mm to 7mm.

The blade clearance on non-active side is 3.5 to 6mm.

Bearing

Journal bearing help the rotor to rotate smoothly on the lubricant oil film. These rotors bearing has white metal coating on which oil film is formed. The thickness of oil film is depending upon viscosity of oil. These are precision part of turbine [5]. The composition of babbitt metal is 89.3%tin,7.1% antimony and 3.6% copper and that formula is marked today by some manufacturers as ASTM B-23 Grade 2 Babbitt or as “Genuine Babbitt” [11].

Figure 8: Bearing impression on rotor

Defects: - The main defect in the bearing is to increase the clearance of bearing due to degradation of white metal. Witness marks disappeared and scratches are appearing on bearing.

Causes: - The increment in clearance of the turbine bearing is due to sudden great fluctuation in RPM of turbine rotor. Poor filtration of controlling oil and lubricating oil contained particle of metal. Due to this particle Scratches and marks are appeared. Another reason of bearing damage is low oil pressure of lubricating oil in bearing, which is insufficient to make film.

Consequences: - There is a pressure drop in bearing due to increased clearance of bearing, which leads to low pressure trip. In which the controlling oil is drained and ESV (Emergency Stop Valve) is closed and inlet steam is stopped, after all turbine is trip.

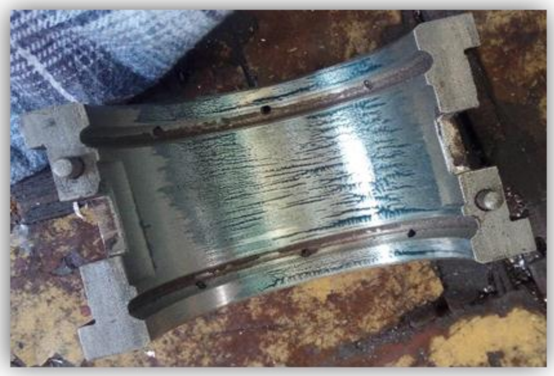


Figure 9:- bearing with blue paste impression shows non-uniform messing with rotor

Remedies: -The material used for rebabbitting is pure the old bearing babbitt material is not mix with new one because very seldom will someone know the exact composition of their old babbitt, much less if it is even a tin based or lead based product. Because mixing these two causes the low melting 63Sn/37Pb eutectic to be formed. The 63/37 melts at 3610F and Grade-B babbitt does not completely melt until 6690F. A premature bearing failure is the result. If babbitt is known tin based babbitt, no more than 30% of pour should be recycled alloy [11].

To remove defects is to change the bearing if white metal is degraded more. Don’t run the turbine before lubricant oil pressure is maintained in range of 1.5 to 2 kg/cm2. Oil pressure is slightly different with turbine of different companies as per their design on same load. proper check the bearing vibration, lube oil pressure and temperature with help of RTD. Deposit the babbitt metal on bearing and apply blue paste on rotor and take blue paste impression on the bearing as shown in fig-8 and fig-9. Match the face of bearing with rotor to examine the formation of uniform thickness of the oil film in bearing during rotation on high speed. Maintain the clearance between the rotor and bearing in the range of 0.25 to 0.35.

Thrust pad

Thrust bearing is very important part in turbine operation. Thrust pad are of two types.

1. Active pad 2. Non-active pad

Figure 10:-Thickness of white metal

These pads are coated with white metal. The number of active pad and non-active pad are equal on both side. These pads are designed to transfer the high axial load of shaft instant of rotation of shaft.

Figure 11: - Thrust pad

Defect in thrust pad: - Only and only one defect in thrust pad is due to removal of the white metal due to the axial movement. This white metal transfers the momentum of the rotor to the pad and prevents the turbine gear.

Causes of defect: -

This is due to condensate water carried with steam and impact on blade occurs due to its weight, which result in axial movement of the rotor, which hits the thrust pad, due to increment in axial clearance of shaft.

Remedies: -

Deposition of white metal on defective pad is cheaper solution than replacing the pad.

Check the axial clearance of the shaft. Compare its design and correct them according to their recommended manual of turbine.

Precaution to avoid entering of condensate water with steam in turbine.

Change the defective pad or deposit the metal in foundry shop and measure thickness of the pad. Tolerance of 0.0130mm is allowed.

Carefully check the drilled holes, oil feed provided in pad is clean.

Steam strainer

Steam strainer is used to avoid entering of debris material with steam into turbine. it is installed at upstream of the stop valve.

Defects; -

The cylindrical shape strainer has holes to filter steam and stop debris material to enter in the turbine casing. These holes get clogged due to rusting because turbine is in stationary condition for long interval of time. These holes are clogged with scale, rust, dust particle as shown in fig-12.

Figure 12: - clogged holes of strainer

Malfunction: -

Strainer should be rapture and debris enter in turbine and may damage in valve seat, blade, nozzle with distortions consequences. Water slug in undrained line is liable to impose serious shock on the turbine. These shock load may result in heavy vibration, uncontrolled speed fluctuation, overspeed occurs and load on the trust pad increases and chances of failure of pad are more.

Remedies: -

Open the clogged holes by using the compressed air at high pressure.

Clean the strainer properly.

Open the clogged holes, change the strainer if the thickness of the strainer is reduced considerably.

Take care that strainer is not rested on ground. Also ensure to free from foreign particle properly, reinstall after cleaning.

Oil filter-

Oil filter purify the lubricant oil by removing the dust partial and metal piece of bearing material, lob. And controlling and oil pipe line. It helps to protect our turbine parts by smooth operation. Filter cartridge is made of the disposable element type having magnetic property. The precision of filtration required for turbine is between 15 to 18 microns. [4] The operating condition of filter is examining by the reading of differential pressure gauge fitted across the filter. If the pressure difference across the filter is more than filer is choked and not fit for filtration

Figure 13: - clogged holes of oil filter

Defects: - Pores of filter is clogged due to dust particle of the oil. Use the sponge for cleaning including tank of oil. Instead of rags cloth waste or any fibrous material.

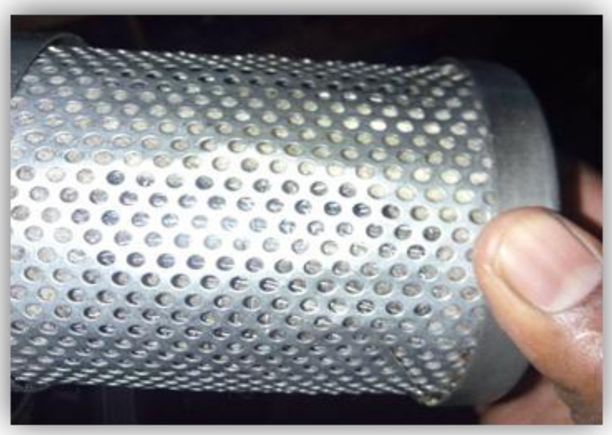


Figure 14:- oil filter after removing dust

Remedies: -

Switch their oil filter and clean plugged side.

Replace filter element when blockage indicator shows red.

Chemical analysis of oil done periodically. Ensure scrupulous cleanliness.

Change the filter after 2000 hrs of working.

Labyrinth gland.

Labyrinth means a complicated route to passage of steam. This type of sealing is preferred to minimise the steam leakage. Tendency of sealing depends on the spring backed labyrinth strip. It is necessary to use six fins group with three pockets at steam ends labyrinth. Labyrinth gland has high-low toothed stepped diameters which are matched with similar stepped diameter made on rotor. Generally, the clearance between the two-consecutive labyrinth strip is 0.3mm.[6]

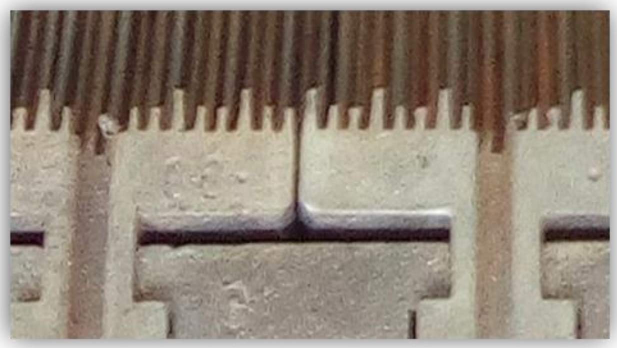


Figure 15: - Damage teeth

Defects: -Increasing clearance between labyrinth and rotor more than 0.45. The labyrinth strips are rubbed and decreased due to friction between teeth and rotor. The teeth are bent and broken. Sometimes these strips are swallow due to sudden very high temp of steam and stick to the rotor. labyrinth is damaged as shown in fig-15.

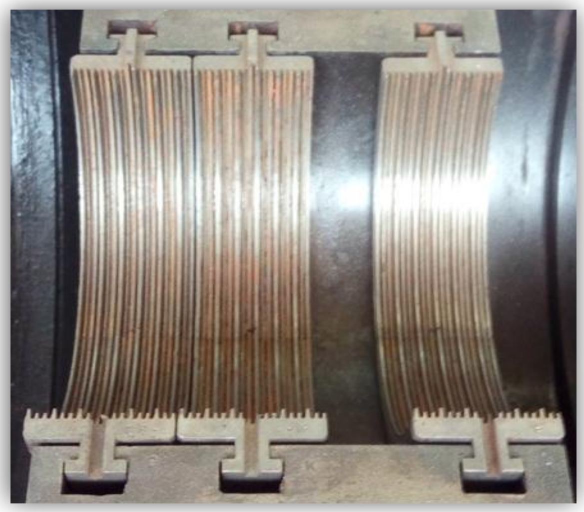


Figure 16: Labyrinth gland

Remedies: -Remove scale deposits on the spring and check its stiffness and elasticity property. If the leaf spring of labyrinth lose its elasticity then changes the spring with adequate spring stiffness. Maintain the clearance between strip and rotor between 0.30mm to 0.45mm. Change the labyrinth strip in case of strip damages.

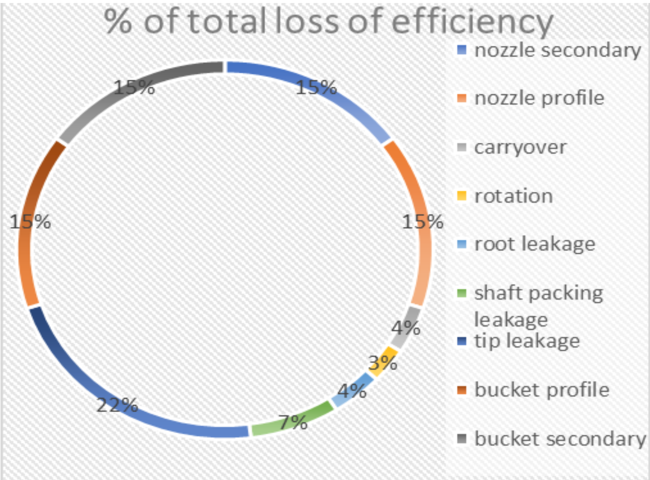
Gear box

Gear box of turbine which is reduction gear of ratio 5.45: 1 to 5.50: 1. The main defect of the gear is backlash clearance, which is increases due to the meshing of teeth of gear and pinion these defects increase the noise in gear box and don’t transfer the torque to the alternator properly.

Figure 17:-Teeth with removed nickel coating on some portion of teeth

Axial clearance should not exceed +/-0.1mm and backless clearance is not exceeding +/-0.1mm. In this defect the teeth of the gear don't mesh with teeth of pinion properly. It means that teeth don't completely mesh with each other and nickel coating of the gears are removed due to high load on small portion of the teeth which may arise the chances of broking of the teeth. To prevent these types of defect regular check the meshing of the teeth by taking blue paste impression. These defects decrease the life of the gear and increase the axial thrust and overhauled condition may arise. Complete gear box is changed for proper operation, which is very costly.

Percentage of total Loss of Efficiency:



Conclusion:-

1) Use monitoring devices like RTD, vibration probe, MPU, to exact condition of operation.
2) Check the chemistry of steam after fixed time interval.
3) Always use drain in steam line.
4) Follow the manufacturer manual and use the operation parameter given in manual.
5) Never overload the turbine and don't operate the turbine below the very low load than design.
6) Use same composition of material in foundry shop for bearing.
7) Properly check the valves of lubricating oil and controlling oil. Open for circulation of oil in line.
8) Always use the Superheated steam as working fluid for turbine to avoid corrosion and pitting.
9) Check the Clearance of the bearing in preventive maintenance.
10) Change the lubricating oil after fixed time interval mentioned in turbine manual.
11) Oil of turbine should be changed as recommendations by the manufacturer of the oil.
12) Check the viscosity of the oil and other chemical properties periodically.
13) ISO viscosity grade should be maintained. For example, Kinematics viscosity at 400c of ISO viscosity grade 46 (41.4 – 50.6) mm2/S and ISO viscosity grade 68 (61.2 to 74.8 mm2/S at 40°C).
14) Reddish colour is appeared on bearing is the indication of high temp of bearing and poor lubrication.
15) Change the oil filter after 2000 hrs of working.
16) Periodically check the axial and radial clearance of gear. If clearance is increased then noise of operation increases. Change the complete gear box.

References

[1] Giri Raju, Ganesh p, Kaul R, Shankar P ram, Tiwari Pragya, Atulkar Ashok, Prowal R. K, Sayal R. K, Kukreja L M, “studies on pitting corrosion and sensitization in laser rapid manufactured specimens type 316L stainless steel” 2012;39:509-21.

[2] https://en.m.wikipedia.org/wiki/steam turbine.

[3] Triveni turbine manufacturer manual.

[4] Machine design book by V. B. Bhandari.

[5] Theory of assembly and operation of Steam turbine book design and assembly by R. K. Singal

[6] Shlyannikov V.N., Yarullin R.R., Zakharov A.P. “Fatigue of steam turbine blades with damage on the leading edge”2014;3:1792-1797.

[7] Urquiza G, Segura J.A, Castro L, Rodriguez J.A, J. M.Rodriguez “Diagnostic and failure analysis in blades of a 300 MW steam turbine”2017;82:631-641.

[8] Stifanese Roberto, Belsanti Lucrezia, Toselli Miena, Letardi Paola, Traverso Pierluigi “Corrosion invstigation of a steam turbine after power generator failure onboard a vessel: A case study”2016;64:58-66.

[9] Fritzl Patrick, Enzinger Norbert, Plesiutschnig Ernst, Somitsch Christof “Fracture analysis of a low pressure steam turbine blade”2016;5-6:39-50.

[10] Mehdizadeh M, Khodabakhshi F, “An investigation intofailure analysis of interfering part of a steam turbine journal bearing”2014;2:61-68.

[11] http://wiki.vintagemachinery.org/BabbittWhatIsIt.ashx

Steam turbine generators are reliable machines, and often operate continuously for many months. Such operation at steady outputs can lead to deposition from the steam on the fixed and moving blades. Deposits cause output and efficiency to drop, by reducing the efficiency of energy transfer and eventually restricting steam flow.Â These effects are particularly evident on the turbine design with both High Pressure and Intermediate Pressure sections in the one casing, with flow in opposite directions. Retractable packings have been developed by manufacturers and after-market suppliers.Â It was deduced from careful study of construction details from available drawings that the second bellows had failed. This conclusion was confirmed by the manufacturer. Use of stage pressures. The main parts of simple impulse steam turbine are rotor, blades and nozzles. Turbine blade is exposed to All mordern steam power plants use impluse-reaction various loads such as thermal, inertia, and bending and may turbines as their blading efficiency is higher than that fail due to different factors like Stress-Corrosion Cracking, of impluse turbines.Â Blade Pro is a roter and analysis the various parameters: cutting-edge example for vertical applications built on the core ANSYS engine using ANSYS APDL. A steam turbine is a device that extracts thermal energy from the steam and converts it to mechanical work on a rotating output shaft. From: Flow and Heat Transfer in Geothermal Systems, 2017. Related termsÂ Turbines are designed with multiple stages to accommodate the volume expansion of steam as the pressure drops. As steam moves through the system and loses pressure and thermal energy, it expands in volume requiring a larger diameter and longer blades in each succeeding stage to extract the remaining energy. Every stage of a turbine has two basic design elements: the stationary nozzle and the moving blade or bucket. This is illustrated in Fig.