Study on Turbine Maintenance: Overhauling, Emergency shutdown, Fault tracing

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Abstract

An effective maintenance program should be such that the basic objective is achieved with minimum possible expenditure. The availability of turbine, and chiefly the operating reliability, depends on the satisfactory operation of its control, protection of ancillary equipment such as pumps etc. The study deals with the tests and maintenance necessary to ensure good operating reliability for the turbine.

Keywords— Fault tracing, Maintenance, Overhauls, Turbine**.**

I. INTRODUCTION

Maintenance- action necessary for retaining or restoring a piece of equipment, machine, or system to the specified operable condition to achieve its maximum useful life.

A system of components working in random environment is subjected to wear and damage over time and may fail unexpectedly. The components are repaired or replaced upon failure and such unpleasant events of failure at the same time are considered as opportunities for preventive maintenance on other components.

The earliest maintenance technique is basically breakdown maintenance which takes place only at breakdowns. A later maintenance technique is time based preventive maintenance which sets a periodic interval to perform preventive maintenance regardless of health status of a physical asset. With development of technology, products have become complex. Higher reliability is required. This makes cost of preventive maintenance higher. Thus, condition based maintenance is used to overcome this.

A. Benefits of Maintenance

- Downtime of equipment decreases.
- Major repairs are reduced.
- Life expectancy of assets increases, it eliminate premature replacement of equipment.
- Improved safety for everyone.
- Economical

B. Types of Maintenance

- *Breakdown maintenance*
- *Preventive maintenance*
- *Corrective maintenance*
- *Routine maintenance*
- *Opportunistic maintenance*

1) Breakdown Maintenance

This is forced maintenance carried out when the equipment breaks down. Breakdowns of equipment are not desirable as it not only hampers the production but may also result in unsafe situation.

2) Preventive Maintenance

Preventive maintenance is the system of maintenance whereby specified checks are carried out to retain the healthy condition of equipment and prevent failure through the prevention of deterioration, periodic inspection or equipment condition diagnosis.

3) Opportunistic Maintenance

It is advantageous to follow opportunistic maintenance in multi-component system. When equipment is taken down for maintenance of one or few component, opportunity can be utilized for maintaining / changing other component even when they are not failed.

II. COAL FIRED PLANT WORKING

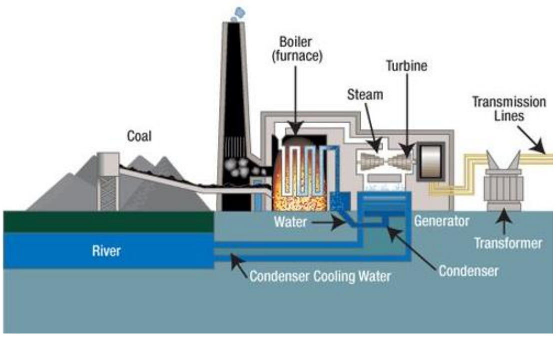

Fig 1. Coal plant

Coal power plants work by using several steps to convert stored energy in coal to usable electricity that we find in our home that powers our lights, computers etc. In a coal-fired steam station—

much like a nuclear station—water is turned into steam, which in turn drives turbine generators to produce electricity. The process

A. *Creation of heat*

Coal is pulverized to the fineness of talcum powder before it is burned. Then it is mixed with hot air and blown into the firebox of the boiler. On burning, the coal/air mixture provides the complete combustion and maximum heat possible.

B. *Water to steam*

Highly purified water, pumped through pipes inside the boiler, changes to steam by the heat. Temperatures of about 1,000 degrees Fahrenheit and pressures of about 3,500 pounds per square inch is reached by steam. Then piped to turbine.

C. *Turbine is turned by steam*

Turbine shaft turns due to high pressure of steam pushing against series of giant turbine blades. The turbine shaft is connected to the generator shaft, where electricity is produced when magnets spin within wire coils.

D. *Steam is re-converted to water*

When its work on the turbine is done, the steam is drawn into a condenser, a large chamber in the basement of the power plant. In this step, gallons of cool water are pumped through a network of tubes running through the condenser from a nearby source. Steam is converted back into water by cool water in tubes that can be used again and again in plants.

Boiler gets the steam water to repeat the cycle and the cooling water is returned to its source without contamination.

III. TURBINE

Mainly a device extracting thermal energy from pressurized steam using it to do mechanical work on an output shaft which is rotating. Turbine is best suited to drive an electric generator because of its nature of generating rotary motion. The steam turbine is steam driven rotary engine. The steam turbine's principle is that the steam energy is converted into mechanical energy by expansion through the turbine. Expansion occurs through a series of fixed blades (nozzles) and also moving blades. In each row fixed blade and moving blade are called stage.

Components-

1) Casing
2) Rotor
3) Blades
4) Control valve
5) Oil befell, steam befell
6) Governor
7) Bearing (general and thrust)
8) Gear box (epicyclic)
9) Oil pumps

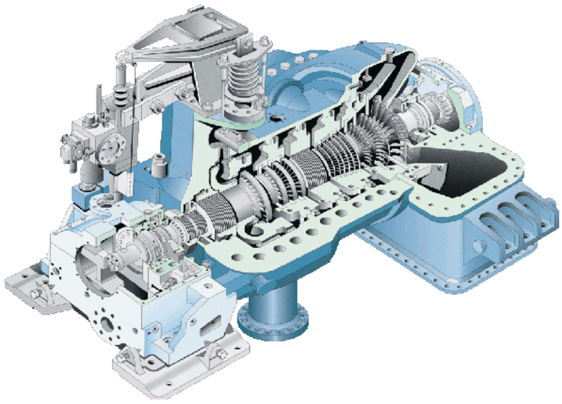

Fig 2. Turbine

IV. TURBINE MAINTENANCE

The availability of turbine, and therefore chiefly the operating reliability, depends on the satisfactory operation of its control, protection of ancillary equipments such as pumps, etc.
Conditions of turbine determine whether maintenance work must be carried out during operation or during short interruptions in service.

By means of efficiency measurements or stage pressure measurements it is possible to discover, for example whether there is any build up deposits in the turbine blades which will have to be removed by wet steam washing.
It is necessary to shut down the plant and appropriate measures must be taken to prevent corrosion of various parts of the turbine.

Overhauls – take a part or piece of a machine to examine it and also repair it if necessary.
The following intervals between overhauls are recommended:
Minor overhaul after not more than 3 years or 20,000 to 25,000 operating hours. Major overhaul after 10 to 12 years or 1,00,000 operating hours. If possible this overhaul should be carried in manufacturers assistance.

A. *Minor Overhaul*

- Couplings: check for teeth condition, visual inspection for cracks and bend in coupling bolts. Check for radial runouts and axial float.
- Bearings: check for bearings condition- scoring, bearing clearance, bedding and D.P. test and check for fit of the bearing in bearing housing.
- Oil glands: check for radial and axial runouts if necessary to be repaired/replaced.

- Bearing housings and casing supporting elements: spring/washers to be cleaned and assembled.
- Emergency stop valves, governing valves, bypass valves are to be opened and checked.
- Drains are to be checked for chocking.
- Main oil pump to be opened- Bearing, sealing rings, rotor, impeller etc, to be checked.
- Complete governing system and protection equipment to be cleaned and checked.

B. *Major Overhaul*

In this overhaul, all elements are to be checked thoroughly including turbine casing, rotor and blading. Besides all the checks that will be done under minor overhaul, the following checks are to be carried out-

- Bearing housing is to be lifted out and the bearing.
- Casing to be checked for parting place clearance in free condition- parting plane to be checked. Check cracks.
- Supporting elements of inner casing to be checked.
- High temperature zone bolts are to be measured in length. Check for deformation/elongation.
- Rotor

a. Check for rubbing marks
b. Check for runouts
c. Check for lock blade condition
d. Check for thrust collar

- Guide blades including nozzles to be cleaned thoroughly and checks to be made for cracks.
- Oil tank to be emptied. Oil quality to be checked.
- Oil cooler: tune bundles to be taken out. Tubes to be cleaned mechanically and chemically. Check for leaks.
- Oil piping should be checked for leakages.
- Piping supports and hangers to be checked and adjusted if required.

C. *Emergency Shutdown*

In an emergency, the turbine can be shutdown at any output level by tripping either directly at emergency trip gear or by using the solenoid valve for remote tripping.

Possible reasons for an emergency shutdown include:

- Sudden rise in vibration amplitudes.
- Limit values of the lube oil or bearing metal temperatures at the axial or radial bearings being reached or exceeded.
- Excessive expansions.

V. FAULT TRACING

TABLE I

A. *Serious Faults*

Fault Other Symptoms(Serious Faults)	***Cause***	***Remedy***
Load Rejection -Turbine generator remains in operation after short-time rise in speed.	Breaker opens as a result of an internal or external fault.	Control valves and extraction valves closed by the turbine governor to stop the steam flow through the turbine manual intervention is not possible as automatic shutdown is too fast.
Load rejection with turbine trip -Turbine speed reaches trip speed of overspeed trips. An overspeed failure on a big steam is one of the most frightening industrial accidents.	Breaker opens as a result of internal or external fault; Advrse conditions during load rejection; Control malfunction	Emergency Shutdown and investigate conditions. We can also use electrical overspeed shutdown system.
Turbine Trip -Turbine tripped by protective devices.		Stop and control valves and extraction valves close; Generator disconnected from system by reverse power protection relay;
Turbine-generator unit in imminent danger		
Shaft assembly runs down without lubricating oil -Fault in auxiliary and main oil pumps, jacking oil pump in operation; -Fault in jacking oil pumps		Speed drops; Auxiliary oil pump cuts in due to loss of pressure as speed drops; Turning gear operation commences; Reduce condenser vacuum to shorten coastdown -open vacuum

Fire or fire hazard during operation	Leakage of oil and steam	breaker; -stop air extraction; -allow air to enter condenser plant. Check bearing metal temperatures; If permissible high, inspect bearings Danger of bearing whipping check bearing metal temperatures; Check bearings; Set off fire alarm; Follow fire protection rules; do not pour water on hot turbine.
Escape of stream	Leakage in piping or other turbine components	Localize steam leakage immediately and de-pressurize system concerned, if possible; If there is a rupture hazard (pre-rupture leak), shutdown turbine generator unit immediately; Carefully consider rist erosion at sealing surface and decide on the time of shutdown;

B. *Vibration Faults*

Rapid or instantaneous increase in vibration over the permissible limits or the range of the measuring system (alarm of instrument display) 1.Loud noises and/or the following operating parameters exceed their limits. Wall temperatures because of rapid temperature changes.	Suspected damage , e.g. broken blades or metal to metal rubbing Clearances eliminated by causing distortion Clearances eliminated by casing distortion Axial clearances eliminated bearing damage	Caution: Stop turbine immediately even with accuracy of readings is doubtful; Check whether increased vibration is maintained after load is reduced and when running down; Measure the time taken to run down; Listen for noises during this period
Casing differential temperatures Differential expansion Bearing metal temperatures. 2.Low frequency vibration, Vibration frequency less than rotational frequency. Irregular point trace from recording instrument	Unstable running due to self excited vibration	Reduce turbine load immediately until vibration decreases; Examine vibration; Load turbines slowly to stability limit.

C. *Bearing Temperature*

Fault	***Cause***	***Remedy***
Bearing Temperatures High -Rapid rise of one or more bearing metal temperatures to the preset alarm level; similar temperature rise mot observed before under comparable operating conditions.	If a fault in temperature measuring equipment can be ruled out , the bearing is damaged . -Inadequate oil supply -Dirt	Shutdown turbine immediately to prevent consequential damage; Check bearing, clarify and remedy causes of bearing damage Check oil pressures upstream of damaged bearing; Check flow

-Rapid rise of all bearing metal temperatures	-Tilting of bearing (incl. thrust bearing) -Excessive thrust(in thrust bearing) Fault in oil temperature control system.	restrictor setting, check filters for contamination; Check bearing signs of wear; Take oil samples; Check bearing installation; Clarify cause of excessive thrust;
	-Fault in controller -Fault in cooling water supply	Check oil temperature down stream of cooler; Switch off controller Establish normal oil temperature; Establish oil temperature manually;
	-Cooling water temperature high -Oil cooler fouled	Check water flow through cooler; shut down turbine generator unit if temperatures reach the permissible limits in the event of cooling water supply failure; Start up standby oil cooler; Change over to stand by oil cooler

VI. RESULT

This paper provides a brief about procedures and steps regarding the maintenance of turbine. Maintenance of turbine is an important issue to keep it in operation conditions without disturbing its function.

VII. CONCLUSION

The study includes the Overhauling (Major and Minor Overhaul), emergency shutdowns, fault tracing and maintenance of turbine. The availability of turbine, and therefore chiefly the operating reliability, depends on the satisfactory operation of its control, protection of ancillary equipment such as pumps etc. The study deals with the tests and maintenance necessary to ensure good operating reliability for the turbine. At the same time it is possible to assess the condition at anytime in respect of any necessary action to be taken during overhaul or to decide the time for overhaul.

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