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Research Paper

APPLICATION OF MONITORING APPROACHES ON STEAM TURBINE OF THERMAL POWER PLANT FOR BETTER PERFORMANCE

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Steam turbines are utilized in numerous industries to drive boiler fans, boiler feed and water pumps, process and chillier compressors, blast furnace blowers, paper mill line shafts, sugar mill grinders, and generators in a variety of industries and applications. In any plant, stoppage of steam turbines results into the stoppage of entire plant, which in turn results in loss of productivity and profit of the industries. In this paper monitoring Approaches on steam turbine of thermal power plant define for to effectively manage the health and performance of steam turbines, improve power generation capacity, reduce maintenance cost and mainenance problems. Monitoring approaches are supporting all thermal power plant systems. The Result of these steam turbine Monitoring efforts should be directed toward diagnosing and justifying the problem and failure of the total system and help of these get better performance of the plant.

Keywords: Steam turbine, Thermal power plant, Performance

INTRODUCTION

Steam turbines are used at high temperature, high pressure, and high speed and closely assembled with many components. Steam turbines can range from being small and simple in design/construction to large, highly complex designs/arrangements consisting of multiple sections and multiple shafts. Specifying the desired maintenance and overhaul intervals for steam turbines, therefore, has to take into account the design/construction of the turbine as well as the industry and application utilizing the turbine. Besides the configuration and industry associated with the steam turbine, the infrastructure for monitoring, operations and maintenance including specific practices, and steam quality can have a major effect on the reliability of steam turbines regardless of the industry or application.

To effectively manage the strength and performance of steam turbines, there are a number of turbine parameters which should be

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measured, monitored and/or displayed on a continuous basis. The current situation regarding the assessment, testing and inspection of power plants frequently results in the formulation of the following question: how long can power plants be operated safely and cost-effectively while satisfying increased requirements pertaining to operational availability and reduced pollutant emissions? In order to answer this question the operational capability of the existing plant must first be investigated.

MONITORING APPROACHES

Equipment Monitoring

How much information is monitored is a function of the steam turbine design and application, but with today's modern steam turbines, the following parameters should be monitored:

Steam Turbine Parameters to be Monitored Continuously

- Speed (RPM)
- Power (MW or SHP)
- Steam Turbine Inlet Pressure
- Steam Turbine Inlet Temperature
- Steam Turbine 1st Stage Pressure
- HP Turbine Outlet, IP Turbine Inlet, IP Turbine Outlet/LP Turbine Inlet Pressures and Temperatures
- Admission Steam Inlet Pressure and Temperature (As applicable)
- Extraction Steam Outlet Pressure and Temperature (As applicable)
- Turbine Exhaust Steam Pressure
- Turbine Exhaust Steam Temperature
- Sealing Steam Pressures
- Sealing Seal Exhauster Vacuum
- HP and IP Turbine Shell/Steam Chest Temperatures/Differentials
- Rotor/Shell Differential Expansions
- Rotor Eccentricity
- HP and IP Stress
- Extraction Line and Drain Line Thermocouples
- Lube Oil Supply Pressure
- Lube Oil Supply Temperature
- Lube Oil Sump Level
- Bearing Metal or Drain Temperatures
- Bearing Vibration (Seismic, Shaft Rider, or Proximity Measurements)
- Thrust Bearing Wear/Temperatures
- Hydraulic Fluid Pressures and Temperatures
- Cooling Water Supply Pressures and Temperatures for Lube Oil and Hydraulic Fluid Heat Exchangers
- Water and Steam Purity Monitoring
- Control Valve Position (%) Indication
- Admission and Extraction Valve Position (%) Indication

Monitoring of these and other parameters is typically done in conjunction with today's modern turbine digital controls and plant control room systems. These systems will also handle the starting sequence, synchronizing, loading, speed governing, alarms, and trip logic for the turbine, gearbox (if present), generator, and any supporting systems. These systems also provide the electronic portion of the protection (i.e., turbine overspeed) for critical turbine and generator parameters. There usually is a limited display of monitoring parameters. For even older units, all operation will be manual with only a gage panel to monitor a few turbine parameters.

Water and Steam Purity Monitoring

Contaminated steam is one of the prime causes of forced and extended maintenance outages and increases in maintenance costs. Contaminants can be introduced into steam from a variety of sources but can generally be categorized into two categories:

- Inert or deposit forming and
- Reactive or corrosion causing

The sources of contamination include the following:

- Water treatment chemicals for the boiler or condensate system
- Condenser leaks
- Demineralizer leaks
- Chemical cleaning of the boilers
- Process chemicals such as residues from black liquor in paper mills to polymers used in chemical plants
- Makeup water which may have rust, silica and other chemicals
- Corrosion products from condenser tubes and condensate piping

The principal cause of small to moderately large steam turbine contamination is mechanical carryover from the boiler system. These can result from:

- Over steaming
- High water levels
- High drum solids
- Separator problems
- Rapid load changes
- Chemical contamination

To systematically minimize these effects, design and implementation of water and steam chemistry controls that protect the boiler and turbine need to be established, super heater attemperation operation needs to be prudent, and steam purity monitoring needs to be implemented. The monitoring for the steam turbine, as a minimum, should include sodium and cation conductivity monitoring at the steam inlet to the turbine. In addition, it is advisable to monitor sodium and cation conductivity in the condensate and feed water system downstream of the condensate pumps or Demineralizer and at the deaerating (DA) tank outlet or economizer inlet to provide advance warning of water chemistry problems. Together, cation conductivity and sodium monitoring allow for the detection of the primary chemical causes (chlorides, sulphates, hydroxides) that are responsible for stress corrosion cracking of turbine steels. While other parameters (silica, hardness, etc.) in the water/steam may be monitored, their effect on turbine reliability is small compared to the primary chemical causes.

Water Induction Monitoring

Significant turbine damage can occur to a steam turbine when cool water or steam flows back into the turbine. When this happens during operation, steam turbine nozzle and/or bucket vibration increases and increases the potential for these components to break in the vicinity of where the cool water or steam is being introduced. Similarly, if the cool water or steam backflow occurs during starting, it can thermally distort the steam turbine rotor during the start and may cause major seal rubs and severely damaged blades. If the water or steam induction occurs during a shutdown after the circuit breaker has been opened, the turbine can and does overspeed to destruction.

For the small to moderately large steam turbines, the following is suggested as the minimum basic requirements to detect and reduce the probability of water or cool steam induction:

- Test extraction Non-Return Valves (NRV) daily to ensure proper operation
- Install and monitor thermocouples on the controlled and uncontrolled extraction lines to detect drops in temperature that may be indicative of a potential water induction incident
- Ensure sealing steam drains and casing drains are free, that valves installed downstream of drains are in the proper position, that drains are not manifolded together to restrict flow, and that the drain lines actually drain downward
- Ensure that feed water heater (if present) levels are kept at required levels and that level detector alarms are added to alert the operator of a problem
- Ensure steam header low point drains, main steam stop and control/extraction valve drains have valves in the proper position for draining and that the drain lines do drain downward, not upward
- Ensure attemperation spray control valves close on boiler fuel and turbine trips and that there is a block or shutoff valve in series with the spray control valve to ensure there is no leakage into the turbine
- Monitor the difference in thermocouple readings (if present) on the upper and lower halves of the turbine shell. A large difference between halves and/or a cooler lower half could be indicative of water induction

Condition Monitoring

While continuous monitoring of steam turbine parameters is important, use of that information to detect changes in equipment health and condition in advance of possible failures is equally important. As such, the steam turbine parameter data can be used for historical recording, for trending of turbine readings, for calculating turbine performance, and for detecting changes in vibration signatures (level, phase angle, frequency changes, orbit changes, etc.) with time. Consequently, if the data is collected and analyzed properly, changes in state or leakages between or within components can be detected and utilized for assessing turbine life issues. These analyses may be done off-line or may be accomplished on-line with intended goal of detecting changes in health before failure so that corrective actions can be taken in timely and cost effective manners.

SUMMARY

The reduction of maintenance costs of turbines and auxiliary machinery in power plants is an engineering task of increasing importance. The primary reasons are the falling electricity prices due to the current market liberalization as well as the continuous maturing work at turbines of different design. The increased requirements in terms of efficiency, flexibility and short-term amortization put an enormous pressure on manufacturers and utilities. It can be observed in these days that the actions currently concentrate on cutting staff and operation costs to reach short-term cost reduction. However, it is obvious that in certain cases these measures have a very limited potential. Not only manpower is reduced. Due to precocious retirements of technicians accumulated knowledge is lost, additionally.

Long-term and engineering oriented solutions have to be developed for the future. Implemented process control systems have to be combined with advanced process and quality monitoring. New technical requirements will grow by improved concepts for hardware and software modules which can be subdivided among others by the concepts of improved infrastructure in the performance of information and control systems, to interlink planning, start-up, production and maintenance, as well as to build up computerized information centres to merge the experiences and investigations of machine manufacturers, the operators, and the related insurance companies. Ultimately the target is to optimize life cycle costs, influenced significantly by condition monitoring and maintenance strategies, including the knowledge based information technology and plant management, as well as the detection and prediction of faults and failures.

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