Research Paper

EFFECT OF STEAM INLET TEMPERATURE ON PERFORMANCE OF PARTIAL ADMISSION STEAM TURBINE

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Energy analysis helps designers to find ways to improve the performance of a system in a many way. Most of the conventional energy losses optimization method are iterative in nature and require the interpretation of the designer at each iteration. Typical steady state plant operation conditions were determined based on available trending data and the resulting condition of the operation hours. The energy losses from individual components in the plant is calculated based on these operating conditions to determine the true system losses. In this, first law of thermodynamics analysis was performed to evaluate efficiencies and various energy losses. In addition, variation in the percentage of carbon in coal content increases the overall efficiency of plant that shows the economic optimization of plant.

Keywords: Steam inlet temperature, Energy losses, Economic optimization

INTRODUCTION

Power plants are part of the infrastructure of the modern society and it is essential that these power plant facility by constructed so as to achieve a higher level of reliability. Moreover it is mandate of power plants involved in this industry to contribute to society by realizing higher performance. Energy analysis helps designers to find ways to improve the performance of a system in a many ways. Most of the conventional energy losses optimization method are iterative in nature and require the interpretation of the designer at each iteration. Typical steady state plant operation conditions were determined based on available trending data and the resulting condition of the operation hours.

LITERATURE REVIEW

Ghosh et.al. (2005) states that the limited primary energy sources and awareness of environmental pollution has led to ever increasing end over to develop new steam turbine power plants with the highest possible efficiency. Considering their output, even small step increase in efficiency can result in major saving for the customers. As overall cycle efficiency is strongly dependent on

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steam turbine performance, Continuous improvement are sought to increase the turbine efficiency. These effectors are directly primarily towards improvements are blading as the key component of the turbine

Kenji Nakamura et.al (2010) response to global environmental issues, higher efficiency and improved operational reliability are increasingly being requested for steam turbines, essential equipment for thermal power generation. By increasing the temperature and pressure of the steam turbine operating conditions, more efficient power generation is realized, and in order to realize a turbine applied with the higher temperature conditions of 700°C for the future, Fuji Electric is participating in the METI-sponsored development of advanced ultra-supercritical power generation, and is evaluating and verifying the reliability of materials used for high-temperature valves.

Paul I. Nippes et al. (2002) worked with the current practices of extending periods between turbine-generator planned outages is the need for improved and careful condition monitoring. By determining the condition of the turbine generator units and their suitability for continuing satisfactory operation, outages can be scheduled, often preventing forced outages. A relative newcomer to the field of monitoring is shaft condition monitoring, which also usually projects to train condition monitoring. This is accomplished by placing reliable shaft-riding brushes for shaft grounding and voltage monitoring. As can be imagined, a wide plethora of shaft grounding current and voltage data is available so the issue becomes one of sifting through to identify and project hidden messages as to the shaft, and unit condition. Illustrations and descriptions of shaft grounding currents and shaft voltages, based on measurements made on installed units is the main purpose of this paper.

**PARTIAL ADMISSION**

Partial admission applied as control stage yields high part load efficiency and high specific work output due to a maintained high inlet pressure for the turbine in the fully admitted sectors. The thermodynamics of partial admission can be explained by a comparison to simple throttling valve, as illustrated in Figure 1, where it is noted that the average entropy of the steam into the subsequent stage is lower for the control stage than for a simple throttling valve due to the maintained large pressure ratio across the open admission arcs.

**EXPERIMENTAL SETUP**

The equipment has a data acquisition system to collect the information. A systematic block diagram of the experimental system is shown in Figure 1.

![Figure 1: Experimental Set up](image)

The location and function of the data instruments of the setup is given below:

Digital flow meter and display gauges mounted on the steam supply lines are used to measure and display the flow rate and temperature of the steam. Controller monitored pressure display is used to display the set point and acquired pressure. Analog pressure gauges mounted at various locations on the apparatus
are used to measure and display the pressure of the steam or water. Thermocouples mounted on the condenser unit are used to measure the temperature of steam entering condenser, water entering condenser and water leaving condenser.

Experimental Procedure
1. At the moment of taking the readings, the steam turbine will be operational in the no load condition. So, the first step is to set the 1/2 of the maximum load applied on the turbine by the generator.
2. Allow the system to reach steady state, and take readings. They are:
   a) Turbine inlet temperature.
   b) Turbine exit temperature.
   c) Turbine inlet pressure.
   d) Turbine exit pressure.
   e) Mass of steam flow.
   f) Time operation.
3. The above procedure is repeated for the 3/4 of the maximum load applied.
4. Finally apply the full load to the turbine and allow the system to reach up to the steady state. Now take the readings at full load.

Assumptions
As per literature survey, the following assumptions are considered for the efficient operation of power plant.
- Each component of the cycle is analyzed as a control volume at steady state.
- The turbine operated adiabatically.
- Saturated vapor enters the turbine.
- Condensate exits the condenser as saturated liquid.

In calculating the turbine efficiencies, the enthalpies at the relevant state points were taken.

Full Load Steam Turbine Performance
The load on the turbine is a variable that can affect the output power and the efficiency. The load is a number between 0 and 100, and it represents a braking or drag resistance to the shaft rotation. The greater the load, the greater the resistance applied. The load affects the power output because it influences the RPM and the mass flow rate of the steam. For any steam turbine, if there is increase in the load, the RPM will be going to plummet unless the mass flow rate is increased.

Effect of Steam Inlet Temperature
Enthalpy of steam is a function of temperature and pressure. At lower temperature, enthalpy will be low, work done by the turbine will be low, turbine efficiency will be low, hence steam consumption for the required output will be higher. In other words, at higher steam inlet temperature, heat extraction by the turbine will be higher and hence for the required output, steam consumption will reduce. Figure 3 represents the effects of steam inlet temperature on steam consumption, keeping all other factors constant for the condensing type turbine.

RESULTS

![Figure 2: Effect of Steam Temperature on Steam Consumption](http://www.ijerst.com/currentissue.php)
EFFECT OF STEAM INLET TEMPERATURE AT 75% LOAD

CONCLUSION
Steam Turbines are one of the main energy consuming equipments, even though not much attention is paid to them. Trimming of operating parameters are essential for efficient operation of these turbines. Illustration given in the work shows impact of operating conditions on steam turbines. Savings presented are for a typical operating conditions.

REFERENCES


