DESIGN & ANALYSIS OF LOW-PRESSURE ECONOMIZER BASED WASTE HEAT RECOVERY SYSTEM FOR 60 MW COAL-FIRED THERMAL POWER PLANT

M Tech Dissertation

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Abstract

Savings energy play a key role in reducing the temperature of exhaust gas and increasing thermal efficiency. It has been designed to reduce the coal consumption rate for the thermal power plant and improve the plant's performance by reducing flue gas emission and temperature. It lies between the water heaters and the gas tower. Industrial projects at Saurashtra Cement Limited combines 60 MW thermal power plant to ensure their safe operation and an optimum financial condition.

There are two installation cases of LPE: (1) LPE between the condenser and low-pressure heater, and (2) LPE between the high-pressure heater and low-pressure heater. The Case-2 is found to be more effective than Case-1 by exergy analysis. The flue gas temperature decreases from 155℃ to 131℃.

The heat exchanger area of 2.88 m^2 is defined by the thermal design of LPE. It is concluded from the literature that the compact finned tube heat exchanger is more suitable for a gas-to-liquid heat exchanger.

The output temperature of the flue gas is not to be less than 80℃ by flue gas analysis, because at this temperature sulfur & nitrogen agents become active. It reacts with the moisture in the flue gas that transforms into sulfuric acid and nitric acid. This acid thus causes corrosion on the surface of the chimney at low-temperatures.

The compact (finned tube) heat exchanger should be suitable for LPE design. Consider the approximate values of the input variable for the actual design calculation. HTRI software used to validate the calculation of the actual design. The actual design and HRTI design values found almost the same. The pressure drop can be allowed up to 5200 Pa in both actual design and HTRI design. Taguchi Method is used to design LPE to reduce various low-cost LPE design experiments.

The temperature and mass flow uncertainty analysis was found to be 0.1 and 3%. In calculating the uncertainty analysis for the calculated qualities of the heat exchanger, some precision is determined for the LPE design.

The geometry was made from Solidworks software to produce the low-pressure economizer's virtual model. The main objective of geometry in solid works is to design heat exchangers with filly assembly of different LPE components

We consider only 3 rows of tubes in Shell. This reduces the elements counts in the model. The meshing time will be reduced in that case.

The hexahedral meshing provides a grid size of 3.5 mm on the shell side. The automatic meshing also provides the same grid size on the side of the tube.

The result of the analysis shows the physical behaviors, the maximum speed found in a velocity contour between tubes and the minimum speed found behind the tube surface.

While the maximum velocity was found at the center & minimum on the tube surface. In the pressure contour, the maximum pressure drop found behind the tube surface also reduces the pressure intensity as it passes through the number of tubes row.

The temperature profile shows the shell-side temperature difference between 5°C and 8°C while the tube-side temperature difference between 3°C and 5°C is similar to the design prospects.

LPE design is validated with HTRI design, which found similar values in almost all variables.

By economic analysis, the coal consumption of approx. 3.42 kg/kWh or water consumption of approx. 1.8 kg/sec should be reduced to improve overall power plant efficiency.

Annually, Rs 1,19,460/- ($ 1739) cost savings as coal save about 30 tons. The period of payback was up to 1 to 1.5 years.

Keywords: Low-Pressure Economizer, Exergy Analysis, Thermal Power Plant, Acid Dew-Point Temperature, Compact (Fin & Tube) Heat Exchanger, Uncertainty Analysis, Taguchi Method, Ansys 17.1 (Fluent), Economic Analysis.