CleanAir

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Heat Rejection Cycle Analysis: A Path to the Recovery of Lost Megawatts

An area often disregarded when evaluating power plant efficiency is the heat rejection cycle. Major components such as the cooling tower, condenser, and circulating water pumps slowly degrade over time and their performance is often overlooked until catastrophic failure occurs or generation is curtailed due to backpressure limitations. This is most evident for combined-cycle and nuclear plants with a fixed heat input that also experience a loss in generation capacity as increased back pressure negatively impacts turbine.

Plants with underperforming thermal or hydraulic heat rejection equipment pay a year-round price in reduced efficiency which is clearly noticed in the summer months when these systems are stressed and a premium is paid for generation.

A heat rejection cycle analysis is a cost effective way to evaluate the major components of the cycle so that operation and maintenance (O&M) or capital dollars can be targeted effectively to improve plant efficiency and system availability.

Heat Rejection Cycle Evaluation

The heat rejection cycle analysis first begins with a commitment from the plant to improve performance. CleanAir engineers then begin by developing a test plan to determine the performance of the major components for an economic evaluation as follows:

Cooling Tower Performance Testing

Cooling tower thermal performance tests are conducted under the guidelines of the Cooling Technologies Institute (CTI) ATC-105 or the American Society of Mechanical Engineers (ASME) PTC-23 Test Code in order to determine the cooling tower capability. In addition to the tower capability, CleanAir will determine the impact of the tower performance on cold water associated with the test result.

CleanAir conducts the test using CTI code compliant calibrated test instrumentation and test representatives. Mechanically aspirated psychrometers are deployed in an array in front of the air inlets to determine the average inlet wet-bulb temperature. A minimum of one hour of thermal data is acquired for the tower using an automated data acquisition system equipped with precision RTD's. Water flow rate to the tower is typically measured via pitot tube traverse.

Condenser Performance Testing

Condenser measurements include the condenser pressure and inlet temperatures in order to calculate the Heat Exchanger Institute (HEI) cleanliness factor for the condenser. The resulting condenser cleanliness factor will help characterize and quantify the condenser performance and its contribution to the heat rejection cycle performance.

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Pump Performance Testing

CleanAir will measure the flow rate for the system while under heat load and evaluate the performance of individual pumps of multi-pump systems while the unit is at reduced load. System discharge head, lift, flow rate and calculated velocity head are used to plot the operating point for the system or individual pump flow rates. This allows an evaluation of the actual performance of the pumps versus the predicted flow from the pump manufacturer's curves and is used to evaluate the degradation of pump systems.

Economic Evaluation and Recovery of Lost Generation

Using the performance test results, CleanAir will evaluate the impact on the plant heat rate based on the local meteorology of the site. Using a statistical evaluation of the inlet wet-bulb temperature, CleanAir presents the impact of the combined heat rejection cycle as well as the individual components on turbine back pressure and generation capacity. This analysis is presented for both the summer months and on an annual basis.

The plant using this evaluation can then determine the payback associated with repair of the individual components to their original design specifications and the corresponding recovery of lost megawatts.

Schedule Considerations

Since many of the measurements required for a cooling tower performance test are common to the evaluation of the condenser and pumps, it is cost-effective to evaluate a heat rejection cycle during cooling tower performance testing and determine the performance all of these components at the same time.

Heat rejection cycle testing is typically performed when the inlet wet-bulb temperature is within 15 degrees of the design specification. This means that most tests are performed between the months of April or May and November.

Flow measurements can be performed at anytime without compromising accuracy (and with or without a heat load), but cooling tower evaluations are most accurate when the inlet wet bulb and heat load are contained within the supplied performance curves.

Single pump flow measurements are usually made at night or in the cooler months when the plant is at reduced load or can operate at a reduced water flow rate.

If you would like a CleanAir Engineer to contact you regarding your plant specific application, please contact us at Knoxville@cleanair.com or 800-208-6162.