

Thermal predictive maintenance at a coal plant



Testing Functions Case Study

As monopolies, electric utilities are charged with providing the highest quality product to the public at the lowest possible cost. Simultaneously, as publicly-owned companies, they also need to generate a return on investment for their shareholders. They have a fiduciary responsibility to operate efficiently, and predictive maintenance is an essential component in fulfilling this responsibility.

While many people in the power generation industry are familiar with annual infrared thermography surveys as part of PdM, the coal plant in this case study uses a thermal imager year round. There are two differences in their approach.

1. They use a mid-range thermal imager with enough pixel count, accuracy, and temperature range for their applications.
2. They use it to troubleshoot problems, track critical equipment more closely, and follow up repairs after the annual survey.

Power distribution

Delivering consistent, reliable electricity is a power generator's highest priority. For this reason, the primary use of infrared thermography at this plant is regular monitoring of power distribution equipment. For example, 2300 V and 4160 V breakers and transformers should be inspected with a thermal imager to identify problems prior to scheduled maintenance outages.

Application Note

Switchyard

Switchyard inspections are normally performed during the pre-dawn hours in order to avoid solar reflections and effects from wind. During pre-dawn, the load is lighter but the air is usually calm, so any problems that are observed are certain to be significant, as they will be much hotter during the period of peak load. Traditionally, these inspections would be performed during periods of maximum load, however local conditions at that time of day can mask serious problems.

Boilers, pipes, traps and valves

While delivery of electricity is essential, efficient production is equally important. At this coal plant, for example, steam is produced from coal fired boilers and electricity is produced from steam driven turbines. When steam valves leak or fail, high energy content steam or water blows through to the condenser. This represents significant money down the drain. The thermal imager allows maintenance staff to regularly scan the pipes, valves, and traps, identifying these problems early on and controlling the operational cost of electricity production.

Measuring tools: Fluke Ti30 Thermal Imager

Operator: Coal plant/ power generation

Tests conducted: Power distribution, switchyard, motors, boilers, pipes, traps and valves

Energy losses are not limited to the steam lines. Infrared thermography is used to inspect the boilers to identify areas of insulation breakdown. Hot areas on the boiler walls indicate areas of worn insulation and significant energy losses. Infrared thermography helps identify these areas so they can be repaired during the next maintenance outage.

Motors

At most plants with in-house imagers, nearly all of the infrared analysis is qualitative and comparative—examining similar pieces of equipment under similar load. A primary example is the inspection of pulverizer motors. The steam boilers are hungry for coal. Twenty-seven 400 to 500 horsepower motors drive the pulverizers which feed the boilers.

In advanced PdM systems, each aspect of the system may have its own monitoring program. For example, this coal plant should have a motor casing monitoring program, where the case temperature for each motor is regularly examined. Motors all have NEMA temperature ratings on their nameplates, providing the usual operating temperatures as a baseline. The normal apparent temperature is approximately 120 - 140 °F, depending on ambient conditions. As the temperature rise approaches 40 degrees, it usually indicates the need to clean the filters. When the temperature rise exceeds 40 degrees, it indicates that the motor needs to be scheduled for cleaning and reconditioning. Since the motors are all about the same size and operating under similar loads, it's a fairly simple matter to identify "hot" motors comparatively and take corrective actions.

Prioritizing problems

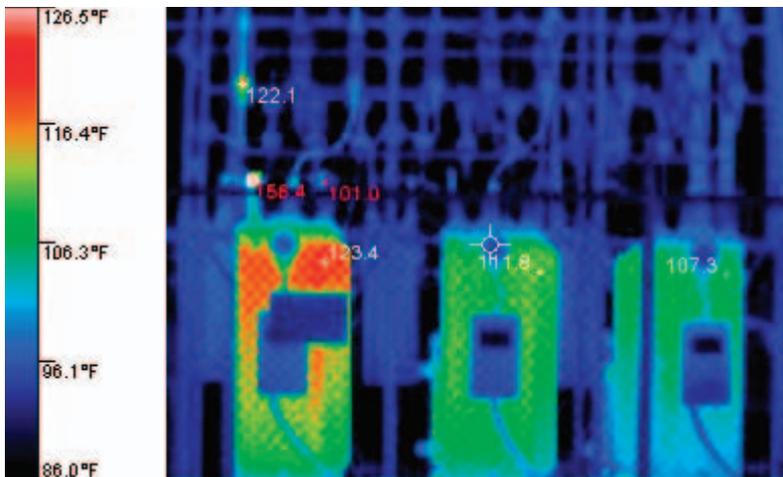
Infrared thermography helps identify maintenance needs but prioritizing the problems requires thoughtful evaluation of many factors. The most significant problem is not necessarily the one with the hottest apparent temperature. Other factors include criticality of the equipment, total repair/replacement cost, safety concerns, and lost production costs.

Basic vs. advanced thermography

Much of the equipment in coal-fired power generating stations can be efficiently inspected using comparative infrared analysis. In this case, the plant continued to hire out the annual survey, so that it had professional thermal images of all critical equipment to compare their own images to during the year.

For example, most of the metal surfaces in a coal-fired plant are heavily oxidized and coated with fly ash. This means that most of the surfaces of interest generally have an emissivity of about 0.95. Since that's the default emissivity setting on most thermal imagers, those surfaces yield accurate thermal images year round.





This thermal image shows hot secondary connections on the transformer.



Examine transformers, comparing similar connections under similar loads.

However, if the metal surface of a motor casing is shiny, it looks like a mirror in the infrared region. Instead of seeing the temperature of the motor, the infrared camera “sees” a combination of some of the heat of the motor and some of the heat of objects around the motor. To compensate, thermographers paint a black spot on the surface or use a contact temperature probe to allow them to adjust the emissivity until the infrared reading matches the contact probe.

While issues like emissivity are minimized by dirty metal surfaces, other issues like reflections, convective losses due to wind, and other conditions can lead to erroneous conclusions.

More advanced infrared thermography involves learning the principles of heat transfer, reflectance (mirrors), emittance (walls) and transmission (windows). Special settings for each piece of equipment can also be obtained from the annual consulting thermographers.

Predictive maintenance basics

Predictive maintenance is especially important to power-generation facilities because so many are running past their original design lives. Preventing unplanned downtime while operating aging equipment on a fixed budget doesn't leave too many options.

Predictive maintenance (PdM) involves monitoring equipment over time for conditions that indicate impending failure, determining whether corrective action is required, and, if necessary, taking that action before the equipment fails. The goal is to avoid unplanned downtime and schedule repairs.

PdM technicians identify critical production assets, determine how often they need to be monitored, set up an inspection route and schedule, and regularly measure key indicators.

Then, they compare those measurements over time, looking for changes in operating conditions that indicate potential breakdowns. Available monitoring and measuring methods include infrared (IR) temperature measurement, vibration analysis, oil analysis, ultrasonic testing, electrical measurement, power quality, insulation resistance, and thermal imaging.

The benefits include significantly reduced downtime, maximized uptime, stocking an optimum number of spare parts, and lower labor costs for maintenance. Overall, PdM programs increase capacity or productivity using existing equipment. Some power generation facilities find that the data collected for predictive maintenance is also useful for meeting environmental documentation requirements.

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