FLUKE®

Inspecting furnaces and boilers

Application Note

Furnaces and boilers play important roles in many industries as well as in the heating of commercial and institutional buildings. They heat products in petroleum, chemical and pharmaceutical industries and produce or handle molten products in glass, steel and other industries. In most cases, if only because of their high operating temperatures and their capacity to cause injury or death as a result of some failures, furnaces and boilers should be included in predictive maintenance (PdM) programs that monitor their condition while they operate.

Check for abnormal hot spots indicating refractory insulation breakdown.

The purpose of a PdM program is to detect and prevent imminent failures before they occur to avoid the shutdown of critical equipment. One especially powerful tool for monitoring the condition of furnaces and boilers is thermal imaging, which captures two-dimensional images of the temperature profiles of objects. Thermal images can reveal potential points of failure in furnaces and boilers and help extend the life of their refractory insulation.

The following discussion focuses on using thermal imaging or thermography to troubleshoot furnaces and boilers, especially the refractory insulation directly inside a unit's exterior wall or the insulating lining of vessels handling or conveying molten material.

What to check?

Use a thermal imager to check any critical furnace, process heater or boiler, prioritizing those whose failure could threaten human health or safety, property, productivity or the product itself.

Highly skilled thermographers report some success checking the tubes of furnaces and boilers for hot spots, which can signal a potential failure. Clearly, a breach in the wall of a tube containing very hot water, steam or hot product could be catastrophic, but those who would attempt to use thermography for such monitoring must realize that to do so is difficult and dangerous, putting both the thermographer and the imaging instrument at risk. Also, it requires substantial knowledge, training and experience to get reliable results in environments as harsh as the inside of a furnace or boiler.

By contrast, as long as a unit does not have a shiny surface, exterior thermographic inspections of furnaces and boilers are relatively safe and easy and can help determine the unit's health.

What to look for?

To protect personnel and property, furnaces, boilers, process heaters and other heat-generating units have insulation or refractory lining their external

walls. Using a thermal imager, technicians can look for hot spots on the walls. The hot spots will reveal where the refractory is less effective. The goal is to maximize the useful life of the refractory and to schedule repairs before a burn-through of the unit's wall results in fire, injury or worse. Of course, a secondary concern with ineffective insulation or refractory is energy loss, which increases operating costs and can jeopardize process efficiency due to heat loss.

A sound approach to furnace and boiler inspections is to create regular inspection routes that include all key furnaces, boilers, process heaters and other heat-generating equipment. A good approach is to determine the frequency of inspections based on the nature and function of the equipment. For example, you might perform quarterly inspections on indispensable equipment operating under severe conditions and annual inspections on equipment operating under less severe conditions.

What represents a "red alert?"

Equipment conditions that pose a safety risk should always receive the highest repair priority. Clearly, one of the most potentially dangerous situations that might occur is the failure of a furnace or ladle for a molten material such as glass or steel.

Monitoring such equipment serves a two-fold purpose: 1) to maximize the life of the unit's refractory and 2) to guard against a breakout that discharges very hot molten materials into a facility.

What's the potential cost of failure?

A catastrophic failure in the glass or steel industry would constitute a multi-million dollar production stoppage, even if there were no injuries or deaths. Cold glass cannot be reheated. And how does one recover solidified, once-molten iron or steel?

Here are some representative hourly downtime costs for some selected industries in which boilers, furnaces and process heaters are key to production: Pharmaceuticals, $1 million; Food and Beverage, $800,000; Chemicals, $700,000; Metals, $550,000. These figures are tied to loss of IT performance, but are cast in terms of general downtime.*

Follow-up actions

When you discover a problem using a thermal imager, use the associated software to document your findings in a report that includes a thermal image and a digital, image of the equipment. It's the best way to communicate the problems you found and any suggested repairs.

In general, if a catastrophic failure appears imminent, the equipment must either be removed from service or repaired while operating. In the steel industry, both strategies are employed. When it comes to ladles for molten product, mills generally have enough ladles to take a failing one out of service for repairs and replace it with a sound one. However, the refractory in some kinds of furnaces and heaters in the steel industry can be repaired during operations using a grout pumped onto areas of weak or damaged refractory (as identified in a thermal image).

In either case, following repairs, new thermal images can be used to assess the effectiveness of repairs and evaluate the repair materials used. With this information, you can continuously improve your PdM program for furnace and boiler refractories.

*Source: IT Performance Engineering and Measurement Strategies: Quantifying Performance and Loss, Meta Group, Oct. 2000; Fibre Channel Industry Association as found on the Web site of the Association of Contingency Planners, Washington State Chapter - www.acp-wa-state.org.

Imaging Tip:

A comprehensive comparative or qualitative analysis of refractory can yield substantial cost benefit. A detailed infrared examination of a new ladle or relined refractory wall, contrasted with a similar infrared examination of a similar ladle or furnace wall just prior to relining, can help you establish benchmarks for performance. These benchmarks become the future standards for determining acceptance criteria for a new unit, and guide the user for determining when the next relining is required.

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Web access: http://www.fluke.com

Printed in U.S.A. 8/2005 2524871 A-EN-N Rev A