IR inspection program for fired heater mechanical integrity

Infrared (IR) thermometry has been used for 40 years to monitor tube metal temperatures in refining and chemical furnaces. The application of IR thermometry has often been characterized as highly operator dependent and therefore developed a very poor reputation in the industry from poorly applied and interpreted results. There is no question that when absolute accuracy is unimportant, IR thermometry is an excellent diagnostic tool for detecting tube hot spots from internal fouling and heat distribution non-uniformity in fired heaters. However, to capture the full capability of IR thermometry, a proven methodology is required to measure accurate temperatures in a repeatable process.

IR thermometry is the nondestructive, nonintrusive, noncontact mapping of thermal patterns on the surface of objects (e.g., tubes). For fired heaters, understanding the tube metal temperature defines the performance capability and inherent reliability of the fired heater and ultimately the risk of a tube rupture failure. An effective infrared inspection program allows the mechanical integrity of fired heaters to be managed.

Today, IR thermometry is primarily accomplished with two instrument types: thermal imaging cameras and pyrometers. The thermal imaging camera forms a twodimensional thermal image of the target surface, while the pyrometer provides only a single target point temperature. Each instrument has its advantages and disadvantages, and effective programs should include using both. The imaging camera provides meaningful images and measurements for a historical record that can be used to assess tube creep damage rates and long-term performance changes. The pyrometer should be used for accurate field measurements to compare specific tubes and troubleshoot real-time performance issues.

All infrared measurements, whether made by an imaging camera or pyrometer, are subject to measurement factors which affect the accuracy and repeatability of the measurement. The fired heater’s environmental factors are the target tube’s emissivity, target reflectance and the flue gas effect on the measured temperature. The instrument factors affecting the temperature measurement are the instrument infrared wavelength, calibration, size of source effect and the emissivity setting. Each of these factors must be understood and accounted for in an effective infrared inspection program, otherwise measurement errors as much as 180°F can occur, which also affects the repeatability of the measurements.

An effective infrared inspection program for fired heaters accounts for these measurement factors. Software is available that automates the rigorous correction calculations based on simple field data collections. This allows any operator using either IR instrument to collect repeatable tube metal temperature measurements. The correction software employs algorithms based on well-established physical principles of blackbody infrared radiation and radiation exchange, including a specific geometrical model of the subject fired heater and characteristics of the measurement instruments. In order to determine the true (or actual) tube temperatures, corrections must be made to the instrument readings based on the geometry of the furnace, the emissivity of the tube material, atmospheric effects and knowledge of the operating characteristics of the instrument, all of which are performed by the software.

An effective infrared inspection program is an absolute necessity to monitor the integrity of the fired heater tubes, as well as provide a wealth of diagnostic information that may be used to evaluate the performance and reliability of major fired heater parts (e.g., tubes, tube supports, burners, refractory and structural systems). By fully understanding the IR measurement factors and employing field collection practices and IR temperature correction software, accurate and repeatability infrared temperature measurements are achievable.

For more information, visit www.QuestIntegrity.com or call (303) 415-1475.