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This process can help move a maintenance department to the next level and better prepare for the future.

Operators of high-temperature pressure vessels now can see in vivid color the advantages of new wireless radiometric imaging technology for safety monitoring of shell temperatures. The largest such system, using 14 Mikron infrared cameras and MikroSpec R/T software, has been online for more than a year monitoring a Chevron-Texaco-designed gas separation system in Texas.

Developed by Mikron Infrared Inc., Hancock, MI, as a turnkey installation, the system provides continuous real-time tracking with computer-generated alarms for possible burn-through and temperature excursions, while storing trend data for analysis and process improvement. In addition, the imaging data gives plant operators a color-coded graphic representation of conditions inside the vessel, enabling them to make inferences about the overall quality and uniformity of the process. This is the second gas separation monitoring system in the Oil Patch, and the technology is applicable to any refractory-lined equipment, as well as reactors, regenerators, boilers, and furnace tubes.

The gasification unit consists of two vessels operating at about 1100 psi with internal firing at approximately 2600 F and exterior shell temperatures ranging from 200-500 F. A lining of AA22 castable refractory insulation 6-8 in. thick protects the integrity of the 1 in. thick carbon-steel shells, which have a melting temperature around 1700 F. Loss or breach of insulation in a monitored area is immediately visible as a temperature spike on the infrared system's monitor graphics, while the system computer generates an alarm.

Replaces grid system

The wireless visual system replaces a 12-in.-square, thermocouple-grid monitoring system fixed directly to the shell's exterior surface. Failures of thermocouples or problems with fiberoptic connecting cables left holes in the monitoring scheme until replacement or repair could be made—always under difficult conditions. Grid problems put both the gasification unit and maintenance personnel at risk.

The critical vessel monitoring system was developed to enable remote monitoring by multiple cameras with simultaneous wireless transmission of images in real time to a single PC. At the Texas installation, the 14 cameras are located at distances of 10-40 ft from the gas separation unit. Real-time radiometric temperature data is transmitted by wireless Ethernet from each camera to a control room 1100 ft away, received by antenna, and fed by Cat 5 cable to the PC

running the infrared software.

High-resolution monitors provide real-time, color-coded displays of temperature at user-defined regions of interest (ROIs) on the vessels. The software allows each camera's field of view to be set up to track up to 32 ROIs, each defined by any of 10 shapes, including freehand. The 14-camera system enables specific temperatures to be monitored at up to 448 discrete locations. More than 80 percent of the total surface of two 60-ft. high vessels, every critical area, is monitored by the infrared cameras. The plant's engineers knew the weak points in the processing system, and concentrated the monitoring resources on those areas. Thermocouples are now limited to noncritical areas where there has never been a problem.

Data can be analyzed

Besides real-time monitoring and alarming, the software allows data to be saved for further analysis. Details can be retrieved on temperature ranges and alarm conditions within each ROI and graphs created by software tools for temperature range analysis. Data also can be exported to an Excel spreadsheet.

Plant engineers believe this new information could provide indicators for ways to improve or modify the process in the future. Thermal images give a graphic representation of what is going on inside the vessel. They allow operators to see irregularities in the thermal patterns on the vessel as they develop.

While thermal imaging is typically seen as looking for hot spots, vessels also may have piping, manways, nozzles, and areas of poor combustion where cooling can be as much of a problem as overheating is in others. If the temperature gets too low, condensate can build up between the shell and refractory, which can lead to corrosion and degraded pressure containment capability. Corrosion also can cause the refractory to flake off, allowing sudden burn-through of the shell.

Vessel monitoring is a significant safety issue. The temperatures and pressures of the gas separation unit present some of the most extreme conditions of any process industry.

Systems have been installed in a wide range of pressure vessel and industrial heating applications. Installations include crude units, ethylene and ammonia plants, coke furnaces,

asphalt and concrete plants, mineral wool production, gypsum wallboard dryers, plywood ovens, paper mills, reformers, kilns, and boilers. One system has been supplied to NASA for testing adhesives that hold ablative tiles to the Space Shuttle skin. The adhesives and tiles must withstand thousands of degrees of change between the cold of space and reentry heating.

Sealed enclosures

The cameras are mounted in totally sealed environmental enclosures with infrared transparent windows and continuous purging and cooling by instrument air from a UL-certified air purge system. Positive pressure inside the enclosure prevents dirt or dust from entering, even in the harshest conditions, and protects against explosion hazard in areas where volatile gases may be present. The operator can select from a wide range of monitoring/measurement modes, including interval time, display difference between points A and B, max/min temperatures in operator-defined region, temperature range, and multi-spot measurement.

Each camera has a wireless Ethernet board built in. Data from the Ethernet board is carried by Cat 5 cable to a router box, then on to the antenna for wireless transmission to the control room. Wireless capability shortened and simplified system installation on the gas separation unit by eliminating the need to run conduit and wires a fifth of a mile between cameras and control room.

An antenna in the control room receives the data, which passes over Cat 5 cable to a single dedicated process Windows-based PC. Proprietary software simultaneously monitors and analyzes temperature from all the cameras and compares with alarm limits. Output graphics go to individual monitors, or the system can be configured to show multiple screens on a single monitor. Screen choices allow data to be displayed and tracked in multiple, selectable formats.

Thermal images are displayed in a spectrum of colors from dark blue for the coolest temperatures to red/orange/yellow for the hottest. The colors are keyed to a temperature graph covering the range of temperatures encountered in the particular system. The operator can cross-reference a color to a temperature graph located alongside an image on the same screen. **MT**

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