(Re)Designing thermal technology

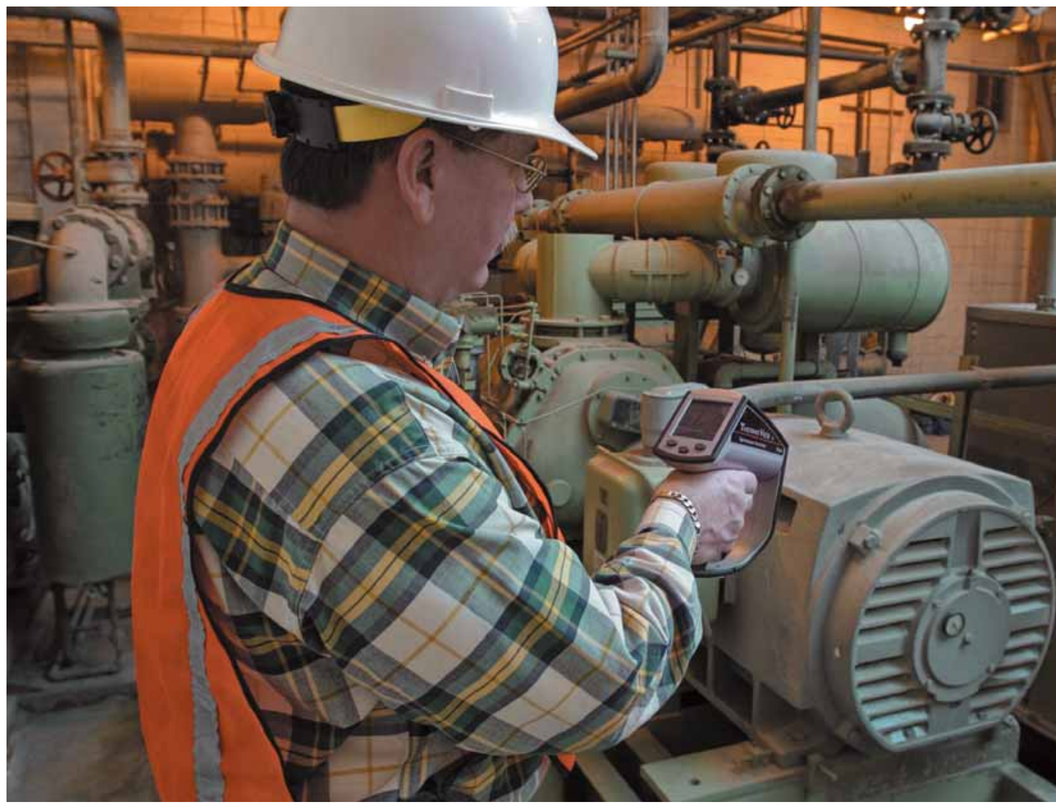
Thermal imaging for industrial predictive maintenance

Application Note

For a long time, thermal imaging was one of those technologies with great promise but little practical implementation. Theoretically, technicians could use thermal imagers to quickly scan their facilities for unusual heat, save benchmark images of key capital equipment, and then regularly repeat the sweep for quick, effective preventive maintenance.

In reality, implementing a regular thermal imaging inspection routine required hiring experts to operate sophisticated thermal imaging cameras and investing up to $50,000 in hardware, accessories, software and training.

So what's changed? Almost everything.



What is thermal imaging technology and how has it evolved?

At the core of thermal imaging technology is a Focal Plane Array or FPA with thousands of pixels or individual infrared energy detectors arranged in a two dimensional rectangle on top of an integrated circuit.

That circuit captures the "infrared signal" and processes the data, displaying a two dimensional thermal picture on an LCD or similar display device. Common array sizes include 160x120, 320x240 and even 640x480 (often used in military and R&D applications).

Initially, thermal imagers were designed to meet extremely high-end military and R&D specifications and performance requirements. For example: infrared detectors produced in the early 1990s could accurately measure absolute temperature differences of only 0.05 °C. To do that, they required stabilization to a very cold reference temperature using liquid nitrogen or some other cooling agent. That requirement made the technology cumbersome and very expensive.

Today's detectors are still cooled, but to higher temperatures than in the past and with only a tiny thermoelectric cooling device. Some detectors can accurately measure temperature without any cooling at all.

Other technology advances and increased market demand have further reduced the costs of critical components and, as a result, the price of thermal imaging cameras. Some manufacturers, like Raytek Corporation, a Fluke Company, have also made thermal imaging cameras much easier for maintenance electricians and mechanics to use.

Why use thermal imaging as part of a predictive maintenance program?

When critical operating systems unexpectedly malfunction, it inevitably increases costs, requires the reallocation of manpower and material, reduces productivity and, if not corrected, threatens profitability.

According to R. Keith Mobley, the author of *An Introduction to Predictive Maintenance*, eliminating unscheduled or unnecessary repairs would allow manufacturers, processors and generators to reduce the need for corrective maintenance by as much as 90 percent over 5 years.

Mobley also says that a successful predictive maintenance (PdM) program reduces the life-cycle cost and extends the useful life of critical systems by up to 60 percent, as well as increases manpower utilization by as much as 85 percent.

Since heat is often an early symptom of damage or malfunction, it's a key performance value monitored in predictive maintenance (PdM) programs. Using infrared imaging (thermography) and other inspection technologies to monitor heat as part of a PdM program can help mitigate the impact of, or even prevent, failure-prone electromechanical systems from going off line. Keeping production lines up and running maximizes efficiencies that lead to increased productivity.

Until recently though, many plant managers couldn't afford the high-resolution infrared thermal imaging cameras needed to establish and maintain a PdM program. The alternative was to use a point radiometer or non-contact, single point, infrared temperature device. However, point devices aren't designed for quickly scanning large areas or numerous pieces of equipment. They can capture isolated surface temperatures but they don't allow comprehensive evaluation, they don't document the location, and they don't save benchmark images for later comparison.

Bridging the gap are new thermal imagers designed specifically for industrial predictive maintenance. For example, the ThermoView Ti30 from Raytek, is affordable, takes only a few minutes to learn, and can easily scan and permanently record the temperature and infrared thermal image of crucial equipment.

Two companies experience real benefits from predictive maintenance

Bill Gray, a maintenance reliability specialist at the Wausau-Mosinee Mill in Rhinelander, WI, was one of the first in the world to purchase the ThermoView Ti30 imager when it debuted in 2003, and within four months this decision paid off.

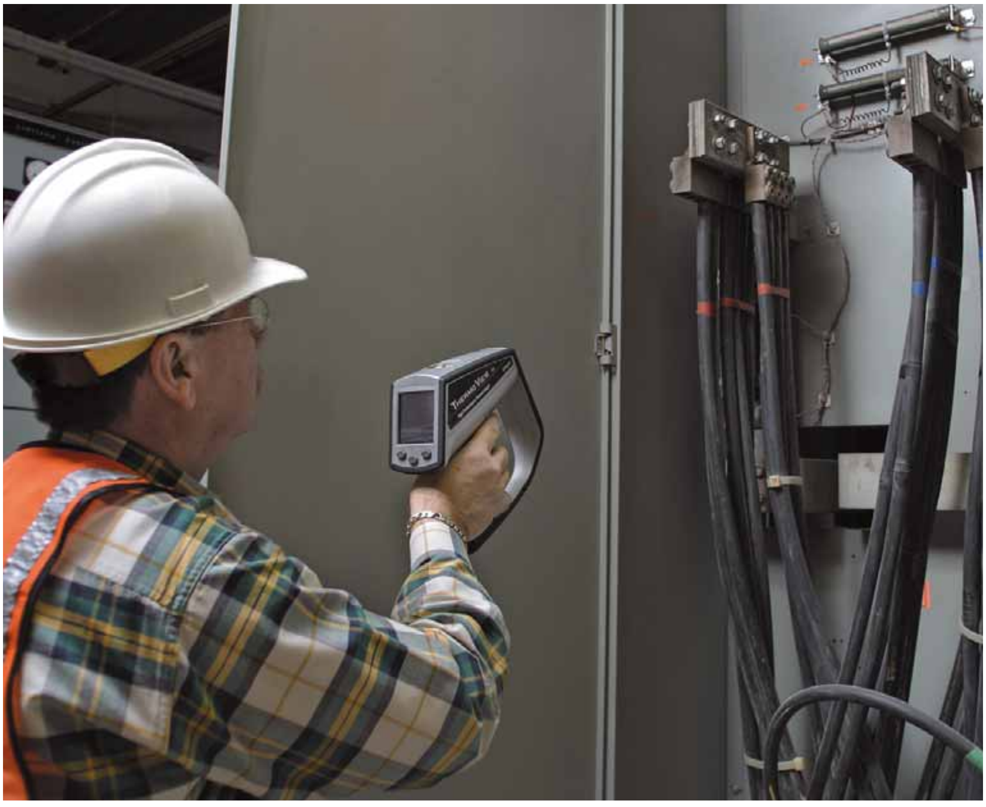
Every year, Gray hires an outside firm to conduct a thermal imaging survey of his paper mill's electrical switchgear. After the survey, he and his crew make repairs to any problem connections identified in the survey report. Immediately after purchasing his new imager, Gray used it to survey his repaired equipment. To his surprise, he found that the repairs he had made didn't fix the problem.

"(Without the imager) We would have had to wait another year to find that out," he said.

Infrared imagers monitor the thermal efficiency of critical process systems that rely on heat transfer or retention, such as electrical equipment, and other parameters that will improve both the reliability and efficiency of all plant systems.

Infrared imaging can detect dysfunctional pumps, under performing surface heat exchangers and identify problems in a variety of plant systems and equipment, including electrical switchgear, gearboxes, electrical substations, transmissions, circuit breaker panels, motors, bearings, steam traps, steam lines, and processes. Unlike vibration or lubricating oil and wear particle analysis, thermography is well suited to monitor all types of production and processing equipment.

Like Bill Gray, Robert Norman, Chief Operating Officer at Wood County Electric Coop in Quitman, TX, hires an outside contractor to conduct a thermal imaging survey of critical points of power delivery around the system during the hot summer months. But when he discovered an abnormally high failure rate of lightning arresters installed on the Cooperative's power lines,



he knew he was facing an emergency. Because he knew he could use it for on-going maintenance as well as the arrestor problem, he was able to justify the purchase of an imager.

Lightning arresters monitor the voltage level flowing on the power lines and when spikes or surges caused by lightning occur, the arrester diverts the excess voltage to ground protecting components of the electrical system as well as customer facilities.

"When arresters fail they often cause customer outages, but more seriously, they pose a safety issue to service personnel working around the equipment because shards of porcelain are sometimes forcefully blown away from the arrester when they fail," he said.

Norman's crew has surveyed several thousand arresters with their Ti30, and about halfway through the project have found approximately 7 percent of the arresters imaged to be 15-to-20 degrees above the ambient temperature, making them suspect for failure.

Norman also found out quickly how valuable infrared thermography can be for surveying transformers. During a sales demonstration, the imager detected a hot transformer that served one of the largest supermarkets in the area, much to Norman's surprise. As a result of the discovery, the supermarket manager was put on alert, and arrangements were made for service crews to repair the loose connections at the transformer. Although the customer did experience an outage while repairs were done, they were done at a time that was more convenient for all.

Norman said having his own imager available has reduced expenses because his crew can now perform the annual imaging survey. And, at the same time they are using the imager to check the arresters and transformers for which they are responsible. He believes this proactive methodology will allow him to avoid problems such as those discovered at the supermarket.

"It gave me reason to pause and think that we will be using this instrument to look at the transformers of our largest customers and critical points of power delivery as well as provide better service," he said. "And the pleasant surprise is finding things that we weren't expecting."

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