Beyond the Usual Applications for Infrared Thermography

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Introduction
Think of the world as a radiator…infrared thermographers do. Thermal energy travels at the speed of light in all directions. An infrared (IR) camera detects this [heat] energy and converts it into pictures or thermographs of heat. One can learn a lot about the world by looking through the lens of an infrared camera.

Infrared Predictive Maintenance (IR/PM)
If you are trying to maintain electro-mechanical equipment, you might be interested in knowing that heat kills—but you already know this! Ever had a piece of equipment burn up? Think back to all those components that went into the dumpster last year, like fuses, switches, breakers, motors, bearings, couplings and the like. Unless the forklift operator ran over it, it probably died a death of heat. Here's the good news…it got hot first. Maybe it burned in a millisecond, but chances are it happened over a much longer period of time and if you are inclined to watch it with an infrared camera, it will let you know it is failing. Now, just watching it is not remedial in any way and even if it is adjusted it may still fail, because the damage is done. But the downtime is what is so expensive these days, so you can get another component and change it out before it fails at an inopportune time and cost *real* money.

Excess ***resistance*** is usually what causes failures in electrical components and excess ***friction*** with mechanical devices (see figures 1, 2). The practical use of IR/PM then, in a nutshell is: seeing the thermal energy emitted from all objects, knowing normality and reporting only abnormality in a graphic, usable and easy-to-understand fashion, so that someone can act to fix whatever is wrong. This works on heat emissions from all types of objects not just electro-mechanical. There are many uses for infrared thermography other than inspecting electrical switchgear and mechanical components.

Process Improvement
Use IR to make your machines run just 10% faster with just 10% less waste and profits will soar. If you can fix a problem at the beginning of the manufacturing process, you will eliminate waste, eliminate product returns and promote customer goodwill. Infrared surveys are very inexpensive compared to throwing away product that you sent all the way to the end of the line before discovering a flaw…or worse, sending a defective product to your valued customer, only to have it returned at your expense. Even if it is not possible to look directly inside a machine, the effects of the machine on the product can almost always be seen using IR after it exits (see figure 3). The key to process improvement infrared is to get the machine designers, operators and industrial engineers

involved in the process. They usually know all about the machine and the process. They just need to "see" in the infrared waveband. On-line IR monitoring of manufacturing lines is becoming more popular as manufactures seek more efficient methods of producing goods in a competitive marketplace.

Non-Destructive Testing
IR/NDT is used to find out characteristics of an object without damaging it. In general, there are two ways to get information about what is going on inside any object:
1) Don't do anything, just watch the object radiate self-generated heat, or 2) create the conditions needed to see what you want to see. Apply heat [or cold] to the object and monitor the results, or, apply heat to the object and monitor what happens when then object cools, or, put a heat source behind the object and watch what happens when the heat comes through it. There are variations on these, like vibrating the object and looking for the friction that a crack creates.

Research & Development
R&D applications are literally worth millions of dollars. Only a small percentage of these techniques and applications are published, because they are tightly held and legally protected secrets. Often it is not as simple looking at something and seeing a defect (see figure 4). Instead, these techniques have been developed over the course of years and refined by scientific scrutiny at a cost of hundreds of thousands of dollars.

Facilities
There are four types of buildings by use: residential, commercial and industrial and institutional. All types of buildings benefit from IR surveys of heat loss, moisture and quality control.

Building Thermal and Moisture Envelope
Inspecting buildings for heat loss was one of the first commercial uses for infrared thermography. As we decide to become less dependent on fossil fuels, IR will again be used as it was in the 1980's to monitor the energy efficiency of buildings. In very cold climates, poorly installed insulation and vapor barriers can lead to condensation problems and the degradation of the building itself. Badly designed, poorly constructed, poorly maintained, leaky buildings are not energy efficient and often have moisture and mold problems. In some cases, damage to the building is caused by insufficient ventilation and/or an under-designed or over-designed HVAC system. Preventive/predictive maintenance in buildings of all types is very uncommon. First, all buildings should be kept dry during the construction process. Then, all buildings should also be tested within a few months after construction or major renovations to the structure, the thermal envelope, the moisture envelope and the HVAC system.

Building Quality Control
Infrared thermography can be used as a building quality assurance tool. Almost all building materials will retain heat energy and therefore can be checked for quality of installation. Improper installation of insulation and/or seals in buildings can be seen in the form of heat loss and air leaks. Also, building components "inside" the walls, ceilings

and floors are recognizable because of their differences in mass. For example, infrared thermography can be used to determine the presence and correct placement of grouted cells in concrete block walls (see figure 5). If the owner of a new block building spends a little money checking their [low-bidder's] work with infrared thermography, the contractor will be forced to build the building per specifications or face the added direct cost of repairs and resulting loss of schedule repercussions.

Roof Surveys

A well prepared, graphic and accurate map of the infrared signatures of a roof can be of tremendous benefit to a building roof owner at all stages of the roof's limited life. Knowing where the subsurface moisture is located will help the roof owner manage his assets. This form of predictive maintenance works well on many types of flat and low-slope roofs. Here are the basics: At night, areas of roof moisture are warmer, because the accumulated heat (from daylight sunshine and heat) in the trapped water mass is greater than in the dry, functioning insulation or roof substrate. After sunset, as the roof's structure cools down, the wet areas of roof insulation and other materials maintain higher temperatures because of their higher mass, allowing the infrared cameras to detect the sources of heat and record them for later analysis. There are two ways to perform IR roof moisture surveys: on-roof and aerial. On-roof thermographers walk from roof to roof looking for subsurface moisture patterns and when found, mark the extremities of these areas on the roof with paint. Aerial IR is used when the owner wants to document the wet areas with straight-down photos, IR and CADD drawings (see figure 6). The biggest advantage of aerial infrared is not its use on roofs that have well-defined areas of moisture at all, but those roofs that are the most difficult to image from any distance or angle. I am referring to the roofs that, for instance, have a lot of ballast, are covered with reflective coatings or ones that for whatever reason are impossible to image from the roof. With high-resolution aerial imagery, slight nuances of temperature can be seen from far enough away to recognize the pattern of heat.

Other Applications

There are industry-specific applications, i.e., auto, steel, etc., and many more. The point is that there are too many to list. With modern infrared cameras, software and computers, infrared thermographers today are almost never limited by the infrared equipment's ability to measure temperatures or discern differences in temperature. Rather, we are only limited by our imagination. So, get an IR camera and look at the world in a different wavelength. You will be amazed at what you see!

Gregory R. Stockton is president of Stockton Infrared Thermographic Services, Inc. The North Carolina-based Corporation operates seven application-specific divisions performing many different infrared services in the US, Canada, Central and South America. Mr. Stockton has been an infrared thermographer since 1989 and has published fifteen white papers and numerous articles on infrared thermography. Greg is the infrared editorial board member for UPTIME Magazine and will publish a series of articles on the subject of infrared thermography.

Figure 1

Figure 1) Fault on electrical lug connector.

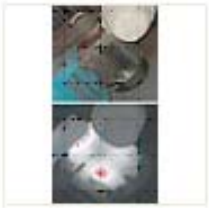

Figure 2

Figure 2) Overheated electric motor winding.

Figure 3

Figure 3) Socks exiting a boarding machine.

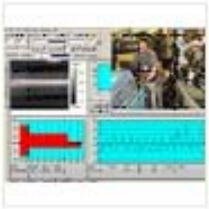

Figure 4

Figure 4) Typical R&D set-up and software.

Figure 5

Figure 5) Concrete block wall on a commercial building wall.

Figure 6

Figure 6) Aerial photograph, aerial thermograph and CADD drawing of a flat roof.