Think Thermally®

Practical news for practicing thermographers

May 2005

See inside:

Conference Review: Thermal Solutions® 2005

It's official. This year's Thermal Solutions® conference was an overwhelming success. The event is now one of the largest infrared specific conferences available for thermographers.

On opening night 250 attendees, presenters, exhibitors and guests filled the main ballroom at the Marriott Suites on Sand Key Resort in Clearwater Beach, Florida and were treated to an opening dinner reception filled with food, friends and entertainment. Marko the Magician provided an enjoyable mixture of comedy and magic while thermographers, colleagues, friends and families looked on in amazement.

The momentum generated by Monday evening's reception never stopped. Twenty paper presentations, a variety of Expert exhibits and the largest exhibit hall of any infrared specific conference in the industry carried everyone through the week.

Along with two popular panel discussions, professionals from a variety of backgrounds gave a number of paper presentations during Tuesday, Wednesday and Thursday. Those who participated in the panel discussions experienced one of

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Thermographer Harold Van De Ven discusses motor couplings with a group of attendees.

Optimizing the Performance of Belt-driven Equipment

Rich Wurzbach
Maintenance Reliability Group, LLC

The following paper was presented at Thermal Solutions® 2005. It has been edited for length. The complete version, including information on how Vibration Analysis and Laser Alignment are applied when analyzing belt drive equipment, is available online at the Snell Infrared web store (www.snellinfrared.com/_store) as part of the 2005 conference proceedings.

Belt-Driven machinery makes up a significant portion of mechanical systems, particularly in air handling applications. Buildings which house manufacturing, research, office or living space all include integrated systems for comfort, air supply and removal. The maintenance of these systems has often been overlooked in the past, as the focus fell on critical production systems instead. However, many institutions have begun to look closely at the criticality of certain belt-driven machines, and at the over-all cost of maintaining even low-criticality equipment. Through the application of technologies such as vibration, infrared thermography, and others, an optimized maintenance approach can be applied that improves the reliability of belt-driven equipment, directs proper maintenance techniques, and reduces the costs of maintaining and operating these systems.

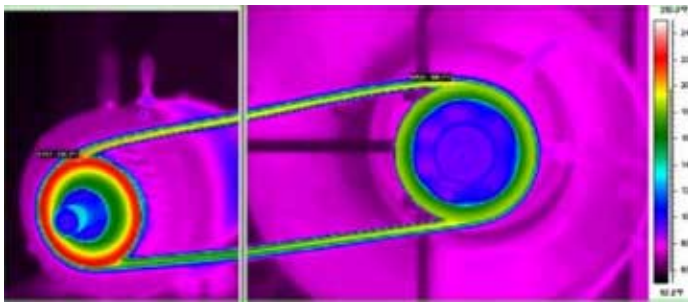

Figure 1: Overheating belt drive

Belt-Driven Equipment

The most common style of belt-drive in use in air-handling machinery is the V-belt. It consists of a driver and driven sheave or pulley, driving one or more belts. The ratio of the pitch diameters (the diameter of the sheave at the point where the belt rides) determines the ratio of the driver to driven speed. In order to function properly with good reliability and low vibration, it is important that the system is mounted on a stable base or properly designed isolated system. Sufficient rigidity must exist between the bearings of the driver and driven sheaves, so that the driver sheave can be moved to properly tension the belts.

Three main things are important with respect to the condition and operation of the driver and driven sheave: first, they must be sized correctly; secondly, they must be in good condition; thirdly, they must be properly aligned and oriented. Correct size is a function of the design for desired speed ratio and also the pitch.

Both sheaves must have the same pitch designation and belts of this pitch must also be used to obtain a matched setup. The other aspects of size concern sheave rotational speed, minimum sheave diameter, and the impact of speed-up drives. Tables exist that limit the maximum outside diameter for cast iron pulleys as a function of speed, provide minimum sheave diameter for given belt cross-section, and minimum sheave diameter for motors based on horsepower and frame number of the motor (NEMA standard).

The condition of the sheave must also be inspected when in service. Too often, a failed belt is observed, and the corrective action consists of placing a new belt on the same sheaves. If the sheaves are worn or damaged, we will see the same belt failure in short order. Sheave inspections must be performed whenever belts are replaced or adjusted, and should consist of a check of the smoothness of the sheave V-surface. A rag or glove must be used to prevent finger cuts due to sharp surfaces. Any nicks, sharp edges or wear grooves are unacceptable, and sheave must be dressed or replaced.

Sheaves should also be checked for uniform wear from the original pitch angles by use of a pitch gauge. Something as simple as the sheave being dropped in shipment or installation can result in a dent across the sheave grooves. This raised metal can strip away a belt very rapidly, and greatly diminish belt life.

Alignment and orientation are the most common problems with belt-drive systems. In practice, belt tensioning and alignment must be performed simultaneously, since the movement of the motor is typically used to achieve belt tension, and the motor can move in at least two planes when being moved. This means that unless the orientation of the motor sheave is not monitored while tensioning, the final setup will be mis-aligned. Misaligned belts wear more quickly, wear the sheaves unevenly, and put excessive forces on the bearings.

In all of these considerations, attention must be given by the system designer, the flow balancer, the maintenance staff, and the diagnostic technician. It is not uncommon for technicians responsible for maintaining air handling units to have or develop expectations of periodic component failure or to institute frequent Preventive Maintenance (PM) tasks to replace component parts.

Belts, bearings, and sheaves are thought to be limited life components, and often little is questioned when these parts require frequent replacement. Because the overwhelming majority of these machines that are placed into service around the world are not tested to any acceptance specification, the manufacturing and

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Optimizing Performance, *continued from previous page*

installation quality is often much less than might be expected. One vibration testing company employed by the pharmaceutical industry to establish acceptance testing for air handling equipment found that nearly 80% of new air handling equipment failed a basic vibration specification at the factory.

Belt-Drive Diagnostics

Most building fan systems are belt-driven centrifugal units, although some are direct drive or vaneaxial units. Belt-driven fans can be single belt or multi-belt configurations. Both consist of a continuous flexible belt drawn over a pulley or sheave. The interaction of the sheave and the belt generates friction as the belt engages and leaves the sheave surface. Additionally, cyclic tension and compression in the elastic belt creates internal friction. Both of these processes generate heat, which can be observed by thermography.

By establishing the normal amount of heat generated in a properly operating belt-sheave system, criteria can be established for identifying improper operation that results in increased temperatures. A well-designed and installed system will typically generate very little heat, and the cooling effect of the movement of the belt through the air will tend to cool to ambient temperature.

Inspecting the belts and sheaves of these systems with infrared thermography can reveal problems in the design and particularly the installation. One of the most common problems with multi-belt systems is misaligned sheaves that result in belt slippage. In vibration analysis, this condition will show up in the spectrum with higher than normal vibration. The appearance of motor shaft speed frequencies in the fan spectrum, fan shaft speed frequencies in the motor spectrum, and multiples of belt speed in both are good indications of slipping belts.

Infrared thermography can also be effective at illustrating belt problems and can complement the vibration data when investigating the cause of high vibrations. Figures 4 & 5 show a significantly higher than normal belt temperature, indicative of loose belts and misaligned sheaves in this unit.

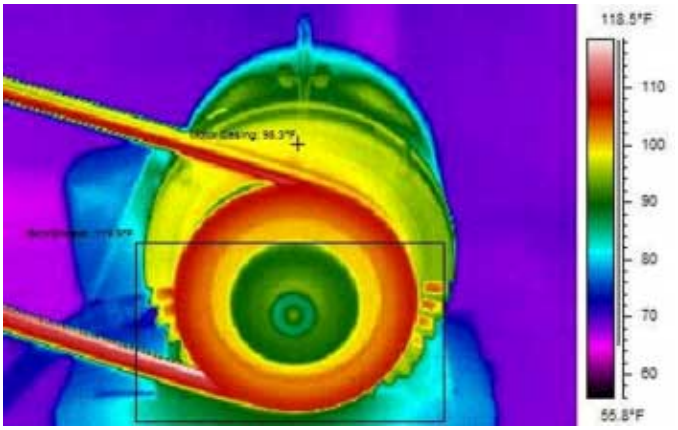

Figure 4: Infrared image of overheating belt/sheave

Figure 5: Visual image of belt-drive

Belt-driven equipment is pervasive in our buildings, factories, and facilities. Even low-criticality equipment has an impact on productivity when unnecessary maintenance is expended. By employing infrared, as well as vibration analysis, on these systems, and understanding and recommending the proper corrective actions, reliability can be significantly increased, and life-cycle maintenance costs can be significantly reduced.

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Reports: There's More to Them Than Just Pictures

Why is infrared such an effective tool in a condition monitoring program? It is because this highly visual technology communicates information clearly and effectively. When an infrared thermographer writes a report, communication becomes the thermographer's primary job. The report's fundamental purpose is to transfer useful information that comes from the data collected by the thermographer. In that report, FACTS are essential and it is the image that carries the day.

Qualified thermographers understand what great care must be taken in capturing a thermal image. Ideally, the thermographer wants the location of the thermal problem to be immediately evident with regard to the physical surroundings. Whoever views the image should not struggle with "what is this?" This critical data capture skill comes with experience, good work habits and a devotion to the end result. The image must be in the correct range with thermal level and span adjusted properly. Selection of a palette that best shows the problem is also critical; skilled thermographers understand the power of selecting the right palette to show the problem most clearly. Of course, all the fieldwork must be done safely, efficiently and at the right time.

Some infrared systems and software certainly make reporting simpler, but good reports go beyond what type of camera you use. The report writing process has begun long before the thermographer goes into the field. Again, training and experience are essential to getting the job done. One must also have the appropriate tools and support.

The image is just part of the data that must be collected in the field. Is the equipment location data accurate? What are the load conditions? What about ambient conditions and target parameters? Can an accurate radiometric measurement be made, and, if so, how does it relate to past measurements? Can other technologies be used to verify or illuminate the findings?

A well trained and skilled thermographer also understands what questions must be asked about the equipment operation and its history. Typically some limited field evaluation can be made about the significance of the finding, but even the best thermographers must know (and respect) their limitations. All this data must be gathered and recorded efficiently (regardless of the amount of time saved) as possible if the assigned inspection routes are to be completed.

Back in the office, the thermographer should organize the data with two goals. They must consider both the short term process of assembling the report and the long term needs for analysis and archiving. The short term goal—the report—is the focus of this article. Much of the image processing and reporting software available today is powerful and easy to use. Inexpensive color printers with glossy papers give us the ability to easily print reports that make managers and customers marvel—the people who need to see them.

Who should get the report? Great question, and one that you should consider carefully! The opportunity exists for a report to achieve many purposes besides just passing on the facts. A few dramatic thermal reports, especially showing before and after images, can not only catch management's attention, but also empower them to move your information up the corporate chain where it can have an even greater impact.

How might the thermographer approach the report and what they wish to convey? An old friend remarked wisely when I asked him the secret of his successful infrared program, "I do whatever I can to make both my thermographers and my managers look good. If they look good, then I do too." We've seen this simple truth validated again and again.

One might also ask "Will anyone, in our paper-filled world overflowing with deadlines, actually act on this report?" How often do we see shelves lined with binders of nice, glossy, unread reports? These too are great questions and, like it or not, issues on which our success depends. The true measure of our success is that the report results in effectively addressing the problems we've found in a cost-effective manner.

Finally, many thermographers miss the greatest opportunity provided by the technology, which is to accumulate a "big picture" of results over time. An "asset health index," as some call such an approach, provides a manager or customers with a quick snapshot of the overall health of the plant. In fact the asset health index is one of the best measures of the effectiveness of a reporting system. If you are providing reliable information in an effective manner, problems will be corrected and the asset health will remain high. In more than one case we've seen a root-cause of poor asset health to simply be poor data collection and reporting procedures.

Thermal Solutions® 2006

Thermal Solutions® moves south to Sarasota, Florida, January 23–26, 2006 and the Hyatt on Sarasota Bay. This beautiful resort, marina and conference center is situated on the water in the heart of Florida's west coast. Many onsite amenities are available including fishing, boating, biking and golf.

The hotel's larger conference facilities provides the perfect setting for what will be an expanded Thermal Solutions® conference in 2006, preparations for which are already well underway.

Snell Infrared is presently looking for those who would like to present a paper at next year's conference (see below right). A track specific to building applications is planned, along with the return of Ask the Experts and the panel discussions.

According to John Snell, "The use of the technology for building diagnostics is expanding exponentially and having a separate track for these applications was logical. If you are using IR for buildings, plan to attend! For anyone looking at getting into the industry or purchasing new equipment, Thermal Solutions® is the best place to see all the vendors in one place at one time. Come and see some great products, all in an environment conducive to learning rather than high-pressure sales."

Stay tuned to the Thermal Solutions® web site at www.thermalsolutions.org as more information is announced in the coming months.

Conference Review, *continued from front page*

the largest live open forums available in the predictive maintenance industry.

New this year were the "Ask the Expert" sessions which provided attendees with an "informational trade show" on a variety of topics hosted by professionals who are proficient in a specific field or application. This new session was well-received and brought a whole new dimension of learning to Thermal Solutions®. Look for "Ask the Expert" to return in 2006.

John Snell, reflecting on this year's event, expressed similar enthusiasm. "We are very excited about having this conference serve the needs of the growing infrared community. Thermal Solutions® is about professionals learning from professionals! The content of the papers, the interchange during the panel discussions and the interaction during Ask the Expert sessions was fantastic."

For those of you who were not able to participate in Thermal Solutions®, an assortment of images from the 2005 conference are available for viewing in an online photo album at www.thermalsolutions.org. Take a moment to look back at what was the largest Thermal Solutions® conference ever including pictures from the paper presentations, panel discussions, Ask the Expert sessions and Monday evening dinner reception.

Thank you to everyone who made Thermal Solutions® 2005 such a tremendous success. See you at next year's conference!

Call for Papers:
Thermal Solutions® 2006

Snell Infrared is currently looking for those people interested in presenting a paper at Thermal Solutions 2006. Please write a brief abstract (100-200 words) and submit it for review by the Conference Steering Committee.

Presentations are sought in the following areas:

- ***NEW:*** Buildings-Specific Track for 2006
- Condition Monitoring
- Nondestructive Evaluation of Materials
- Biological Life Sciences
- Applied R&D
- Cost Savings Issues
- Spot Radiometers
- Public Service (firefighting, law enforcement)
- Process Monitoring using IR
- Program Management

All papers must be non-commercial in nature and will be published in the Thermal Solutions® Proceedings in both print and CD format. To compensate authors for their presentation, Snell Infrared offers a discounted conference fee of $295.

Submit abstracts to: abstracts@thermalsolutions.org
or Thermal Solutions®
PO Box 6
Montpelier, VT 05601-0006

Snell Infrared

Remaining 2005 North American Training Schedule

Level I	$1,495
Indianapolis, Indiana	May 9–13
Minneapolis, Minnesota	June 6–10
Toronto, Ontario	June 13–16
Montpelier, Vermont	July 25–29
San Diego, California	August 22–26
Charlotte, North Carolina	September 12–16
Indianapolis, Indiana	October 3–7
Toronto, Ontario	October 17–21
San Antonio, Texas	November 7–11
Montpelier, Vermont	December 5–9

Level II	$1,495
Indianapolis, Indiana	May 9–13
Minneapolis, Minnesota	June 6–10
Cincinnati, Ohio	September 19–23
Toronto, Ontario	October 24–28
San Antonio, Texas	November 7–11

Level III Best Practices	$1,495
Indianapolis, Indiana	September 19–22

FIIR Software	$750
Toronto, Ontario	June 23–24
Toronto, Ontario	September 29–30
Toronto, Ontario	December 8–9

Research & Development**	$750
Toronto, Ontario	September 27–28

Electrical Applications*	$750
Indianapolis, Indiana	May 17–18
Detroit, Michigan	September 13–14
Dallas, Texas	November 14–15
Toronto, Ontario	November 29–30

Mechanical Equipment*	$750
Indianapolis, Indiana	May 19–20
Detroit, Michigan	September 15–16
Dallas, Texas	November 16–17
Toronto, Ontario	December 1–2

Building Systems*	$750
Indianapolis, Indiana	June 7–8
Minneapolis, Minnesota	October 5–6
Toronto, Ontario	December 6–7

Products & Processes*	$750
Toronto, Ontario	June 21–22

*Level I or extensive thermographic experience is a recommended pre-requisite for these two-day Specialty Courses.

**Level I training required.

Snell Infrared

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