FEATURED IN
Industrial Heating

Maximizing Your Data-Acquisition System Investment

Scott Johnstone – Super Systems Inc.; Cincinnati, Ohio

No other segment of heat treating has seen more changes in technology than data-acquisition (DAQ) systems. While the investment in a new data-acquisition system can seem quite high, the benefits and return on the investment can happen quickly if the use is maximized. The cost per point of a data system decreases significantly as the number of points increase.

Early data-acquisition (DAQ) systems were comprised of simple analog chart recorders. These were continuous strip chart recorders and circular recorders that plotted temperatures and setpoints of process parameters. The charts were cumbersome, hard to read with any resolution and required long-term storage/archiving of paper. The recorders also required a calibration schedule to ensure that accurate data was being plotted.

In the 1980s, personal computers became more affordable to the average user. The computer allowed for DAQ system software to communicate directly to process-control instruments and store this data digitally. Digital storage improves the analysis of data by presenting it in a functional, organized format. While most heat-treat shops utilize their systems for basic process storage such as temperatures, vacuum and carbon levels, the typical system consists of a computer residing in the corner of the met lab, only to be consulted when a customer calls with an issue or concern. However, an effective DAQ system helps prevent troublesome incidents before they arise and is more beneficial for handling those that do occur. This article will focus on data signals that are not typically logged or analyzed and practical uses for that data.

Water Temperatures

While it is common to monitor cooling-water temperatures feeding the entire facility, observing inlet and outlet temperatures of equipment is often overlooked. Even rarer is the practice of examining individual components on the equipment. Unfortunately, ignoring these factors will only generate problems. Over time, lime and scale deposits will start to restrict flows, causing increased equipment temperatures. It is common to see the outlet temperature rise, indicating a plugged cooling system. By monitoring the inlet and outlet temperatures consistently, it is much easier to schedule maintenance for cleaning and flushing during slow periods and to avoid a failure during peak production times (Fig. 1).

Fan and Motor Failure

Quite often, motors, fans and pumps are viewed as nothing more than common machine components. However, these parts have a significant effect on the lifetime of the machine. Regardless of their sizes or shapes, the most common failure of a motor is the bearings. The bearings are often overworked due to high temperatures, lack of lubrication, out of balance blades or improper application. While some motors are easily accessible, many are located in remote areas or totally enclosed, which does not allow for routine inspection and maintenance. Causes of vibration include bent shafts, over-tightened belts, sheave misalignment and mechanical looseness.

In the past, simple piezoelectric accelerometers could be mounted on the motors and monitored. These accelerometers required complex signal conditioning and amplifiers to convert the raw signals into a

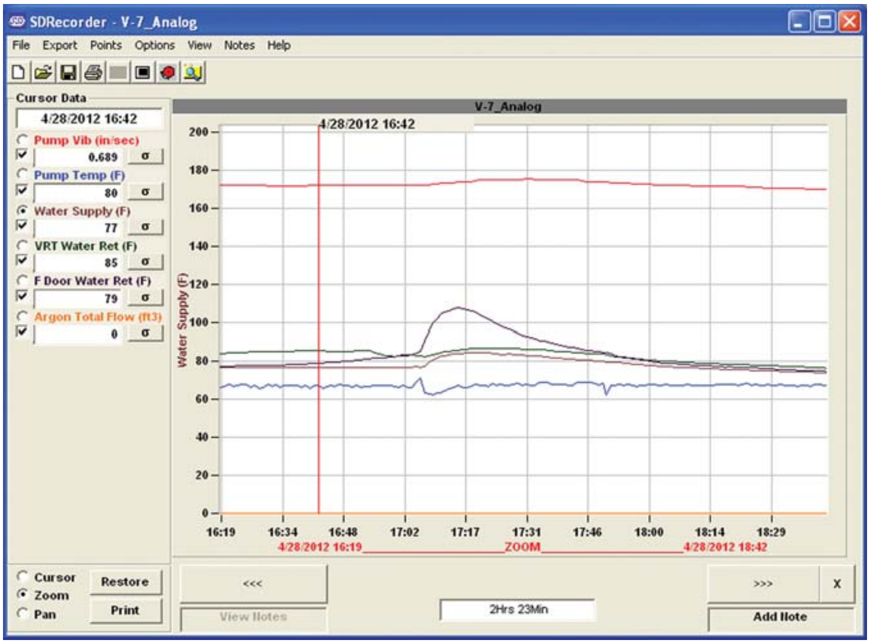

Fig. 1. Chart shows roughing-pump vibration/temperature and furnace supply water temperature as well as front door and VRT return water temperatures during a furnace cycle. Examining these parameters helps keep maintenance requirements current.

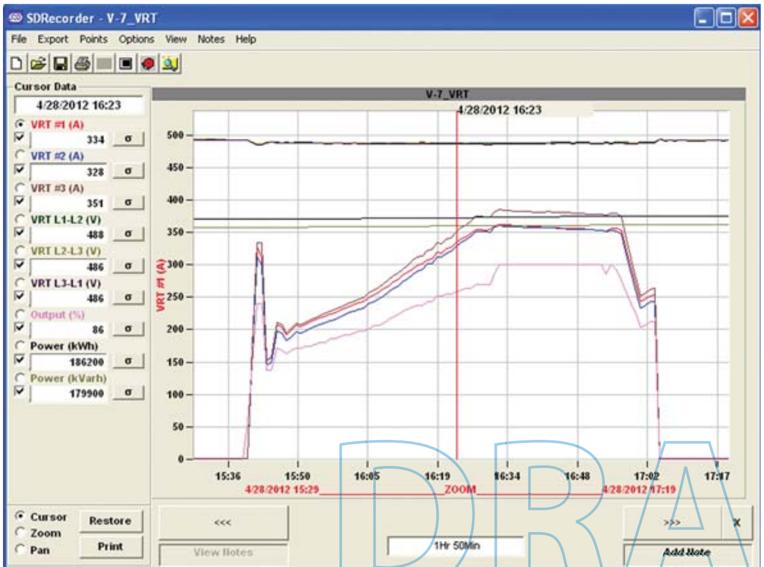

Fig. 2. Chart shows three legs of voltage, current and power with respect to controller percent output during a furnace cycle.

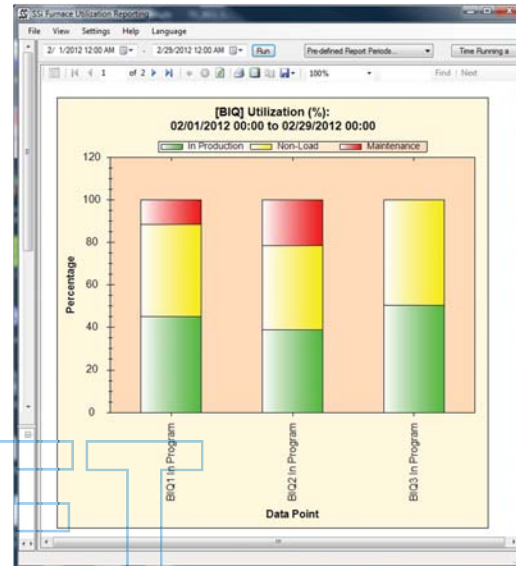

Fig. 3. Graphical representation of an atmosphere department's internal-quench furnace performance over one month identifying time running a load, time in maintenance and idle time.

usable format. Fortunately, there are now low-cost vibration/temperature monitors that can be installed on motors that will provide a usable analog signal to the DAQ system without any additional conditioning.

Average vibration will not point to the root cause, but it will point to the source and alert the user that a problem is developing. Once a problem has been discovered, more complex vibration/frequency analysis can help establish the cause of the vibration. This type of preventive care in a facility is invaluable. While it is relatively easy to replace a motor on a furnace handler or agitator, it can be an extensive and expensive repair on an agitator, heat fan or cooling blower. Total failure of a rotating device at high RPMs can cause widespread damage and quite possibly injuries.

Belts

The efficiency of a motor and belt setup is determined by the condition of the actual belt and sheaves. On a new application, almost all of the usable energy of the motor is transferred to the load through the belt. As time passes, fluctuating temperatures, wear and contaminants will cause slippage of the belt. This is often overcome by increasing the tension on the belt. Although this may temporarily mask the problem, it can cause premature failure of bearings due to increased side loading.

Simple proximity switches have been used in the past to monitor the shaft of the driven load and sound an alarm if motion is not detected. This solution will simply alert a total failure; it will not give an indication of the actual condition of the belt. By monitoring the actual speed of the motor shaft as well as the speed of the load it is driving, a simple calculation based on the sheave diameters will help to determine the total slippage caused by the belt.

Electric Power

Increasing energy costs have pushed more and more heat-treat companies to examine their energy usage. Understanding how a utility company bills for energy consumption and managing energy-usage requirements can result in significant cost savings. Most commercial companies are billed on the hourly demand as well as the peak demand, which corresponds to the reserve energy a power company must be prepared to provide. Reducing the peak demand is crucial. A customer who uses constant energy for a given time will pay less than a customer who has large peaks of power usage.

Another consideration for energy cost is the actual power factor of the plant. Power factors will vary from one load to the next. A purely resistive load, such as heating elements, will have a power factor of 1, which is desirable. Non-linear loads, which are loads with rectifiers or capacitors, will have lower power factors.

To capture power, one of the simplest approaches is to monitor current using a low-cost current transformer. These windings are doughnut shaped and will provide particular turndown ratios and window sizes for specific applications. The turndown converts the current going through the transformer into a 0- to 5-amps signal. For example, if the heating elements on a furnace are drawing 100 amps, then a 100:5 transformer will provide 5 amps for 100 amps. A simple signal conditioner will convert this amperage into a 4- to 20-mA signal, which is a common input to any data system. Any one leg of the three-phase system can be monitored, and it can be assumed that all three legs will draw about the same amount of current in a balanced system. Using a constant voltage, the KVA usage of that system can then be calculated. This method will provide a rough estimate of the total power to the system, but the assumption of a balanced load and constant voltage will cause a certain degree of inaccuracy (Fig. 2).

A more accurate method for monitoring power consumption is to use a power-monitoring meter. The power meters can range in cost, but even the low-cost units will provide comprehensive and useful data. With a power meter, a current transformer is installed on each leg of the three-phase system. The meter also monitors the actual voltage of the supply power. Using this information, power (kW), active energy (kWh) and reactive energy (kVARh) are provided, and power factors can be retrieved using communications back to the data system. Most systems will provide this data as instantaneous values as well as totalized values.

Analysis of the data will not only provide the power usage of the system, but it can also provide helpful information regarding the health of the system. Unbalanced loads (phase-to-phase current) can indicate maintenance opportunities for the system.

Utilization

For the most part, modern industrial equipment is now controlled with programmable logic controllers (PLCs), recipe programmers or a combination of both. By logging the status of equipment, the gathered data can be turned into key performance indicators addressing a specific stakeholder such as production manager, sales/estimating, maintenance, etc. With many DAQ systems, a considerable amount of data is compiled without a proper summary, and the task becomes overwhelming and underutilized. Simple reviews covering a defined period of time can easily lead to furnace utilization (Fig. 3), equipment or component usages, and improvements in furnace performance and equipment downtime. Summarizing statistics such as time at temperature, time in program and number of pushes per shift can provide a report that enables good decision making, which results in reduced downtime, maximized utilization and improved profitability.

As with everything, there are no magic solutions. Data can be gathered and points can be added to a system, but proper analysis of the data is vital. Analysis should be done on a weekly or biweekly frequency so baselines can be established and anomalies detected.

Furthermore, to actualize the merit of a modern data system, the data must be presented in a convenient, usable format. In some cases, this could mean data is trended on an X-Y plot, and in others it may mean that tabular data is exported and manipulated by the customer. Regardless of the specifics, proper use of a data-acquisition system can minimize equipment downtime and maximize per-load margins, resulting in a positive outcome no matter what the application. **IH**

SuperSystems incorporated

For more information: Contact Scott Johnstone, vice president of engineering at Super Systems Inc., 7205 Edington Dr., Cincinnati, OH 45244; tel: 513-772-0060; fax: 513-772-9466; e-mail: sjohnstone@supersystems.com; web: www.supersystems.com