Staying Ahead of the Curve with Advanced Controls Technology

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Advanced controls technology will give you the operational flexibility needed to measure and analyze your equipment and processes with ease. You can then use that analysis to refine and adjust the settings and parameters of your equipment to enhance your process. With advanced controls, this optimization is simple and also ensures less human error in the production process because it eliminates several manual processes, automating them for precise, repeatable control (Fig. 1).

Revitalizing older equipment with controls upgrades increases capabilities and overall flexibility, keeping it up-to-date and in line with your current systems. One example of the benefits of upgrading an older system is that many older vacuum furnaces require a manual adjustment of the heating elements via trim pots. With a controls upgrade, the heating elements can be monitored and adjusted through the industrial computer's graphical interface. By removing the need for manual adjustments, you rely on the program logic controller (PLC), thus eliminating potential for human error.

In addition to perfecting your process, many heat treaters may need to meet rigorous industry specifications like those in the aerospace industry, including but not limited to Nadcap and AMS 2750. Demands for compliance to industry-specific regulations have never been greater, but the trend toward more precise measurement and control is increasing even outside these specifications and regulations.

**Assessing Your Needs**

Before purchasing a furnace or upgrading an older one, the first step is assessing your process and production needs. There are many types of thermal-processing equipment, and you want to be sure you are investing in the proper furnace or upgrades.

Vacuum-furnace systems are classified into six categories, identified by Class One through Class Six. Class One applies the most stringent furnace requirements with the smallest range in temperature uniformity.


**Advanced Controls Technology**

There are many options to consider when it comes to advanced controls technology including instrumentation, software, data storage and monitoring systems. All of these features offer the intelligent, superior control needed to achieve peak performance from your equipment, both new and old.

**Instrumentation**

Enhance your instrumentation by applying state-of-the-art technology that can improve your measurement and capabilities, which makes running and maintaining your equipment easier and more cost-effective.

**Hygrometer (Dew-Point Analyzer)**

Installing a hygrometer upgrade on a furnace affords users the ability to monitor the moisture content in the process gas. Its design allows the flexibility to operate and monitor precisely under various conditions (Fig. 3). The hygrometer is mounted in an enclosure near the furnace backfill inlet to ensure that the system receives an accurate sample. Many specifications mandate that the backfill and partial-pressure gases are scrutinized before being exposed to the parts. In general, this is a best practice to prevent discoloration of your parts. Some customers choose to use the hygrometer for information only, but others choose to integrate it with their control system for a “go, no-go” condition. If it deems a no-go condition, the software will sound an alarm and, in some cases, prevent the gas from entering the vessel.

**Vacuum Gauge**

Vacuum gauges provide end users accurate and repeatable results. These gauges integrate easily into the furnace and have a modular design that allows for future expansion. The vacuum gauge measures the vacuum and partial-pressure levels throughout the heat-treatment cycle. Some industry specifications mandate the monitoring of vacuum levels prior to the start of a heat cycle or partial-pressure range during the heat cycle, so end users need accurate representation of those levels. It is important to remember that selecting the proper vacuum gauge is critical to adhering to particular specifications.

**Digital Data Recorder**

A digital data recorder adds advanced data collection, storage and reporting (Fig. 4). Data collection and reporting have become one of the most scrutinized parts of today’s control systems. Many older control systems utilize paper chart recorders that record the run based on time intervals. This system requires manual setup and finalization. It also has limited readability and storage capabilities.

With an upgrade to a digital data recorder, paired with a software upgrade, the data can be stored on the industrial computer, sent to a specified network location via an Ethernet connection or both. This ability gives the customer the required redundancy for critical data storage and typically helps to comply with most industry specifications.

Comparatively, a new digital recording system will be far easier to use than an analog paper recorder, allowing you to better track your results in order to refine your process and improve your quality throughput. Charting is made easier with the digital readout, and it can provide on-the-fly reports and adjustable configuration of reports, depending on your needs. Check out the online exclusive for information about AMS 2750E charting requirements.

**Software Control Upgrades**

Software upgrades are often teamed up with equipment modifications in order to provide better functionality and measurement. These upgrades are often referred to as control upgrades in the more general sense because they are typically whole-system upgrades that may include PLC, cabinet-mounted industrial computers and monitors, recipe development and storage capabilities, in-process recipe editing, real-time and historical data trending, and process-cycle reporting.

As mentioned earlier, these software control upgrades can also reduce the possibility of human error by automat-
Pairing this software control upgrade with a digital data reprinted. also be retrieved by date and then be displayed on screen or and historical information at any time. This information can login information (Fig. 5). Users can toggle between real-time log data to populate the trend screens, alarm history and user When the system is switched on, it will automatically begin to now capable of tracking 32 data points selectable by the user. Another great new software feature is that the systems are calculates the math to give you real-time data. being selected for partial pressure or backfill and automatically There is software available, however, that knows what gas is being selected for partial pressure or backfill and automatically gives you real-time data.

The software can also perform a similar action when dealing with the utilization of either argon or nitrogen gas for different part processing. There is a specific density change between these gases: argon is heavier. You cannot calibrate and tune your machine for nitrogen and then run argon gas, or vice versa, and expect the system to display corrected vacuum readings. There is software available, however, that knows what gas is being selected for partial pressure or backfill and automatically calculates the math to give you real-time data.

Another great new software feature is that the systems are now capable of tracking 32 data points selectable by the user. When the system is switched on, it will automatically begin to log data to populate the trend screens, alarm history and user login information (Fig. 5). Users can toggle between real-time and historical information at any time. This information can also be retrieved by date and then be displayed on screen or printed.

Pairing this software control upgrade with a digital data re-

**Effects of Partial Pressure on SAT, TUS**

One perceived issue that hasn't been addressed in AMS 2750 is that end users may be running parts in partial pressure and not always in a vacuum environment, but the specification only outlines the requirements for vacuum. The concern is that the results of your SAT and TUS can vary widely, depending on if you are conducting them in vacuum or partial pressure. If end users are charged with emulating the production environment for SAT and TUS, one must take into consideration the effects of partial pressure if it is utilized in the production cycle.

There are many uses and benefits of partial pressure, but the gas' ability to transfer heat and its ability to negate the insulation factor of the hot zone is of great concern. When high partial pressures are selected during a production cycle, the gas' effect on negating the insulating properties of the hot zone causes the need to increase the temperatures of the heating elements in order to maintain the setpoints. The end user never sees an issue as the furnace ramps normally, reaches setpoint normally and soak[s out accordingly. Depending on the particular hot-zone configuration (e.g., all-metals has greater losses), the actual parts may see significantly elevated surface temperatures during the ramping or soaking modes of the cycle. Based on physics, the heating elements are always hotter than any setpoint temperature while ramping or at a soaked condition.

Different gas pressures and different gas selections (e.g., nitrogen, argon, hydrogen, helium) affect the amount of heat loss, which may vary greatly. The greater the heat losses, the higher the percentage of heating power output must be to maintain the setpoints. One should give greater consideration to the fact that you may wish to consider running your SAT and TUS in partial pressure if you run your production cycles in partial pressure. The reasoning behind this is related to the possibility of the parts being exposed to far greater radiation due to the higher percentages of power being utilized to compensate the gas' effect on heat loss from the hot zone. In order to properly measure the results, you would need to run testing in both vacuum and partial pressure. You may find a vast difference in the results, which is mainly due to the thermal dynamics caused by the heat loss and greater element watt densities.

Although AMS 2750 has not yet defined a solution, the committees in charge of review of the specification will hopefully consider and address this in the future. We believe a best practice in this situation is to perform an SAT and TUS for both vacuum and partial pressure and save the proper adjustments in the control system. Depending on your load configurations, you could then switch between hard vacuum and partial-pressure cycles (all within one furnace) without the risk of overheating parts. Ipsen’s advanced controls systems are currently designed to accommodate for these and similar changes.
corder provides an extra level of redundancy when needed or required. This will ensure that the data will not be lost. Historical files can be transferred to a compact flash card or a networked hard drive via an Ethernet connection. All files created are read-only and cannot be altered without detection, which is becoming extremely important in the aerospace and pharmaceutical industries, as well as other market sectors.

Supervisory Control and Data Acquisition (SCADA) Systems
Upgrading to incorporate a SCADA system provides the means to view furnace data and operational settings on multiple furnaces at the same time on a single display. As an alternative to physically going to each individual furnace to retrieve information, all of the data is sent to the SCADA system via an Ethernet connection. This gives the end user the flexibility of collecting and reporting the data in one central location. This functionality allows for more efficient reporting. SCADA systems provide more robust monitoring and reporting. However, they do not define your production process.

Network Connectivity
If you long to monitor your furnaces remotely, wait no more. Network connectivity upgrades can allow users the ability to monitor their furnace remotely and can be configured to their particular specifications (Fig. 6). With this upgrade, users can review in real time the necessary data critical to meeting their heat-treatment process. This upgrade also includes email notifications of alarms, monitoring of the PLC inputs and outputs, firewall capabilities, and remote diagnostic capabilities.

Putting it All Together
Optimizing your thermal-processing equipment starts by first understanding your process and production needs. Then you need to research the proper furnace type to meet those needs. Finally, it is important to be informed on the advanced controls technology available so you can make an informed decision on how you will measure, operate and analyze your equipment in order to refine your process and meet the requirements of applicable industry specifications. The controls upgrades in this article merely scrape the surface of the options available. All systems can be customized and tailored to meet your specific objectives and provide solutions that help you stay ahead of the curve by streamlining your process to save critical time and money. IH

Potential Nadcap, AMS 2750 rev. E Compliance Pitfalls
A common misconception is that you can purchase a furnace that is AMS 2750E and Nadcap accredited. In actuality, end users are responsible for investing in a furnace that is capable of meeting the specification they are trying to achieve. Then they are required to operate, maintain and test the furnace to obtain certification. The equipment manufacturer cannot control how end users operate and maintain their furnace; that is up to the heat treater. For instance, AMS 2750E outlines the furnace classes and the standards by which each class is determined, but a furnace – as shipped from the manufacturer – is not by itself AMS 2750 or Nadcap compliant. It can only be capable of being compliant since the onus of compliance is reliant on the end-user’s control and operation of the furnace, as well as the particular process variables and specifications they are attempting to meet. See the online exclusive for more AMS 2750 changes.

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Go online for Six AMS 2750E changes you should know about.

Go to www.industrialheating.com/2750E