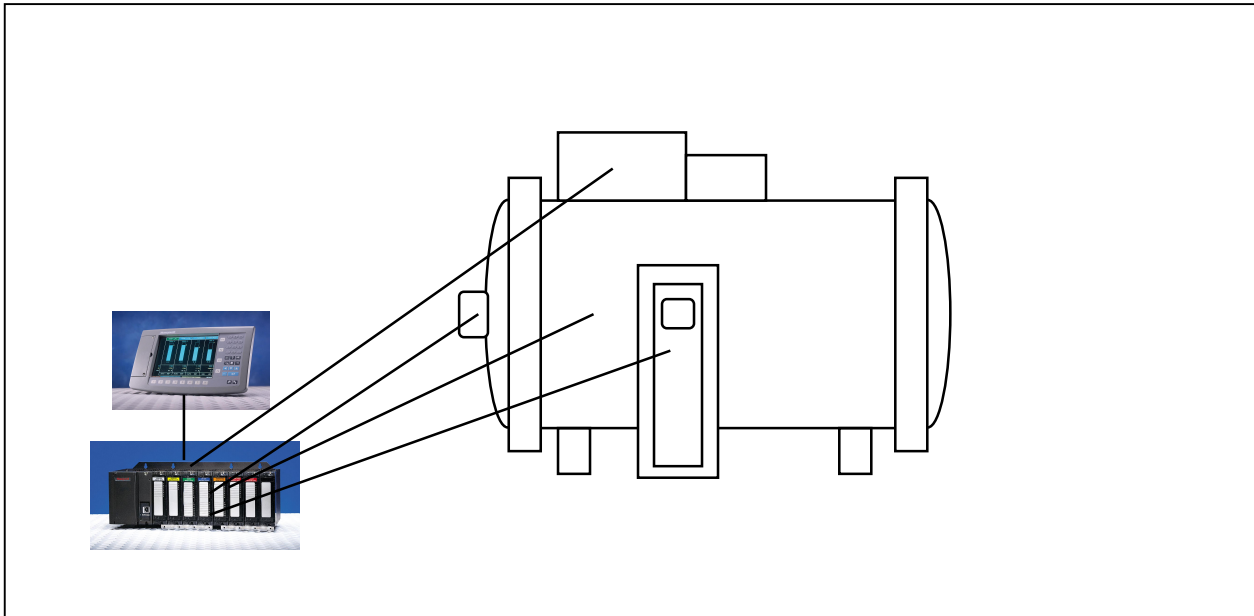


HC900 Vacuum Furnace Control

Industry: Thermal



Problem

Temperature control in the vacuum environment can be difficult because of the changing heat transfer characteristics of the furnace as it moves from conduction and convection to radiation. The rapid heating rate of a vacuum furnace demands precise control, including setpoint program control with soak guarantee inputs. Overshoot of temperature setpoints is usually not tolerated for metal treating applications.

Setpoint program control is often applied to both the temperature and the vacuum, with extensive interaction between the two programs and also with the logic control.

Vacuum furnaces are often used by a variety of products by the heat treater, making recipe management an important function.

Vacuum furnaces are used in the metals industry for applications such as heat treating, brazing, melting, and thin – film deposition. They are used to bring materials to high temperature with a minimum of surface reaction such as oxidation. In addition, surface and internal contaminants on molten metal applications are volatilized and removed. Heating is fast and efficient using radiant energy that heats only the product in the vacuum environment.

Vacuum furnaces for heat treating and brazing are typically single chamber furnaces operating batch cycles. The batch cycles vary from process to process but commonly require regulation of temperature, vacuum and sequence logic. The temperature and vacuum interact extensively with the logic, creating an ideal application for the HC900 Hybrid Controller.

A typical heat treating cycle starts after the product is loaded into the furnace and the door is clamped shut. Some users secure the furnace and perform a leak test before proceeding.

A roughing vacuum pump lowers the pressure to about 0.1 mm. of mercury (100 microns). A second diffusion pump lowers the pressure to about 1 micron. An inert gas like argon is fed into the furnace at a low rate, allowing the pressure to rise to about 50 microns. Once stable, the furnace is bottled up and the temperature program started. The pressure increases as the temperature rises and contaminants volatilize.

Control of the vacuum is maintained at about 50 microns. If the vacuum deviates from 50 microns by more than about 25 microns, the temperature program is held until the condition is corrected. The temperature program goes through a series of ramps and soaks. After a high temperature soak, the furnace is bottled up and the temperature is allowed to drop.

An increased flow of inert gas and circulation of cooling water in the furnace walls cools the work. The cooling lowers furnace pressure, requiring additional pressure control. At 200 degrees, the pressure is controlled to about 500 torr. A light or horn usually provides indication to the operator that the cycle is complete.

The operator brings the furnace back to atmospheric pressure manually and unloads the product.

The HC900 Solution

The HC900 Hybrid Controller meets all of the requirements for safe and productive process operation with maximum operator convenience:

- Program control of sequencing and variables versus time
- Proportional (PID) modulating loop control
- Logic functions for equipment and process status
- Alarm detection, annunciation, and logging
- Data acquisition and data logging
- Recipe configuration, local storage and download capability

HC900 Vacuum Furnace

Control of temperature is executed with a powerful algorithm set that satisfies the most demanding application requirements. Multiple tuning constants may be used to tailor the control response to the dynamic characteristics of the furnace. Approach limits allow maximum heating rates without overshoot, reducing cycle time and optimizing efficiency.

Eight setpoint programmers and two drum sequencers of the HC900 make precise program cycle control easy. The interaction of setpoint, loop and logic functions within a single HC900 create the ideal solution for the requirements of vacuum furnace control

The Setpoint Program capability of the HC900 is used to control the temperature profiles. Up to 99 different profiles, appropriate for a wide range of products, can be created and stored for use when these products are processed.

A single configurable database integrates both the loop (proportional, modulating) functions and the logic (discrete, boolean) functions required by the process.

Familiar operator displays provide the operator with dynamic information about the status of each run as it progresses. Alarms are announced in color on dedicated displays and can be acknowledged directly from the Model 1042 Operator Interface (OI). Product changeover is simplified as new recipes may be selected by name directly from the OI.

The data acquisition and control capability of the HC900 permits ongoing process analysis to define and implement the control strategies while maintaining high production with safety and at low cost.

Benefit Summary

The Honeywell HC900 provides the following benefits when used in vacuum furnace applications:

- Extensive set of advanced algorithms for maximum process performance
- Open Ethernet connectivity via Modbus/TCP protocol provides plant wide process access and data acquisition
- Extensive equipment diagnostic and monitoring to maximize process availability
- Isolated, universal analog inputs allow mix of analog input types on same card, saving I/O cost
- A common configuration tool for both control and OI minimizing engineering costs
- Autotuning and fuzzy overshoot protection for quick startup and proper control operation
- Storage of up to 50 recipes for fast, error-free product selection
- Storage of up to 99 time/temperature profiles. Each profile may be part of a recipe.

Implementation

Overview - The HC900 as shown in Figure 2 consists of a panel-mounted controller, available in 3 rack sizes along with remote I/O, connected to a dedicated Operator Interface (OI).



Figure 2: HC900 Hybrid Controller, Model 1042 OI and Hybrid Control Designer Software

All field signals terminate at the controller. The controller has universal analog inputs, analog outputs and a wide variety of digital input and output types. This controller will provide all the vacuum furnace control functions.

Configuration - The Hybrid Control Designer tool provides advanced configuration techniques allow a variety of strategies to be easily implemented. The run-mode configuration monitoring and editing capability allows these strategies to be tested and refined as process knowledge is gained.

Monitoring - The complete operation can be monitored and controlled from the easy to use, familiar displays of the Model 1042 OI.

Data Storage - The data storage feature of the OI can be used to log process information during the cycle to an integral floppy disk for a permanent record.

Open Connectivity Over Ethernet – Use popular HMI, data acquisition, OPC server, and HC900's HC Designer configuration software over an Ethernet LAN concurrently to access HC900 controllers.

Peer to Peer Communications - Any HC900 can support up to 8 peer controllers for exchange of analog or digital data over Ethernet.