Cutting edge automation in high temperature furnaces

Temperature control during melting, movement of molten metal and controlling the rate of solidification are very important factors for the high temperature furnaces. A single automation system designed by Jumo can do all this — that too remotely.

For the last 19 years, Ena (Elektrotechnologien und Anlagenbau GmbH) has been developing and building customized industrial furnaces based on electrical energy in Saxony-Anhalt, Germany. The temperature range of the furnaces ranges from as low as 100 °C to as high as 1,850 °C and even higher. Even extreme high-temperature applications with thermic plasma of 5,000 to 10,000 K are possible.

The wide-ranging product portfolio includes chamber type furnace, bogie hearth furnace, vacuum furnace, magnesium furnace, pyrolysis furnaces and protective gas furnace. On the basis of the long standing experiences in the field of industrial furnaces and heat treatment plants, ENA offers a complete service ranging from design, development, manufacture and also thermic flow simulations, heat calculations up to commissioning the furnace at the operating location.

Precise temperature control

For the special high-temperature furnaces, which are used for the slow solidification of molten metals, it is important to ensure that metals have particular structural properties, the rate of solidification must be exactly controlled. To do so, the metals/alloys are melted down and then brought to solidification in a controlled manner. If, for instance, you cool a molten alloy so slowly that the system is practically always balanced, crystallites of varying composition break off during the cooling. On the other hand, unwanted martensite or bainite may form if the cooling is too fast particularly so for higher alloyed steels.

To obtain this temperature control for the melting down the metal and step control for the movement of the metals out of the molten zone, the mTron T automation system from Jumo, the Fulda-based measurement and control technology specialist, is being used. Both processes can be optimally and efficiently carried out using the Jumo mTron T system. The system is modular and uses an Ethernet-based system bus and an integrated PLC. The measuring, control, and automation system can be used universally and combines Jumo’s comprehensive process know-how with a simple, application-oriented, and user-friendly configuration concept.

Anatomy of the system

The heart of the Jumo mTron T is the central processing unit with a process map for up to 30 input/output modules. The CPU contains superior communication interfaces, including a web server. For individual control applications, the system provides a PLC (Codesys v3), program genera-
The Jumo mTron T automation system

The available input/output modules are multichannel controller modules, analog input modules with four and eight channels, relay modules with four channels, and the configurable digital input/output module with twelve channels. The four-channel analog input module has four galvanically isolated, universal analog inputs for thermocouples, RTD temperature probes, and standard signals. As a result, the same hardware can be used to precisely record and digitize a highly diverse range of process variables.

A setup program is used for hardware and software configuration as well as for the project design of the measurement and control tasks. This was how temperature control was set up in the furnaces at Ena GmbH. For the step control, a solution was programmed using the integrated Codesys software PLC.

In addition to providing the visualization of all processes, the multifunction color panel enables convenient operation of the controllers and program generators. User-dependent access to parameter and configuration data for the entire system is also possible. The recording functions of a fully-fledged paperless recorder, including a web server, are implemented as a special feature. Standard predefined screen masks significantly reduce startup times. Finally, all the recorded data is analyzed and archived using the PCA3000 software.

Intelligent IPC adjuster

An IPC adjuster – also from Jumo – is used for the electric control of the heating for the high-temperature furnace. This adjuster automatically compensates for changes in the electrical resistance of the heating as the temperature changes and as a result of the aging of the SiC heating elements.

To distinguish an operational change in resistance from a fault – for instance because a heating element has broken – a special monitoring routine has been programmed. The IPC adjuster calculates the electrical resistance on an ongoing basis, transmits it to the mTron T system, and compares it to the saved setpoint value. The temperature-dependent setpoint values for the heating elements are saved in the protected user area. Should a heating element not function correctly, the heating power is automatically reduced to overload the other heating elements. In an overview, the user can see the electrical resistance of the heating in relation to the temperature. Since the solidification process stretches over a long time and runs in the main without operating personnel, the high-temperature furnace control system is connected to the company network. Using the mTron T system's integrated web server, all process screens can thereby be monitored remotely.

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