Control Solutions

White Paper

The changing face of temperature control

Industrial temperature controllers have changed considerably over the last fifty years. This paper looks at how the development of technology has reacted to the changing demands of its customers to create powerful new solutions.

Temperature Control

In the early 1960s, moving coil full DIN (192 x 192mm) temperature controllers were an industry standard but the adoption and progression of electronics would soon change the way controllers were designed and manufactured. Open frame PCB controllers were first introduced incorporating On/Off or proportional control, set by dials on the controller. Proportional control was the most accurate type of control at that time and was achieved by providing a reduced power output around set-point. The proportional output around set-point minimised temperature overshoot. The biggest draw-back of proportional control was that the temperature would stabilise at a level slightly above or below set-point – known as an offset error.

Analogue controllers continued to reduce in size during the 1970s from 1/4 DIN (96 x 96mnn) to 1/16 DIN (48 x 48mm) with little change in functionality. In fact, analogue controllers today have not progressed in technology from controllers in the late 1970's. However, the introduction of digital controllers in the 1980's represented a major step change in temperature control technology. The guesswork that had previously been involved with setting controllers was eliminated as dials were replaced by pushbuttons and digital displays. It was now possible to have PID (Proportional Integral Derivative) capability in controllers, achieving more accuracy due to the development of microprocessors. In addition to proportional control, the integral term removes offset, while the derivative term helps reduce temperature overshoot and changes response to disturbances.

However, although the benefits in terms of temperature management are good, manual setting PID control can be time consuming and require a skilled engineer. Thankfully, PID auto-tune is now available in most of today's controllers. Using the PID auto-tune feature, a controller will calculate the optimum PID values for any given application.

As an example, the easy-to-use CAL

Temperature Control

3300 from West Control Solutions offers integrated PID auto-tune. This means users do not have to set these parameters manually, a task that requires a certain amount of technical knowledge, and can reduce set up time to a few minutes. The PID facility is further enhanced by a unique dAC (Derivative Approach Control) function, which prevents temperature overshoot by increasing the proportional band temporarily during warm-up.

One of the other advantages of modern electronics is that manual interaction in a process can be reduced, hence minimising errors. Automatic variation of temperature during a procedure can be achieved by using a controller with temperature profiling. Programs can be created with temperature ramps rates, soak/dwells, steps, and loops to accurately achieve the required temperature profile for an application. To save time in setting up a machine, programs can also be stored and called for different process 'recipes' as needed.

In some applications (for example, extruders) temperature does not fall quickly enough when power is removed from the heating load. Assisted cooling is therefore required to achieve better temperature control. A heat-cool feature is available in some controllers which means that a single unit can be tuned for governing both heater and cooling loads as required to achieve improved control.

Integration of functions within controllers has become more common in recent years to simplify wiring and reduce installation times. Some medium to high end controllers offer integration of co-working control elements; this is achieved by supporting programming of logic capability around the core process control element of the device. And with a single HMI as the interface used for the complete system, this offers the end user increased efficiency and functionality with easy controllability.

As a case in point, a major component manufacturer in Germany required a new temperature control solution for the special oven they used to heat one of their core products, graphite electrodes. However, the ideal system could not be realised with a standard controller; any upgrade would require a more sophisticated model with, for example, sequence management, but one that would also be easy to operate.

The problem was that a graphite electrode needs to be evenly heated throughout, but a gas burner may heat areas of the oven at different rates and intensities. This can result in expensive wastage if electrodes are damaged through either over heating or because they have not been heated evenly.

The solution arrived at featured a special combination of a gas burner system and a method of heating the oven with pure gas, using enhanced oxygen control. Our KS98-1 temperature controller, a compact mini PLC (Programmable Logic Controller) and DIN controller, perfectly fitted the existing ¼ DIN housing, and came with all the necessary I/O options already on board. For example, the KS98-1 provides a comprehensive function library containing tested PLC and maths functions that are not normally available in a DIN controller.

A standard DIN controller normally has one control loop, sometimes two, but

no kind of sequence mechanism or PLC logic function. The KS98-1 offers this functionality, but all within a DIN housing. And because it is still a DIN controller and not a PLC, the set-up of the process is more cost-effective. The customer's problem could have been solved with a PLC, but this would have also required the expensive services of a high-end PLC programmer with a lot of knowledge.

Like many other devices, communications have changed the way that controllers are integrated as part of a system. Temperature and process controllers have generally been used as a discrete device within a machine. With communications options, monitoring and supervisory control are now possible directly from a PC or via a PLC system. Many generic SCADA (Supervisory Control And Data Acquisition) packages or specialist monitoring software products are available for data-logging, charting, configuration and management. In particular, PC based data-logging has grown over the last decade as more companies require data records for quality control purposes.

For instance, one of our customers, Solent Scientific, produce the 37° Incubation Chamber, an acrylic enclosure integrated with a powerful microscope used to conduct prolonged studies of living human cells, usually involving time lapse image capture.

Using the process monitoring software for real-time logging of CAL controllers, Solent Scientific could prove that the temperature within their chambers was kept to + or - 0.1°C over long periods of time, which is well within the tolerances required for the application. It was also a solution that avoided the considerable cost and development involved in employing SCADA packages.

Although temperature controllers are much more advanced in functionality and accuracy, simplicity in setting up has been retained through features such as auto-tuning. Controllers are now also much smaller in size, making it much easier to integrate temperature control to a machine.

So how will temperature control change in the future?

The need to expand the capacity for gathering process information, provide simplicity of use for the operator, and integrate co-working control elements, is driving the development of solutions that offer single display, such as HMIs, operator panels, or the routing of information back to a PC. This means that the controllers of the future will increasingly become a single product rather than individual devices, bringing to the user the benefits of better application and control functionality, in addition to the monitoring of enhanced system data.

The trend is towards new levels of controller customisation, in which the operation of the device is tailored to the application. The latest display and programming technologies allow the controller to use terminology used by the operator, gain easy access to data, and ensure process changes are optimised for efficiency.

There's also the potential for controllers to integrate with a wider network. The use of Ethernet communication is simplifying integration, with standard cabling and 'non-engineering-based' connectivity, further enhancing the powerful blend of easy operation and increased control capability that continues to enhance temperature control.

One thing's for sure; as the above examples illustrate, industrial temperature controllers are continuing to react to the changing demands of customers, creating powerful new solutions that improve efficiency and quality for a diverse range of applications.

For more details on the complete product range from West Control Solutions please contact your local distributor or visit **www.West-CS.com**.

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