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.
The Changing Face of Temperature Control

WHERE IT ALL BEGAN

In 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 minimized temperature overshoot. The biggest draw-back of proportional control was that the temperature would stabilize at a temperature slightly above or below set-point. – known as an offset error.

ANALOGUE TEMPERATURE CONTROLLERS

Analogue controllers continued to reduce in size during the 1970s from ¼ DIN (96 x 96mm) 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 1970s.

However, the introduction of digital controllers in the 1980s 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 push buttons and digital displays. It was now possible to have P.I.D. (Proportional Integral Derivative) capability in controllers, achieving more accuracy due to the development of microprocessors.

THE START OF PID CONTROL

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 P.I.D. control can be time consuming and require a skilled engineer. Thankfully, P.I.D. auto-tune is now available in most of today’s controllers. Using the P.I.D. auto-tune feature, a controller will calculate the optimum P.I.D. values for any given application.

As an example, the easy-to-use CAL 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 minimizing 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.

**Simplification of Controller Set Up**

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.

**Special Temperature Control Requirements**

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. The **PMA 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.

**Communications**

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, Solent Scientific, a company who produces 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 ±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.

**THE FUTURE FOR TEMPERATURE CONTROL**

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 HMI}s, 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.

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 is 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.