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Advanced controls and analytics for industrial chillers have made process cooling more intuitive and user friendly than ever before. And now AI seems poised to continue the smart evolution.

BY MARK STEPHEN, EDITOR

HMI touchscreen controls from Delta T Systems.
Photo: Delta T Systems

It's no exaggeration to say that plastics processing lives and dies by temperature control. Stable and repeatable cooling supports consistent cycle times, protects mold tools, and helps reduce defects linked to cooling instability by ensuring that plastic parts don't warp, shrink, or develop internal stresses that could compromise their structural integrity. And this stability is what industrial chillers provide. The only problem is, chillers – whether portable or central, air-cooled or water-cooled – are complex systems with multiple failure points that include compressors, condensers, and evaporators.

Preventing this failure is therefore a prime directive for the chiller makers. And it was a challenge for decades, as OEMs struggled to provide controls with sophisticated analytics that could derive actionable insights from their chiller data and maintain a comprehensive overview of the entire cooling system. But the past 15 years have seen chiller performance remade by the fourth industrial revolution of Industry 4.0, which has transformed production plants into smart, interconnected, and highly efficient environments. "Modern chiller controls perform advanced functions that weren't possible with older systems," said Mario Coletti, area sales manager with Frigel North America Inc., in East Dundee, Ill. "These smart controls are designed to continuously monitor operating conditions and automatically optimize performance, improving both energy efficiency and process stability."

Industry 4.0-related chiller control developments have been facilitated by improvements in chiller hardware. "With the availability of speed-controlled compressors, low-temperature-operating compressors, speed-controlled fans, and proportioning water valves, it became more important to sense what was going on in the chiller to take full advantage of all these new components available to us," said Roger Lambert, president of Markham, Ont.-based Temperature Corporation. "And since there was so much information that was being sensed and gathered from the chillers, the chillers had to know what to do with it all."

MODERN VALUES

Fast forward to today, and they know. Modern chiller controls now track key metrics like energy consumption, refrigerant pressures, ambient dewpoint, vibration levels, and component health; and modern chiller analytics platforms transform this raw operational data into clear, actionable insights through sophisticated key performance indicator (KPI) dashboards. The core metric – tracking the ratio between electricity consumed and chilled water produced – provides facility managers with an immediate understanding of system performance. When facilities operate multiple chillers, analytics platforms can automatically determine the optimal combination of units to run based on real-time efficiency data and load requirements.

Beyond this, advanced chiller analytics provide operational insights that extend equipment lifespan to the maximum, including automatically sending alerts for predictive maintenance and analyzing the frequent starts and stops – often caused by incorrect setpoints or load miscalculations – that can degrade chiller performance and shorten equipment lifespan. And for plantwide systems, effec-

tive chiller analytics monitor the entire cooling ecosystem.

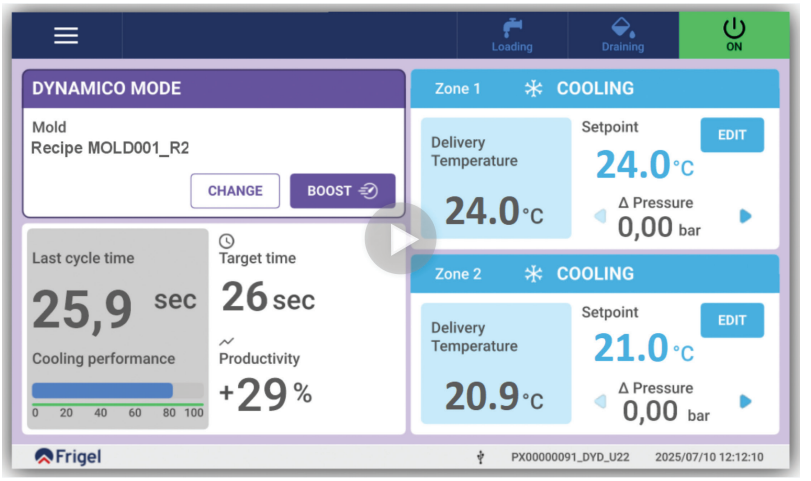
As an extra wrinkle, there's a balance that OEMs are often being asked to maintain – offer chillers that are smart but not confusingly so. "Many plant maintenance teams and outside service technicians still want controls that are intuitive and easy to troubleshoot," said Jon Gunderson, president of Advantage Engineering Inc., in Greenwood, Ind. "In our experience, overly complicated interfaces can slow down troubleshooting when a problem occurs."

Beginning in 2021, Richfield, Wis.-based Delta T Systems began rolling out a single- and dual-zone temperature control heater and chiller package that combines energy-efficient variable speed compressors and fan motors with a heating loop for precise temperature control. Suitable for plastics processors that use chillers and temperature control units in tandem, the standard single controller and program can control two processes at different temperatures and pumping capacities. As an option, the company also offers process monitoring software called DTS Smart Connect that enables remote chiller management and servicing. When equipped with an upgraded, Ethernet-enabled controller, all Delta T Systems chillers can upload specified process parameter data to a cloud-based server. "The package also provides predictive maintenance to customers through 'pop-up' warnings," said company president Jochen Naujokat. Self-diagnostics is an area that Delta T is continuing to work on, Naujokat continued. "Our control technology records the number of hours that each component is running and the number of starts, which will help tell when components are at the end of their life," he said.

Temperature Corporation, meanwhile, offers its System Remote Master (SRM) modular chiller cooling system, which can control 12 chillers with a total of 48 stages. "It monitors the operating and fault conditions of all of the chillers in the group and can pass this information along to the plant PLC or the BMS [building management system]," said Roger Lambert. "Once we log into our SRM remotely over the internet, it's as if we're standing in front of the chiller and can monitor each unit's operation as well as the temperatures and pressures, and we can make changes to the modes from cooling to heating." The SRM will also stage all the compressors in the system to match the cooling load, Lambert added, and if a chiller stops due to a fault condition, the SRM starts the next chiller in line with no interruption and signals the SRM that a chiller has failed.

A NEW ERA?

And now, the plastics industry stands at the threshold of another technological revolution: artificial intelligence (AI). The Industry 4.0 era of manufacturing depends so heavily on data-driven precision that AI feels like the inevitable next step for harnessing all that information, with the promise that algorithms like machine learning and deep learning will mimic the human capacity to learn, reason, solve problems, and make judgements without explicit human instruction, improving prediction accuracy over time.



The user interface for Frigel's Dynamico AI-assisted mold temperature control technology.
Photo: Frigel

That said, these are still early days for AI, and most of its penetration into plastics so far is in the major molding technologies like injection molding and extrusion, less so in process cooling. "We're not being asked about Al yet from most of our customers, but we're starting to go that way slightly with a few of them by adding more code to a controller's programs so they can automatically adjust to changing conditions," said Jochen Naujokat. "We're also working on a preventive maintenance feature for our controllers – the data is already being collected by our sensors, we just have to develop algorithms that present it to the user proactively. It borders on what the industry is calling AI."

Other OEMs are already touting full-blown AI-driven technologies. According to officials with Frigel, its new Dynamico system uses AI-assisted dynamic temperature control to cut cooling times, boost productivity by up to 50 per cent, and reduce unit costs by automatically regulating water temperatures in the various cooling phases – and, in some cases, modulate flows in the two mold halves through powerful booster pumps. The cooling time reduction is suggested by "Dynamico Wizard," exclusive software developed by Frigel that uses AI-assisted algorithms. "Thanks to the initial data requested for the initial setup, the Dynamico synchronizes itself with the process and helps the operator find the best cooling time reducing this value, hence the

4.0

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overall cycle time, to the shortest possible," said Mario Coletti. "Furthermore, internet connectivity opens the way to continuous learning, with algorithms capable of progressively improving performance thanks to data from all machines and molds connected to the network." The solution is already used in various sectors such as automotive, medical, and packaging, he added.

FUTURE-PROOFING

As AI transforms every aspect of manufacturing, there are worries that risk is outpacing governance, and some plastics processors report being uneasy about deploying AI at scale due to concerns about cybersecurity and the transparency of AI systems. "Many facilities are cautious about exposing their production equipment to outside networks for any reason," said Jon Gunderson. And they're not worried for nothing: AI arguably poses a greater data privacy risk than earlier technological advancements, and numerous reports have cited the need for more reliable networks and stronger cybersecurity to fulfill AI's potential. But the right software solutions can address some AI privacy concerns right now, some OEMs say. "We work closely with the IT department of every customer to be sure all the safety protocols are kept in place," Mario Coletti said. "With our Dynamico, we remove the problem by providing each machine with a router and a SIM card, so that each machine has its own internet connection that's independent from the customer's network. Furthermore, the blockchain-based data exchange will guarantee that each machine is anonymous, making it impossible to share sensitive data to third parties."

Going forward, these OEMs say, some customers may need to modernize their networks to increase bandwidth and upgrade unreliable wireless connectivity that could otherwise affect AI operations.

Retrofitting new smart controls onto older chillers is an option that many processors would probably embrace. But is it doable? The answer is, it depends. Assuming the customer has a relatively modern chiller, the OEMs say, a retrofit can probably be done. But there's a limit, usually based on a cost/benefit analysis. "It's sometimes possible, but it can be expensive and complicated," said Jon Gunderson. "Retrofitting often means replacing sensors, wiring, and major electrical components, and the integration work can add up quickly."

Gunderson also notes that process cooling is still nowhere near reaching the point of autopilot, where operators aren't necessary. "Modern controls can help identify inefficient operation such as poor water flow, fouled heat exchangers or excessive compressor cycling; and they can also provide better visibility into how the equipment is operating over time," he said. "But experienced technicians still play a big part. Controls are helpful diagnostic tools, but they don't replace good maintenance practices."

Whether based on Industry 4.0 or AI, the latest chiller controls aren't meant to replace human workers, in other words – they're meant to give them superpowers. **CPL**