Procter & Gamble optimizes temperature control processes

Dynamically controlled multi-circuit temperature control for more transparency, quality and efficiency

Mold temperature control has a significant influence on product quality. This explains why Procter & Gamble Manufacturing has improved the transparency and consistency of temperature control processes using e-flomo and iQ flow control by ENGEL. This not only results in reproducible component quality, but also in significantly higher levels of efficiency.

"Temperature control was a black box for us", says Andreas Franz, process engineer at Procter & Gamble (P&G) in Marktheidenfeld summing up the initial situation. For a long time, only the supply temperature was known. However, it was only possible to investigate how the temperature is distributed over the individual heating-cooling channels during injection molding using thermography, a complex process that does not give more than a snapshot. Three years ago, the Molding Technology division in Marktheidenfeld thus started to analyze and optimize temperature control in the injection molding process. "Our goal was transparency and with it, increased process reliability", says Christian Rieb, Equipment Engineer at P&G.

The P&G production plant in Marktheidenfeld, Germany, fully focuses on oral hygiene. Electric tooth brushes for the Oral B brand are produced for the worldwide market there. The molding shop currently includes 100 injection molding machines in a wide clamping force range from 50 to 500 tonnes. As a health care company, P&G has greyroom production, all processes are validated, and quality takes top priority in all production areas. Innovative technologies that enable more consistent processes and higher quality are generally of great interest at P&G.

For a long time, too little attention was paid to the link between mold temperature control and product quality, but ENGEL triggered a rethink at K 2010. With its electronic temperature control water manifold system, flomo, the injection molding machine manufacturer laid the groundwork for more transparency and consistency in the temperature control process. flomo

replaces the maintenance-intensive cooling water distributors, and even the basic version can individually monitor and document all cooling and temperature control circuits. Furthermore, the next generation e-flomo is able to actively control the flow rates or the temperature difference (ΔT) in all individual circuits. The advantage of ΔT control is that the individually required flow rate is automatically set for each temperature control circuit. Finally, presenting iQ flow control at K 2016, ENGEL took the next step. The software networks the temperature control unit and the injection molding machine to create a single unit and controls the rotation speed of the pumps in the temperature control units on demand. "In injection molding, around 25 percent of all scrap parts are a result of temperature control errors", explains Klaus Tänzler, temperature control product manager at ENGEL. "This is precisely why ENGEL's development team is working intensively on this topic."

P&G in Marktheidenfeld and ENGEL have collaborated since 2007. In 2013, P&G became a test customer and development partner for innovative temperature control solutions. "When ENGEL presented the new e-flomo to us, we already had some idea of the amazing potential the system would open up for us", says Rieb.

Over the last few years, the two partner companies have together acquired a great deal of process know-how and brought light into the injection molding temperature control black box. The implementation of the new technologies not only led to more reliability and process consistency. It became clear that optimizing the temperature control processes can also massively increase efficiency.

Just three instead of ten temperature control units

A mold with 56 heating-cooling channels generally presents a particular challenge and is well-suited to testing innovative temperature control technologies. This mold belongs to the housings of the NGC chargers for the hand pieces of the electric toothbrushes whose manufacturing process was the first to be investigated by the newly established Temperature Control Project Group at P&G.

The oval base of the ASA housing has a thin dome top center that holds the hand piece of the electric toothbrush in place when charging. For stabilization, there are small webs on the inside. In the manufactured product, the housing contains the entire electronics including the connection cable, which is safely embedded in a potting compound. The complex, three-

dimensional structure of the housing makes high demands on precision and process consistency during injection molding. "Even the tiniest dimensional deviations or incompletely injected areas cause the potting compound to leak out", explains Andreas Spitznagel, who manages the Process Technology Group for P&G in Marktheidenfeld. "In the past, we frequently experienced warpage due to uneven temperature control. But what exactly was causing the fault was difficult to determine because there was simply too little information."

In order to efficiently produce large quantities, the stack mold has a total of 32 cavities in two parting surfaces. Since the polymer melt is routed through the first parting surface to the second, a lot of heat is generated on the center mold plate. Ten temperature control units, eight small ones on the operator side and two large ones on the rear side of the machine – this was the status quo with the old plant.

In collaboration with ENGEL, a new production cell was planned and the mold design was optimized for the use of e-flomo. All 56 connections are now arranged on one side of the mold, which improves the overview, speeds up mold set-up and shortens the pipes. There are nine e-flomos near the mold, on the edge of the mold mounting platens, on the tie-bar-less victory 300 injection molding machine. Each e-flomo supplies several temperature control circuits.

From deposits in the temperature control lines and air bubbles to fluctuations in the pump performance, there are many different factors that can disrupt the temperature control process. If such an event occurs on the new systems, e-flomo detects the irregularity and automatically compensates for it. All 56 circuits are adjusted at the same time. "Reproducibility has increased enormously", reports Andres Franz. "The blindfolds have gone and we have a genuinely transparent process now."

The reliability benefits also open up massive potential savings, not least because confidence in temperature control has increased. For example, the new production cell was planned from the outset with just three temperature control units – instead of the ten used before. Each mold plate now has its own temperature control unit, and all three units fit under the clamping unit of the victory machine, thus saving space. The initial temperature of all three units is currently set to 55 °C. Initially, three quarters of the 200 l/min flow rate available on each device was still used, but it has been possible to reduce the flow rate to 40 l/min in the course of system validation. "This is significantly less than we expected", says Rieb. "At the start of the project, it was not clear to us that we could save so much in addition to the in-

creased transparency and reliability." Fewer temperature control units and smaller flow rates means lower investment costs, compact systems and, above all, significant savings in energy consumption.

Even temperature control of long finger cores

In the meantime, the temperature control overhead has also been reduced in a second production cell, while at the same time increasing reproducibility. Again, it features a tie-bar-less victory 300 injection molding machine, on which two products for the replacement toothbrush heads are manufactured: On the one hand, profile rings made of POM in a 64-cavity mold and, on the other, tube sections – also made from POM – in a 32-cavity mold. The flow temperature is 90 °C in each case. Again, high dimensional accuracy is important to ensure the functional capability of the toothbrushes. "Temperature control of the long finger cores forming the tube sections is critical, above all", explains Carmen Stollberger. "If the cores are too hot, distortion can occur. In general, the circuits close to the cavity have a greater influence on the product quality than those further inside the mold." Carmen Stollberger knows the system and all its temperature control pitfalls like no other. She joined P&G in 2015 as a student and wrote her bachelor thesis on the optimization of the temperature control process in tube section production. Today, she is permanently employed by P&G as a process engineer and a member of the Temperature Control Technology Team.

Where the system plant was operated with seven temperature control units plus two pressure boosting units before the start of the project, there are now only five temperature control units without additional pressure boosting for the same amount of heat. "If everything is functioning optimally and is well monitored, you can venture closer to the limits without needing a safety buffer", says Stollberger. Theoretically, even fewer temperature control units would be sufficient for this application, but another aspect is important here. The project team has divided the mold into five temperature control ranges, some of which are set to different supply temperatures.

Checking the processes and not the products

The temperature control experts from P&G pass on their experiences and expertise to different departments within the corporate group. "If no one knows what the new technologies can do and how to use them in the best possible way, they are of little use", says Spitznagel. "For example, we are currently training a process engineer from Hungary." In new projects, we leverage all options to optimize the temperature control process in Marktheidenfeld. "Our goal is to successively retrofit the legacy systems", says Christian Rieb.

After the great success with e-flomo, P&G is taking the next step and using iQ flow control to integrate temperature control into the machine control unit. This mainly promises two advantages. On the one hand, the software continuously adapts the rotational speed of the pumps in the temperature control units to the demand in the on-going process, thus further boosting energy efficiency. On the other, integration further improves clarity. On the CC300 control unit of the injection molding machine, the actual values for all temperature control circuits are shown in a complete overview. Changes or malfunctions can be detected at a glance.

In collaboration with temperature control unit manufacturer, HB-Therm from Switzerland, ENGEL has developed its own temperature control unit series known as e-temp for integrating temperature control units into the CC300 control unit. The first set of e-temp units is currently being commissioned at P&G.

For the connection between e-temp and the CC300, ENGEL relies on OPC UA (the Open Platform Communication Unified Architecture). The communication model is becoming increasingly popular in the plastics industry for networking injection molding machines, peripherals, sensors and applications and is an important component of the inject 4.0 platform by ENGEL. Thanks to inject 4.0, ENGEL is helping clients pave the way to the smart factory, with continuously self-optimizing production processes. Smart assistance systems such as iQ flow control play a key role here.

"We are working on the assumption that we will no longer test the parts in the future, but just the processes", says Andreas Spitznagel. "This is our goal: stable processes that we can rely on one hundred percent."

The stack mold for manufacturing the NGC charger housings has 56 heating-cooling channels, which can be dynamically controlled using e-flomo. The difference between the media temperature in the flow and return lines of a temperature control channel is a measure of the uniformity of the temperature distribution in the mold and thus an important quality parameter.

As a safety-relevant component, the housing of the NGC charger places the highest demands on dimensional stability.

A tie-bar-less victory injection molding machine with an integrated viper 60 dual robot forms the heart of the production cell.

The robot transfers the housing parts from the mold directly to the quality control system, which is located on the rear of the injection molding machine.


Immediately after the injection molding process, the housing parts are forwarded to the in-house assembly shop.

Profile rings and tube sections for replacement toothbrush heads: The finger cores required for the tube sections require constant temperature control to avoid warpage in the components.

Jointly identifying further quality and efficiency potentials: Andreas Spitznagel, Carmen Stollberger, Christian Rieb from P&G, Klaus Tänzler from ENGEL AUSTRIA, Andreas Franz from P&G, Falk Boost from ENGEL Germany, Johannes Baunach and Mario Aulbach from P&G. (from left-to-right)

Pictures: ENGEL