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Sensors stop cost spiral

Cavity pressure measurement eliminates short shots at Fischer GmbH & Co KG of Sinsheim/Germany

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QUALITY MOLDING
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"Defective parts can cause a cost explosion," Erich Fischer says knowingly. As Head of Production at Fischer GmbH & Co KG with headquarters in Sinsheim/Germany, he has had decades of experience with the complex conditions encountered during the injection molding of technical components. For several years though, he has been relying on strategic cavity pressure monitoring with sensors and systems manufactured by Kistler Instrumente AG to ensure a reliable and complete reproduction of plug connectors and electronic housings for customers from the automotive and electrical industry.

Erich Fischer and shift supervisor Martin Weinzettel, industrial foreman for plastics and rubber technology, are convinced that there is no room for cutting corners when it comes to the quality of their injection molded parts, because they know that defects cause problems during component assembly or lead to complaints about the millions of parts supplied to OEMs and tier-1 suppliers

Fischer has identified incomplete filling of the cavity, so called short shots, as the main cause of bad-quality injection molded parts. The medium-sized family-run business has been closely monitoring all relevant machine parameters, all hot runner and mold temperatures for a long time.

Naturally, tolerance bands were set up for parameters, which triggered alarms when they were exceeded. Despite all these efforts, Fischer never managed to avoid the occurrence of incomplete molded parts or minor defects at the end of the flow path. It was this frustration of all his best efforts that drove Fischer to introduce an additional cavity pressure-based process monitoring system.

Since its introduction a few years ago, cavity pressure monitoring has been delivering reliable quality of all molded parts. Erich Fischer is satisfied: "When tolerances are narrow enough and the process has been run in properly, we get very good results". Martin Weinzettel adds: "Cavity pressure monitoring shows us exactly what is happening inside the mold."

Strategic operation of sensors and systems

Fischer is currently operating twenty process monitoring systems. More than one hundred molds are equipped with cavity pressure sensors. "Virtually all our new molds are equipped with sensors and we already retrofitted many of our older molds, too," Martin Weinzettel points out.

The company operates with CoMo Injection Type 2869 process monitoring systems for pressure profiles from four, eight or sixteen cavities. Most of these systems are equipped with multi-channel technology: Single-Wire cables run from the sensor to a multi-channel plug connector on the mold exterior. From there, a multi-channel cable connects to the process monitoring system. All CoMo Injection systems are configured as mobile units and can be changed from machine to machine, as required.

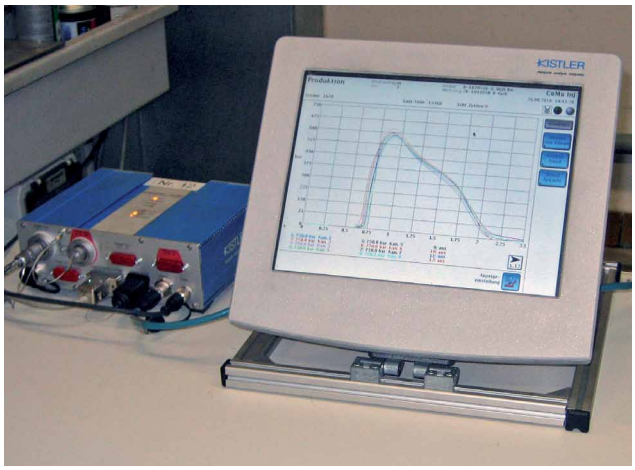
Most of Fischer's machines are fitted with the smallest Kistler pressure sensors Type 6183 with 1 mm front diameter, but some molds are monitored by a larger sensor Type 6182 with a diameter of 2.5 mm. The chrome-plated sensor front protects it from wear during processing polymers with high filler content and abrasive materials.

Cavity pressure measurement during active processes

For Fischer, quality monitoring is not the only benefit of cavity pressure measurement. Martin Weinzettel: "Cavity pressure monitoring is also useful for sampling new molds, for process start-ups and for process optimization. The pressure profile is a direct indicator of the smooth operation of distributors, tips and controllers. With cavity pressure measurement we can easily analyze our molds. Used in multi-cavity molds, cavity pressure measurement allows us to determine the correct hot runner balancing at a glance. Later, the cavity pressure profile helps us detect machine malfunction and wear, Martin Weinzettel reports. "During initial mold sampling, we measure and weigh the molded parts, test all critical quality characteristics and structural properties and record the results. Once the customer has approved the molded parts, injection molding experts will define evaluation elements for the cavity pressure profile in the process monitoring system."

Head of production Erich Fischer (left) and shift supervisor Martin Weinzettel rely on the mobility of the CoMo Injection process monitoring system

Determining the right pressure level is prerequisite to positive quality assessment by means of process monitoring systems. Pressure inside the mold must be higher than the predefined pressure minimum without exceeding the pressure maximum. This is done by means of thresholds. Once the pressure profile fails to reach the minimum or exceeds the maximum, CoMo Injection will report the part as NIO. For more complex quality assessments, Fischer uses boxes to analyze the cavity pressure. These boxes describe a defined pressure range during a specified period of time. The pressure profile must pass through these boxes in a certain sequence.



The monitor displays the cavity pressure profile of an 8-cavity mold
Photo by Kistler Instrumente AG

If the part falls short of requirements, the robot receives an NIO signal that causes it to remove the corresponding part to a reject box or to a grinder located beside the machine. In larger multi-cavity molds, NIO parts are separated and deposited either by cavity or by part. At Fischer's manufacturing facility, free-falling molded parts are rare because virtually all machines are equipped with removal robots. In these cases, the CoMo Injection will activate a reject gate to separate parts that are identified as products of defective NIO cycles.

Fischer mostly places the sensors at a distance from the gate because the focus lies on monitoring the mold filling process. "We are dealing with very short filling times and low wall-thickness levels. Hence, we do not place our sensors near the gate, which would assess the character of the entire pressure profile, but rather examine whether there is a minimum pressure at the end of the flow path, so as to ensure that the complete part has been molded," Erich Fischer explains his strategy. "Similarly, we know that excessive pressure indicates potential overpacking. Quick filling, quick crystallizing and quick cooling followed by demolding – that describes our cycle. With filling times of 0.25 seconds, there is no need to analyze the holding pressure phase, where nothing much changes any more for our range of molded parts. Particularly when we process high-speed material, there is not much time for analysis," he explains his experience with processing the new low-viscosity polymer grades, which are modified with nano particles.

Fischer also uses simulation programs for in-house developments and mold engineering: "Because of the fact that the calculated pressure profile deviates from the real pressure profile, the results of mold filling simulations cannot simply be transferred to the production situation," Erich Fischer explains. Nonetheless, simulation results help with production processes because it provides basic information that helps us find the best position of the pressure sensor: "Is the selected position effective? Is installation feasible? Is the selected sensor handling practical? Simulation gives us answers to these questions," Fischer knows.

Process monitoring of all-electric machines

Since 2005, Fischer has been investing exclusively in all-electric machines with clamping forces of between 500 and 1 500 kN. The company added eleven machines and now operates a total of sixty machines. At the end of 2010, another all-electric machine with a clamping force of 4 500 kN will be added to the facility. Investing in all-electric machines, the company made a great leap forward in terms of precision and constant production conditions. But despite the investment in all-electric machines, Fischer still attaches great importance to the reliable elimination of short shots. Erich Fischer: "Even all-electric machines require cavity pressure monitoring. Stable production does not mean that every single molded part is reproduced sufficiently".

Only a few of the sixty injection molding machines in Fischer's production facility work in continuous operation. Most machines are operating in three shifts with frequently changing products, which requires very quick production restarts after mold changes. Most machine models operated by Fischer are installed with several sets of identical equipment, identical control systems, identical automation systems and identical ancillary equipment, which allows smooth and easy mold changeovers. Normally, there are only minor deviations from one machine to the next. More significant deviations of machine and process parameters or non-compliance of the mold cavity pressure are noticed almost immediately and treated as indicators of machine's condition.

Insight into the balancing conditions of multi-cavity molds
Martin Weinzettel: "The pressure profile is a highly informative indicator of the mold's balancing conditions". With this experience in mind, both Fischer and Weinzettel have developed a keen interest in MultiFlow, Kistler's new, automatic hot-runner balancing system, which was developed as an optional module for the CoMo Injection unit. It synchronizes the filling behavior inside the cavities of multi-cavity molds by means of strategic control of the hot-runner tip temperatures. For Fischer, this concept would dispense with manual hot-runner balancing during set-up and regular rebalancing during serial production. For Fischer, temperature-based process monitoring or hot-runner balancing systems are out of the question. Erich Fischer: "Of course we also monitor the mold body temperature in order to detect inadmissible changes of the cavity wall temperatures. But inside the cavity, we exclusively rely on the pressure level to decide whether parts are defective or not."

Thanks to the introduction of cavity pressure monitoring, Fischer is safely protected from spiraling costs due to customer complaints about products. "In cases where machines, molds, hot-runners and materials are perfectly attuned, cavity pressure monitoring is a very useful tool for improving the quality of the products and eliminating reasons for customer complaints." Martin Weinzettel is convinced: "Ever since we implemented Kistler systems, we are shot of problem of short shots".

A Kistler CoMo Injection process monitoring system Type 2869 (on the right, beside the injection molding machine) monitors the production of plug connectors

Fischer uses cavity pressure monitoring for controlling the quality of its wide range of industrial components.

Fischer in profile

Over four decades, Fischer GmbH & Co KG has become established as a specialist for mold engineering and injection molding among customers from E+E, automotive, machine engineering and the optical industry. The medium-sized business with 180 employees supplies injection molded plug connectors, socket boards, housings for electric circuits and a wide range of technical components.

Founded in 1973 by Werner Fischer as a mold engineering company, the business quickly enhanced its portfolio to injection molding products and is now able to cater to all stages of the entire process chain at its own facility – from product development, mold making and injection molding right through to component assembly.

Fischer processes more than 3 000 tons of polymer material every year on sixty injection molding machines with clamping forces of between 500 and 10 000 kN. The main materials processed are reinforced polypropylene and classic engineering thermoplastics such as PA66 and PBT in mostly glass fiber-reinforced grades with a filler content of up to 50 %, but also more unusual materials such as poly-cyclohexylenedimethylene terephthalate (PCT).

www.fischerwzb.de

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