

Braun avoids rejects with iQ weight control

Turning to constant quality

Producing moulded parts of a consistently high quality shot by shot is the aim of every injection moulder. The iQ weight control process control put this objective within reach. Electric shaver manufacturer Braun used this to substantially boost production efficiency in the manufacturing of functional parts with extremely thin walls.

To be able to shave the top lip, chin and cheeks with the same precision, the razor head needs to be able to tilt flexibly. In the Braun Series 5 and 7 electric razors, the motor rotation is converted into linear motion by means of an oscillating bridge piece. With wall thicknesses between 0.3 and 1.5 mm and a flow path length of 4 cm, these oscillating bridges made of non-reinforced polyphenylsulphone (PPS) are some of the most challenging functional components that Procter & Gamble Manufacturing GmbH Braun injection moulds at the Walldürn plant in Germany.

The facility is a competence centre for high-precision functional components within the Procter & Gamble Group. It is quite common to see production tolerances in the magnitude of a few hundredths. Series 3, 5 and 7 electric razors, and the entire range of epilators are produced at Walldürn, where Braun combines injection moulding, assembly and packaging. "We need to demonstrate every day that we are capable of producing in a competitive way in a high wage level country like Germany," as Frank Breunig, the production planner at Walldürn emphasises. "Our challenge is thus to always stay one step ahead in technology."

Compensating for setpoint deviations in same shot

The processes are constantly reviewed. To continue improving product quality and efficiency, while at the same time reducing rejects and cycle times, Braun continually invests in new production equipment and innovative process technologies. For example, the injection moulder was among the first companies worldwide to deploy iQ weight control, the process

control system developed and patented by ENGEL AUSTRIA. The first tie-bar-less ENGEL e-victory injection moulding machine with iQ weight control was purchased in November 2012. With a clamping force of 1,600 kN, and a second injection unit, a machine with larger dimensions was deliberately chosen to be able to test the new software with a variety of products. "We achieved the best results with the oscillating bridges", says Jürgen Morschek, Group Leader Process Technology at Braun's Walldürn plant summing up the comprehensive range of tests. "With their thin walls and long flow paths, these components are predestined for iQ weight control."

On injection moulding machines with electric injection units, iQ weight control analyses the pressure profile at screw positions in real time during the injection process and compares the measured values with a reference cycle online. Based on this, the system computes a new set of process parameters which allow changes in the injected melt volume and material viscosity to be detected immediately. "If deviations from the setpoint occur, the system responds immediately and automatically readjusts – without affecting the cycle time – still within the same shot", as Falk Boost, a sales engineer at the ENGEL Deutschland Technologieforum Stuttgart explains. This means that the injection profile and the switchover point are individually optimised in each cycle, keeping the cavity fill constant when switching over to post injection pressure. "This helps to compensate for the effect of process fluctuations on product quality and reliably prevents rejects", says Boost.

Batch fluctuations add complexity to thin wall injection moulding

Braun uses a 4-cavity mould for producing oscillating bridge pieces. The injection point is at the centre, however, filling the cavity is anything but trivial due to the various deflections and changing wall thicknesses. And the PPS that needs to be processed adds more complexity. "This is actually an extrusion grade", says Morschek. "We tested many materials, but this was the only one that meets the strict mechanical requirements throughout the long service life of the razors."

There are two main reasons for rejects in manufacturing the oscillating bridge parts: firstly, parts with an incomplete fill, and secondly distortion that occurs if the shot volume is too high because the parts then block during take-off. Both would impair the functional elements' mechanical properties, and also lead to malfunctions on the fully-automated assembly line.

This has meant process optimisers shifting their focus to the oscillating bridges several times over the years. By changing from a machine with a hydraulic injection unit to an injection moulding machine with an electric injection unit, rejects were finally reduced to less than one percent. However, this success by no means makes time-consuming and expensive manual 100 percent checks superfluous.

"One major problem is fluctuations in raw material batches", as the Operating Department Manager, Peter Mechler, emphasises. "The tolerances guaranteed by the manufacturer are too big for thin wall applications." And other influencing factors have a far greater effect in thin wall injection, for example, minor variance in the dryness of the pellets, or the demoulding agent separating during plasticising.

Weight constancy improved by 85 percent

The data for determining the influence of iQ weight control on process consistency in the production of oscillating bridges were acquired and evaluated in the scope of various test series. They took place as part of a project performed by Süleyman Akseven from the Dual University of Baden-Württemberg DHBW in Mosbach. Under exactly the same conditions, the oscillating bridges were produced on the ENGEL e-victory injection moulding machine with and without iQ weight control. 30 shots were sampled in each case and each component was weighed with a precision of three decimal places. While the minimal shot weight in both cases was 5.196 g, there were major discrepancies in the maximum weight. Without iQ weight control, some parts weighed in at 5.216 g. With iQ weight control, the heaviest part weighed 5.199 g. Thanks to the software, weight fluctuations were reduced from 0.02 g to 0.003 g. This is equivalent to a weight constancy improvement of 85 %. All the parts were manually checked using a gauge. Assuming 0.1 % without iQ weight control, it was possible to reduce the rejects for this component to 0.047 %, less than half.

"The results of the test series are unambiguous and reproducible", says Frank Breunig. "We are now totally satisfied with a reject rate of 0.047 percent. Based on this, we have been able to reduce the quality control overhead, and thus improve the efficiency of the manufacturing process."

Leveraging further optimisation potential

For each component, Braun develops a separate tailor-made process and quality control solution. Interior mould pressure sensors and cameras are used, too. "iQ weight control is now another module in our process control strategy", says Breunig. "Our next objective is to combine the software with interior mould pressure sensing. This will offer us more optimisation potential for some products." The current version of iQ weight control is already equipped for this.

After successfully concluding the series of tests, Braun has now ordered another tailor-made single-component machine with iQ weight control for manufacturing the oscillating bridges. Additionally, two existing injection moulding machines are being retrofitted with the software.

"Innovativeness is the be-all and end-all in our business," says Frank Breunig. "We need the best strategies, processes and engineering, and the best suppliers to match. This is why we chose iQ Weight Control by ENGEL."

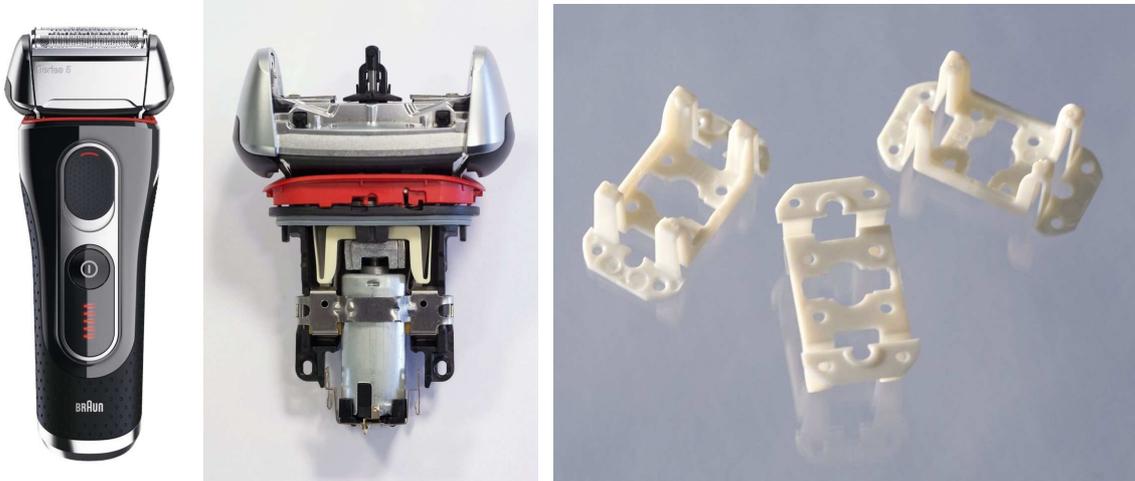
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Staying ahead through innovation

Gaining a competitive advantage with innovative technologies is a fixed part of Braun's enterprise vision. As an example, Braun in Walldürn was an early adopter of ENGEL's tie-bar-less technology.

"We have many mechanically complex moulds, which are relatively large compared to the shot weight we actually need. Tie-bar-less injection moulding machines are the perfect solution for this. Access for mould set-up is perfect, solenoids and all the supply connections can be placed exactly where they are needed. This means that we can set up the mould very quickly", says production planner Frank Breunig. "We know we can rely totally on the stability and platen parallelism."

Today, the ENGEL victory and ENGEL e-victory tie-bar-less injection moulding machines are the preferred machine models at Braun in Walldürn. Of the more than 70 injection moulding machines at the location, only some 15 have tie-bars.



The oscillating bridge is an important functional component in series 5 razors. It converts the motor's rotation into an oscillating action – the precondition for a smooth and thorough shave.



From left to right: Braun's Jürgen Morschek, Peter Mechler and Frank Breunig with Falk Boost from the ENGEL Deutschland Technologieforum Stuttgart.



The ENGEL e-victory 160 combi was where it all started. Now Braun is equipping more injection moulding machines with the iQ weight control software.



The PPS oscillating bridges pose major challenges for the injection moulding process. Without iQ weight control, some parts are not fully injected, or can distort during take-off.



At the ENGEL injection moulding machine's control panel, Jürgen Morschek (left) and Frank Breunig are monitoring online process control.

Photos: ENGEL, Razor product image: Braun