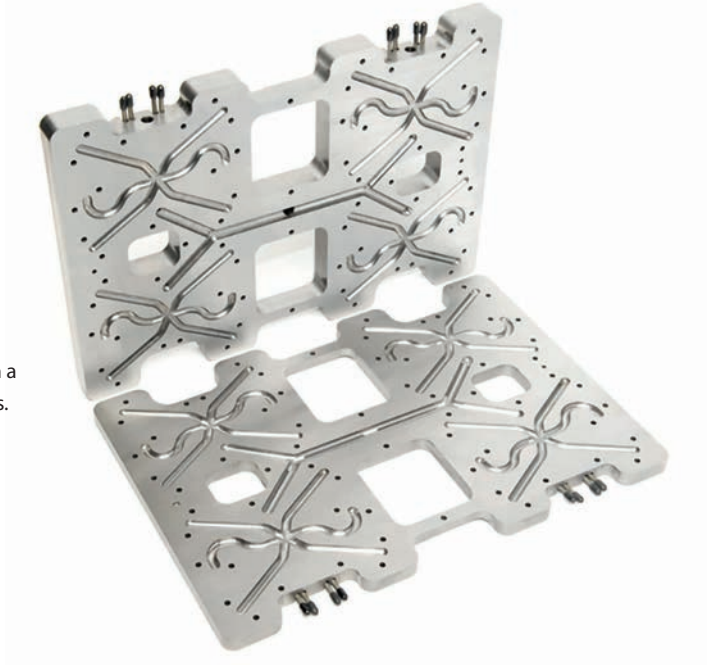
A Talk with Thomas Bechtel of the Hot-Runner Manufacturer Mold-Masters

Innovation Has No Endpoint

Hot-runner technology has a vital influence on the quality and efficiency of injection-molding production. During a visit to Mold-Masters, it becomes clear that development does not follow a straight line, and how solutions conceived for one practical problem can then qualify for other fields of application. Here, a concept that has been tried and tested for decades forms the basis of a number of innovations.



iFlow manifold in 24-cavity design. The two plates are brazed together in a multistage process.

The appointment in Baden-Baden, Germany, begins with an old acquaintance. But age is not a disadvantage, as we will show below with our visit to the European headquarters of the hot-runner manufacturer Mold-Masters – it is more the case that the sum of the experience in this case lays the basis for further innovations. The old acquaintance is iFlow hot-runner manifold technology. Thomas Bechtel (**Fig. 1**), Global Sales Director Packaging & Medical, will tell us how "a hot-runner manifold that we have been making for 30 years continues to drive high-performance results, particularly in the medical and packaging market segments," is preparing the ground for many high-end applications.

In conventional hot-runner manifolds, the runners are drilled into the tool steel. That is already well known. The problem is that, as from a particular size: "The deeper you drill, the more the drill deviates from the intended path. The resulting deviations and surface roughnesses are precisely what one wants to avoid in the melt flow," says Bechtel. In iFlow technology, the runners with rounded contours are milled into two steel plates and polished afterwards (**Title figure**). The two halves are then precisely and robustly joined together in a multistage brazing process. "The runners thus run precisely where they should, and in uniformly high quality," says Bechtel, explaining the advantage. In addition, the heaters, which are tapped into place in conventional systems, are embedded and then brazed into the iFlow manifolds, which considerably improves the heat transfer.

Due to the extensive freedom of design for determining the flow paths, the shearing of the melt streams can be reduced (**Fig. 2**) and the manifold can also be completely naturally balanced (using simulation). As Bechtel explains using a medical example, iFlow provides precise mold fill balance with an overall deviation as low as only 1.7 % for small, difficult-to-form parts. To put this into perspective, it corresponds to a downward or upward deviation of just 0.003 g in the production of syringe plungers of 0.35 g part weight each in a 32-cavity mold.

Melt Feed from Multiple Sides

The special iFlow manifold design is also used for the production of a variety of applications including blood collection tubes. "With a different technology, it would not be possible to achieve such high-pressure applications with a high flow-path/wall-thickness ratio in this quality on the injection molding machine," says Bechtel. However, he says that the key to the quality – i.e. the straightness – of such cylindrical parts with long thin cores is a solution that could reduce the deflection of the barrel by eliminating the core displacement. This is unavoidable in conventional injection molding, Mold-Masters incorporates their proprietary Symfill technology to overcome this limitation.

Bechtel shows the difference by placing two tubes on an inclined plane. While the tube injection molded with the hot runner using Symfill technology rolls straight downward, the one manufactured with a conventional hot runner runs off sideways, as a result of the non-circular rotations. The technology has already proven itself with components such as protective caps, sleeves and other similar parts from the medical and cosmetic industries and the stationery industry. "We now have numerous projects in use, with different shapes and materials, and we have achieved a significant reduction in core displacement in most cases," says Bechtel. In figures: with a 100 mm long blood collection tube, the core offset was 0.45 mm when conventionally manufactured, and only 0.12 mm with Symfill. The advantage is apparent during secondary processing, for

Fig. 1. Thomas Bechtel, Global Sales Director Packaging & Medical at Mold-Masters, explains the advantages of the iFlow manifold.

example by the fact that the concentric tubes in the labeling machine roll smoothly and the throughput and productivity were thereby increased.

"The two tubes were produced on the same machine, in the same mold and with the same material. The only thing that changed was the hot runner," stresses Bechtel. So how exactly? "In the conventional hot runner, the melt flows from one side into the nozzle runner. That means that there is a shadow at the other side of the valve, similar to taking a photo with a light source only from the front. That means that the melt does not flow symmetrically through the nozzle, but along the valve at different speeds," says Bechtel. As a result, the asymmetric filling of the cavity leads to non-uniform loading of the core, which bends to one side. The solution is that, "With our Symfill technology, the melt enters the nozzle runner from multiple sides, and the part is thus filled symmetrically."

When an Existing Solution Addresses New Problems

When asked for details, Bechtel becomes vague: "That is our protected IP. To stay in the picture, we work with multiple light sources, so to speak, so that there are no shadows. As a result of Symfill technology, the melt flows symmetrically through the gate hole into the part; the core is uniformly loaded and remains straight." The gate geometry remains precisely the same; it is even the same nozzle. Bechtel can only disclose so much: "The know-how lies completely in the manifold and in our iFlow manifold technology." This has succeeded in shifting the boundaries of parts with very long, thin cores. With other part geometries, such as shampoo closures, on the other hand, the core shifting is not a relevant problem even with a traditional hot runner.

What began as a specific solution for quality assurance in the production of blood tubes has since evolved. As shown by many examples of innovation from different industries, this presupposes a certain openness to the fact that the suitability of a technology for other application fields is often unpredictable at first. And Bechtel is thereby focusing on "sustainability, which is currently the main topic in our industry." For example, Symfill technology was the only way of achieving the end-customer's aggressive wall-thickness criteria in the production of vitamin-tablet tubes for a Swiss manufacturer.

While the aim of that application was to reduce material consumption, another application using Symfill technology allowed the successful use of post-consumer recyclate (PCR) in the production of cosmetic jars. "Simply by using Symfill here, and thereby completely eliminating the valve shadow, the process window became large enough to eliminate the previously uncontrollable burns, black spots and yellow streaks of the PCR, and ensure a constant high part quality," explains Bechtel. The examples showed how an existing solution could also address new problems. "That's why I believe we are still only scratching the surface and will certainly be able to increase the number of potential applications. If we know the advantages for various scenarios, I can imagine that Symfill technology will become standard in medicine or packaging at some point, because it provides a very high added value and is definitely a unique selling point."

Potentials at the Limits

As another advantage of iFlow technology, Bechtel cites the avoidance of cold runners even under challenging conditions. For example, with a traditional two-component cold-runner application (8+8-cavity mold with rotary table and 16 and 18 mg shot-weight per nozzle) with the aid of an iFlow manifold, the sprue waste could be eliminated and the cycle time thereby considerably reduced. The innovation is that "In view of the low part weight, we chose a runner cross-section of 2 mm to reduce the residence time – you cannot bore such a thing with current manufacturing technology using conventional gun-drilled manifolds."

If we turn our attention from the material to the machine, we can also discover considerable optimization potential in many cases, according to Bechtel: "Particularly in the beverage closure area, we found that machines often have free capacity. That means that only a very few machines, measured by plasticizing unit, tonnage and tie-bar spacing, are really fully utilized." Taken to its logical conclusion, this means: "The only reason why our industry thinks in terms of 48, 96 cavities, etc. is the natural balancing of the manifold. But we could add a few cavities to those," says Bechtel.

That is correct; in principle, this is the best way of producing. "But we are »

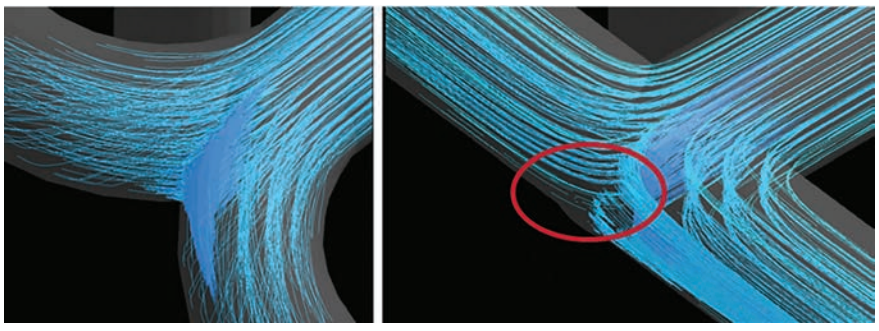


Fig. 2. The rounded contours permit better shear control. © Mold-Masters

Info

More information about the manufacturer:
www.moldmasters.com

talking about taking it to the limits here, and if you want to get the last two or three percent out of the machine, or the maximum that it can actually withstand, that is an option. With a very positive influence on the factors that are important for the end customer." In other words,

Fig. 3. The Apex gate seal is compatible with the Sprint hot-runner nozzle. © Mold-Masters

the part costs are reduced by the higher output – even if the initial investment is greater, for example, for 20 instead of 16 or 80 instead of 72 cavities. Bechtel continues, "For this type of geometry, to achieve a filling pattern that is as uniform as possible, you need an iFlow manifold. Our customers have confirmed that the part quality is not affected."

Improved Stress Cracking Resistance Pays Off ...

Regarding part quality, in this context, Bechtel talks about the new Apex gate seal, which can improve the Environmental Stress Cracking Resistance (ESCR) of closures for carbonated soft drinks (CSD) by up to 34 %. The ESCR term describes the pressure load at which a screw closure bursts. Such a scenario (e.g. when a soda bottle is left in a car under strong heat) is validated with the ESCR test, for which Mold-Masters works together with certified partners such as Dow and Pack Studios. Experience teaches that a crack always runs from the gating point in the center along one of the flow lines that are often (visibly or invisibly) arranged in a star configuration. As Bechtel says, "If we can produce a closure without flow lines, it will last longer by resisting higher internal pressures." And how does that work? The Apex gate seal manages the timing

Fig. 4. Cloudy appearance on a highly polished surface, as with this violet hinged lid closure, is a phenomenon caused by flow lines. After the changeover to Apex, the cloudy appearance was eliminated without process modification. © Mold-Masters

of the melt separation as it transitions into the gate at a different point than conventional gate seals. This gives the still-hot material time to re-crosslink while it continues to flow." There will still be flow lines but they are significantly minimized with the Apex gate seal.

This effect is reflected in the results of the ESCR test. MeltFlippers or other mixing elements in the gate system, on the other hand, are not practical, since the resulting pressure loss is an absolute no-go for closure producers.

But there is another motivation behind the closure solution. "If it was only a matter of making a tried-and-tested closure even better, hardly anyone would make the investment. But if you understand that, with this step, you can perhaps save a tenth of the material at the head plate, things looks different. Simply because material is the main cost factor in the closure range," explains Bechtel. Other advantages of the new Apex gate seal, which is only available with the Sprint hot-runner system: the Apex gate seal is interchangeable with the standard gate seal so the Sprint hot runner system can be upgraded without reworking the mold insert (**Fig. 3**). This in turn reduces maintenance costs because a wear part is eliminated with conventional gate tips which use insulation caps. Insulation caps, common on all brands of hot runner systems for caps and closures, must be replaced with every maintenance service at a unit price of about EUR 50. "That can mount up to 10,000 euros per year for every hot runner system", says Bechtel.

... Faster Color Exchange, too

In addition, Apex can considerably speed up color exchange and partly reduce the resulting rejects by up to half. Bechtel knows of a typical customer with a 48-cavity mold, for whom the difference amounts to 5 t of material waste per year. It is clear that this also results in lower production costs. "At first, the topic of Apex was purely intended for the field of CSD. But, in a similar way to blood tubes, there are continually new possibilities in customer discussions and trials," sums up Bechtel (**Figs. 4 and 5**).

Here, too, we can see two things: hot-runner innovations can improve the molded part quality of an application beyond the standard. And the first idea for a development can no longer necessarily be recognized in later profitable forms of use. ■

Dr. Clemens Doriat, editor

Fig. 5. Flow lines on the satin-finish screw cap of a "premium personal care" product (left). The use of the Apex gate has completely eliminated the flow lines (right). © Mold-Masters