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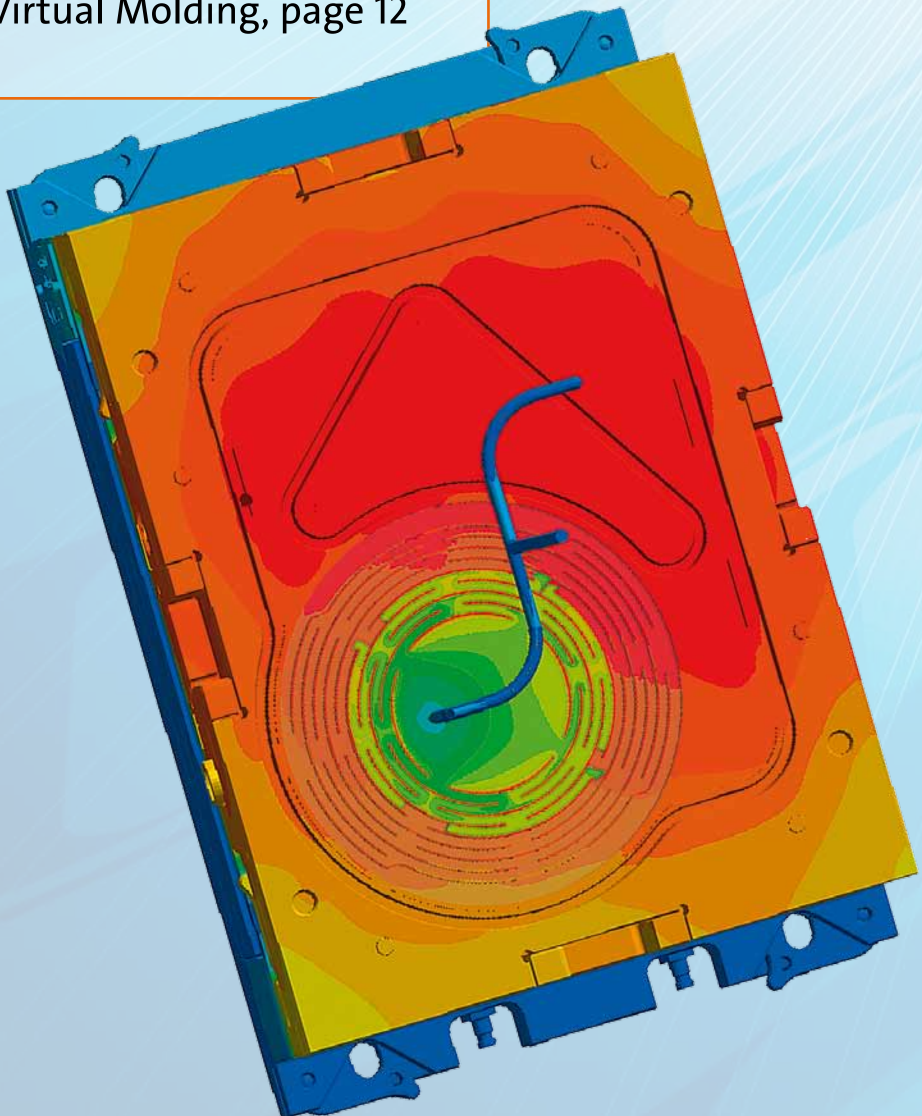
To Pass a Long Way

More transparent LSR Processes with Virtual Molding, page 12



To Pass a Long Way

More transparent LSR processes with Virtual Molding As LIM processes can be quite challenging a thorough understanding of not only the part, but of the whole mold and process are essential for molders to stay competitive. With the help of the Virtual Molding approach one can look into the process upfront and make secure decisions on material, mold and process.

"Ursula", a carry mesh for bottles, was named in reference to the Bond Girl Ursula Andress.

Quelle: CVA Silicone

Products out of Liquid Silicone Rubber (LSR) are steadily gaining popularity because of their good physiological properties and thermal stability. The demand is especially growing in the medical, baby care and design markets. However, the production of LSR products in Liquid Injection Molding (LIM) can be quite challenging.

Molders are faced with a range of error sources such as venting problems, flashing, a high reject rate or an optimized cold runner design. Additionally, LSR offers only a small process window to achieve good results because of its rheological properties and curing kinetics. To face these challenges and to find the optimal process window molders often seek assistance from simulation. While some questions regarding the optimization of the part and runner design can be answered with classical simulation, reliable predictions of achievable part quality and process stability are only possible with Sigmasoft Virtual Molding.

In classical simulation only the part and maybe the runner are taken into account under the assumption of a homogenous mold temperature and ideal boundary conditions (Figure 1, left). This makes it suitable for a first estimation but seldom delivers reliable more-in-depth results. The Virtual Molding approach not only takes all geometries and their material properties into account (Figure 1, right), but all process parameters as well. Thus, all interactions between the mold components and the material are considered. With

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ZUSAMMENFASSUNG

Mehr Transparenz im LSR-Prozess mit Simulation

LIM-Prozesse stellen die Verarbeiter vor einige Herausforderungen, deshalb ist ein tiefgehendes Verständnis von Bauteil, Werkzeug und Prozess unerlässlich, um konkurrenzfähig zu bleiben. Mit der Hilfe des Virtual Molding Ansatzes kann der Prozess vorab im Detail betrachtet werden. Entscheidungen hinsichtlich Material, Werkzeug und Prozess werden dadurch abgesichert. Das in diesem Produkt eingesetzte Silikon wurde von Momentive zur Verfügung gestellt. Der Designer-Artikel von CVA Silicone besteht aus Silopren LSR 2670. Die Herstellung erfolgte auf der Fakuma auf einer vollelektrischen e-mac 100 Spritzgießmaschine mit integriertem e-pic Handling von Engel. Die verschachtelte Geometrie des Formteils mit einem Volumen mehr als 70 cm³ erfordert sehr stabile Fließ- und Vernetzungs-Eigenschaften um einen verlässlichen Spritzgießprozess zu gewährleisten.

the calculation of not only several cycles but also of the heating-up of the mold the real process is reproduced at the computer. With this the molder can evaluate and optimize part, mold and process without expensive trial-and-error procedures and wasting resources at the machine.

Upfront evaluation

When the whole process and mold are taken into account, it becomes much easier to elaborately analyze the process and to find optimization potentials otherwise unnoted. The evaluation possibilities and optimization potentials presenting themselves with this approach are shown in more detail on the example of the design article "Ursula" – a carry mesh for bottles (Lead figure). The main characteristics of the carry mesh are a volume of 72 cm³ and its highly complex, interlaced geometry, which leads to a maximum flow length of 619 mm just inside the part (Figure 2). Additionally, the material has to pass a cold runner system of about 375 mm length. To ensure process capability stable rheological properties and curing kinetics as well as a sophisticated heating and cold runner design are essential.

As a first step the right material for production was to be determined. Two different LSR materials were at choice for the process. A first quick evaluation under the classical simulation approach with a homogenous mold temperature of 180 °C let to the assumption that both materials could be used equally for the task (Figure 3, top). However, a second calculation with the Virtual Molding approach showed this was not the case. When the heating up of the mold as well as 25 cycles to reach a thermal steady state were taken into account, one of the materials could not completely fill the cavity because of premature curing (Figure 3, bottom left). In contrast the second material still ensured a good filling behavior and part quality (Figure 3, bottom right) and was hence chosen for production.

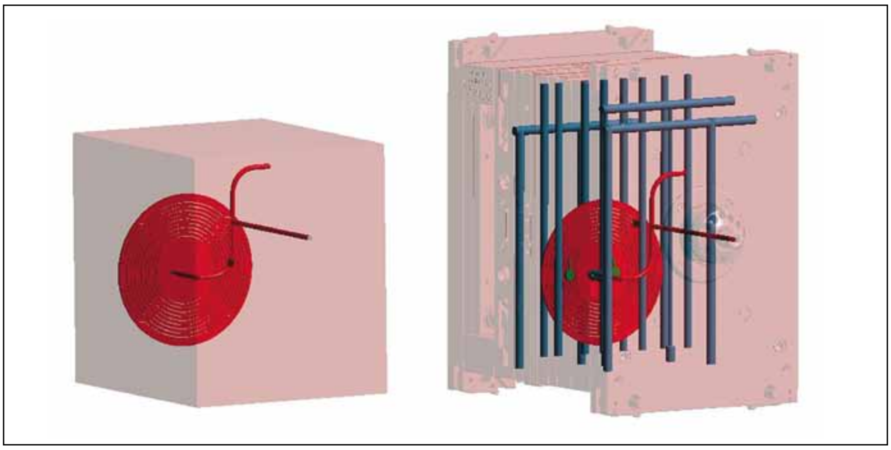

Figure 1: Simulation setup under the classical (left) and Virtual Molding approach (right).

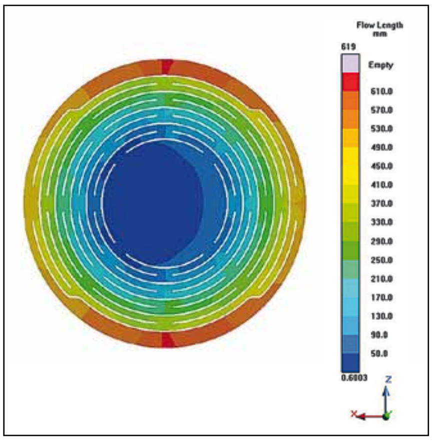

Figure 2: An interlaced geometry and a maximum flow length of 619 mm make the carry mesh challenging for production.

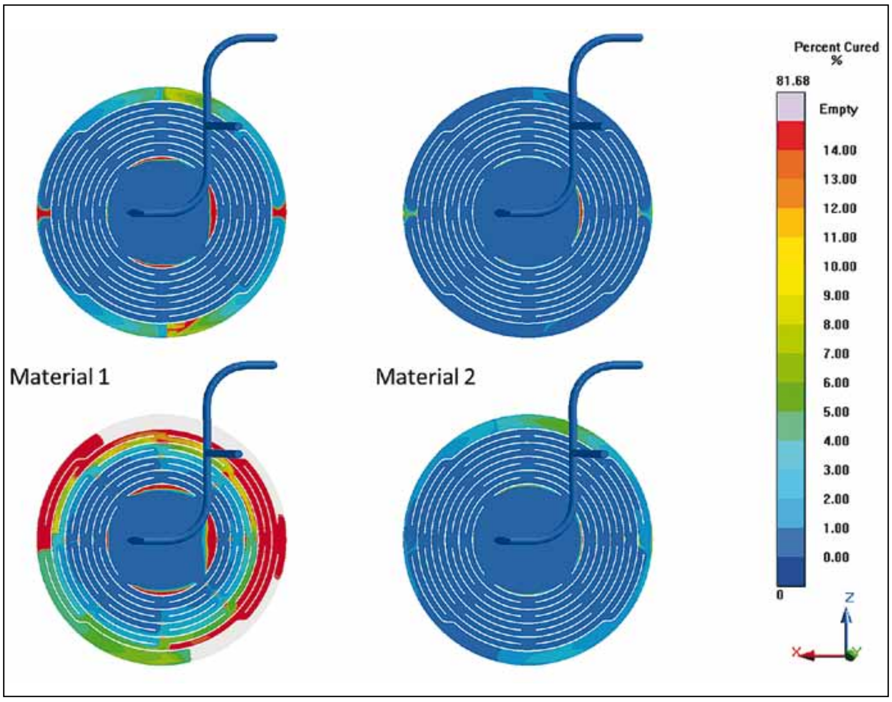

Figure 3: Evaluating the possibility to fill the part under the classical (top) and Virtual Molding approach (bottom) for materials one (left) and two (right).

SILICONE IN DETAIL

Versality and Reliability

The consistency and processability of Silopren LSR 2670 was presented via a designer article application from CVA Silicone at Fakuma. The demonstration was conducted on an electrical e-mac 100 injection molding machine with integrated e-pic handling supplied by Engel. The new servo-electric e-Flow 20 dosing pump of 2KM has the option to regulate the mixed material pressure. The intricate geometry of the part with a volume exceeding 70 cm³ needs highly precise flow and cure properties of the material to ensure a stabile injection molding process. This process has demonstrated that Momentive's Silopren LSR can be used for even most complex manufacturing challenges. The molded part, dubbed Ursula as a tribute to the James Bond girl, is a protective carrier for bottles and has received an award at the Biennale du Design Français.

To address software needs for precise material data in addition to the mold/coldrunner geometry and machine settings, Momentive has started to systematically populate the Sigmasoft database with a variety of standard and specialty LSRs. These database additions will be available with the next major update in November 2015.
"We are excited to demonstrate our LSR's processing reliability not only in reality but also virtually for the first time on the exact same part," said Oliver Franssen, Elastomers Global Marketing Director. "The demonstrations at Fakuma highlight Momentive's technology based approach along with our broad industry network and robust LSR product capabilities."

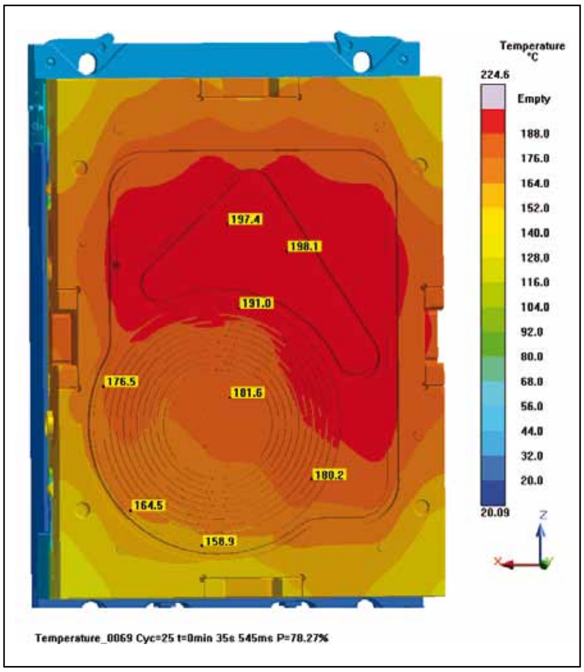

Figure 4: The moveable half shows temperature differences of more than 30 °C in the thermal steady state.

The reason for this varied outcomes is the temperature distribution inside the mold. While the classical approach assumes a homogenous temperature, the real mold shows quite high temperature variations. Taking a closer look on the moveable half after the thermal steady state is reached reveals that just inside the cavity the difference is already bigger than 30 °C (Figure 4). The hot areas at the top of the cavity cause the one material to fast reach a curing degree of over 20 % at the flow front. With an Alpha Gel at 10 % the material cannot flow any longer in this state. Whereas for the second, more stable material the curing degree also rises, but not to the extent leading to an impaired filling behavior.

The temperature distribution inside the cavity does not only influence the filling but also the curing of the carry mesh. During the further evaluation it becomes apparent that the curing reaction is first started at the top of the cavity (Figure 5, left) and then moves from the outside to the center of the part (Figure 5, middle and right). To receive a smoother curing behavior and more balanced filling the molder could try changes for the power settings or a different assembly of the heating cartridges. Both options can be safely eva-

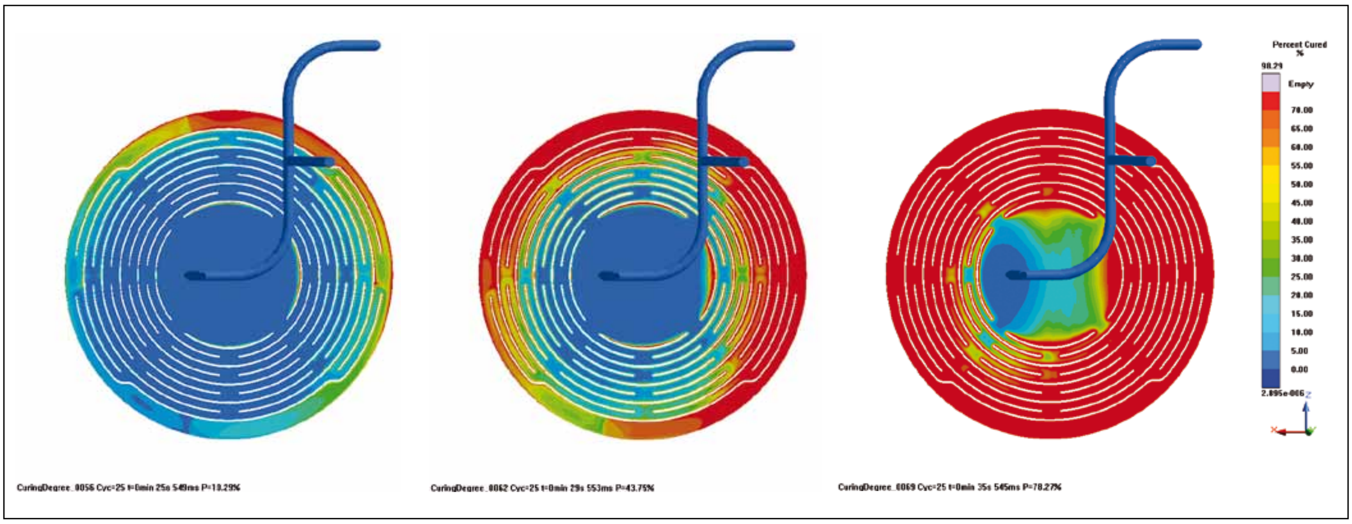

Figure 5: Curing degree at 25.5 s, 29.5 s and 35.5 s (from left to right) of the curing phase.

luated on the computer before making changes on the real mold.

Validation of the simulation

After the evaluation on the computer was done and when the production of "Ursula" started the congruence of the calculated results and reality was checked. For this purpose short shots (partial fillings) done during starting up the process should be compared to the simulated results during filling. As the carry mesh has a volume of 72 cm³ a short shot of every 10 cm³ was planned. These short shots were brought face to face with the corresponding results, when the same amount of material was inside the cavity.

Figure 6 shows the comparison for the short shots with 10 cm³, 40 cm³ and 60 cm³. Because of the slightly unsymmetrical filling, the results can be easily compared with the short shots, as the areas which are rushing ahead of others can be identified without problems. The pictures show that the simulation correlates closely with reality.

This validation proves the reliability of the Virtual Molding approach and shows it is a valuable tool for LSR molders to make sure their processes are not only delivering a good part quality, but also that they have a stable process in an optimal process window. With this knowledge they not only increase profitability and energy efficiency, but also become more confident to virtually test new ideas, as the outcome is known much faster and the trial is less risky. ■

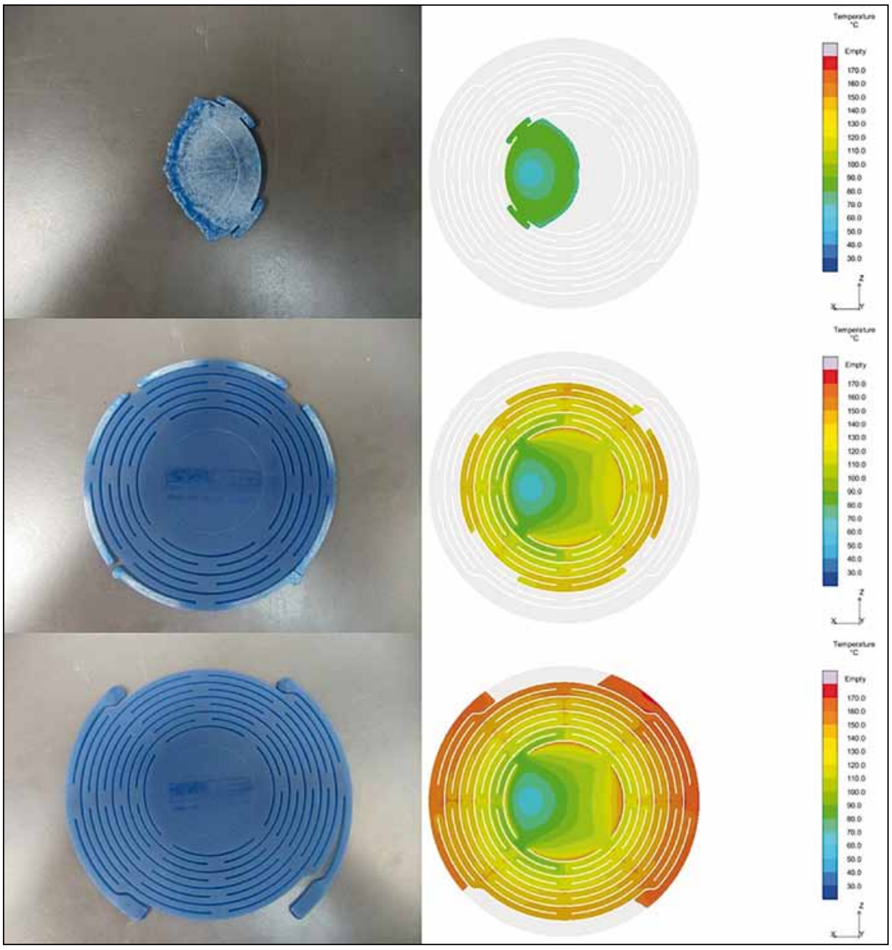

Figure 6: Comparison of short shots and simulation at 10 cm³, 40 cm³ and 60 cm³ (top to bottom).

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