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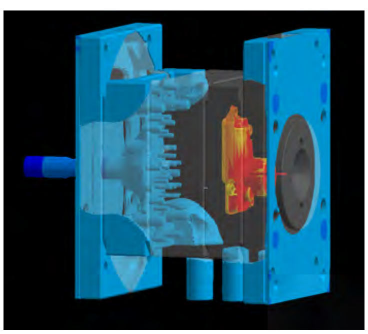
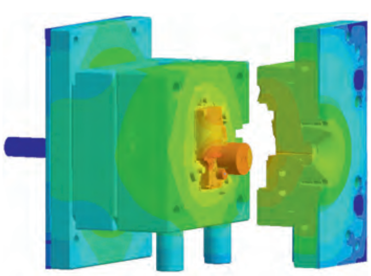
MODERN PLASTICS AND INJECTION MOLDING

Virtual injection molding part I : Simulation offers more than flow analysis

By Clare Goldsberry

For moldmakers who wish they could simulate the molding process without having to build a prototype mold first, Sigmasoft software, designed for 3D injection molding process simulation, may be the answer. Using a completely 3D-approach and the integration of a highly developed thermal solver, the injection molding simulation software allows the calculation of multiple consecutive production cycles, considering the thermal interactions throughout all the components in the mold. The accuracy of the entire simulation is thus dramatically increased.





Sigma Plastic Services (Schaumburg, IL) highlighted this product at the recent NPE, where it says it was well received. The 3D-approach of Sigmasoft allows all the components in a mold, including all the thermal and physical properties of each one of them, to be reproduced. Therefore, the heat transfer process can be calculated between each one of the components.

"In conventional injection molding software, a fixed mold temperature is defined, and the whole simulation is carried out under the assumption that this value remains constant over time," explained Marco Thornagel, executive director of Sigma Engineering.

"In reality, however, you have a very complex thermal process taking place within the mold: the steel is cooled with a tempering system, the mold is heated when the hot polymer melt enters the cavity and there is a loss of thermal energy towards the surrounding environment. All governed by the heat transfer properties of the materials present throughout the system: polymer melt, runner system, inserts, mold, isolation materials. Only when these complex interactions are considered, will the real production conditions be reproduced in the simulation. And our customers really appreciate that we already have 25 years of experience in how to make this kind of simulation, with a user friendly meshing algorithm," observed Thornagel.

To accurately simulate the production conditions, the heat transfer process taking place in reality must be exactly reproduced in the simulation. This includes the heat-up during the start-up of the machine, when the mold is heated from room temperature to its production conditions (typically between 60-120°C) by the tempering system. It also includes the warming up produced by the hot polymer melt over several consecutive pre-production cycles, as happens in actual run conditions.

What differentiates Sigmasoft from other material flow software analysis is Sigmasoft's ability to exactly reproduce processing conditions. The heat-up stage, as well as the thermal evolution of the mold over multiple consecutive production cycles. This accurate calculation predicts the real temperature in each location of the mold during production, producing a condition that more closely reflects reality for the polymer as it sets inside the cavity. This allows the software, for example, to predict how long the polymer remains in a fluid condition so that post-pressure can be applied, or where the thermally induced deformation will most likely compromise part quality.

At NPE, PlasticsToday sat down with Christof Heisser, president of Sigma Plastic Services Inc., who explained, "Because no other software program can really simulate the actual molding conditions, mold designers throw it over the wall and the molder has to deal with it. It becomes a matter of trial and error. Yet, you can actually simulate in the virtual world for accurate, real-world results. We create the part, the cooling lines, and material temperatures to simulate actual molding conditions."

Another advantage of multi-cycle simulation, said the company, is the ability to calculate how many production cycles are required for the mold to achieve cyclic equilibrium—and thus consistent quality conditions over a production run. Therefore, the number of parts required before the actual production begins can be more accurately predicted. The system can be optimized to minimize the number of pre-production parts that are required. Another benefit is the ability to compare the efficiency of different tempering systems to understand how to achieve equilibrium more quickly or how to consume less energy.

"Typically with other software programs, you can't simulate the mold from the process side," Heisser explains. "Usually these types of programs have only been used on the design side to make assumptions about the mold, but you can only look at the part because they are not capable of capturing the entire process.

"Even those programs that can come close can only simulate certain aspects of the process, not what happens in the real production world. We're the only one that can simulate every detail of the hot runner system, the needles, channels, etc. We go into that detail that is critical to every aspect of the molding process."

Heisser noted that the big issue for Sigma is that the minute someone says "simulation" they say moldmakers believe there is nothing applicable to them. "What we offer in Sigmasoft is virtual molding processing development," he stated. "We simulate every volume of all the different components and assign properties to each of the components."

Because Sigma comes from the metal casting world – it's a division of Magma Foundry Technolgies Inc. – Sigma has developed huge data bases of heat transfer data. Matt Proske, Applications Manager for Sigma Plastics Services, said, "We need to have temperature dependent physical properties of plastics and metal to know how it flows and solidifies. We spent 30 years measuring all these properties for metal properties at Magma, so if you leave the mold open and it gets too cold, you'll see that in the simulation.

"If you ask a molder how much a role mold temperature plays in the molding process, they'll say 'a lot.' If you don't know the mold temperature—the thermal gradient inside the mold, because the rate of heat transfer is driven by that temperature differential—if in a simulation you don't have the mold temperature—you have to calculate it, and you can't possibly get the right information," Proske added. "With Sigmasoft, you can go through the entire cycle—from mold close to mold open—and all the heat transfer is calculated. By the end of first cycle the mold has a temperature—a thermal gradient—and some heat is released from the material to the mold steel. During the second cycle, the steel starts out the same temperature as it had at the end of the first cycle."

Heisser said that while this requires a lot of calculations it's not a problem because that's what the computer does. The solid model of the parts that the tool shop has already is loaded into the program, along with the starting temperature of the cooling medium, the cycle time and the injection temperature of the plastic. "The molder doesn't have to sit there for days like in traditional simulation, and make or fix meshes," said Heisser. "Just press a button and the computer prepares the entire simulation. You just decide the same things you'd decide as if you were actually processing the part."

Certainly processing knowledge is needed but Heisser said this is a tool that can be put in the engineering department of a molder. "You don't need an analyst, you just need people who understand the process rather than people who know how to run simulation," he stressed. "Other tools need finite element meshing specialists. We made a simulation tool—a virtual mold/process development tool for engineers."