New Product

Simulation Eliminates Die Casting Scrap

A manufacturer of switches used in the aerospace industry was experiencing a high scrap rate due to porosity for one of its switch frames. The manufacturer invited Littler Diecast Corp., Albany, Ind., a potential new supplier, to quote the difficult part.

The 1.25 x 1 x 0.5-in. (3.175 x 2.54 x 1.27-cm) cast A380 aluminum switch frame consists of a flange and a perpendicularly-mounted post. A core pin forms a center hole in the post, which is threaded in a secondary operation. The walls of the post are thin after threading, so little porosity can be tolerated in this area. The part was originally gated with a single gate and runner down nearly the full length of the long side of the flange. When the original supplier produced the part, porosity was seen throughout the flange and the post. Porosity caused failed parts in the field.

To pinpoint the problem, Littler Diecast turned to Flow-3D computational fluid dynamic (CFD) simulation software from Flow Science, Santa Fe, N.M.

Littler Diecast chose Flow-3D because during trial stages, the program's results matched the short shots, as well as defects seen in x-ray inspections of the final parts. Engineer Mark Littler added that FLOW-3D can model the interaction of fluid with a moving solid object.

"Flow-3D makes it possible to simulate the entire injection cycle, including the core and sleeves," Littler said. "If the plunger has a bad motion profile in the sleeve, it can create waves that tumble over on themselves and generate entrained air in the metal before it even goes into the mold."

Littler imported a solid model of the switch frame into FLOW-3D to create a mesh for analysis, with injection, pressure and die temperature as boundary conditions. The simulation results showed the flow entering the gate, jetting to the far side of the flange and then backfilling the flange. The melt moved quickly to the top of the post and rebounded, trapping air pockets in the middle of the post. The simulation pinpointed the formation of air pockets and revealed that due to the thinness of the part and the extra distance traveled by the melt, the metal solidified before the part was filled.

"We saw there was a lot of metal splashing around in the cavity and realized that we needed to fill the part as evenly as possible and with the smallest possible amount of turbulence," Littler said. "Minimizing turbulence is important because turbulence causes bubbles to form in the molten metal and gives them a chance to solidify."

The simulation results also showed that the two overflows used in the original design were not large enough.

"With the original gating design, there

was so much turbulence inside the gate that a large amount of air and oxides were mixed into the melt," Littler said. "A much larger overflow volume than was actually present would have been needed to clear this out. Even then we could not be sure because some areas might have solidified before they reached the overflow."

Littler converted the filler simulation data into an animation and presented it to the OEM manufacturing and quality control managers.

"They all started laughing at the same time," Littler said. "They said, 'That's exactly what is happening to our part.' They were impressed that the simulation was able to nearly duplicate what they were seeing in the parts shipped by their previous supplier."

Littler then turned his attention to solving the problems highlighted by the simulation and came to a final design of three gates on one side of the part all aiming at the post to focus heat and minimize the microporosity in the threaded area. The approach angles of the gate were designed to prevent backflow in the post, and the size of the overflow was increased.

Simulation of the new design showed the metal flowed evenly into the part, eliminating backfilling and reducing turbulence in the gate. Backflow in the flange was reduced, allowing the hottest fluid to enter last. Trial parts were produced and tested using x-ray and break testing.

Break testing showed a consistent crystalline grain structure with no voids, demonstrating that the failure was due to exceeding the strength of the material and not a casting defect. An x-ray examination of the trial parts showed no visible porosity. Based on these results, the OEM gave Littler Diecast an order to produce the parts. The part is now in production with a scrap rate of almost zero. ***MC***

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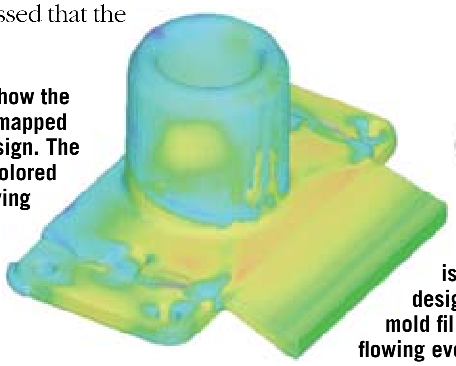
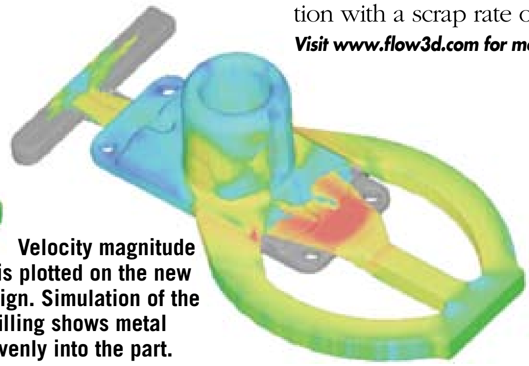


Simulation results show the velocity magnitude mapped onto the original design. The metal in the areas colored dark blue is not moving while metal in the areas colored red is moving the fastest. Voids are seen as streaks in the image.



Velocity magnitude is plotted on the new design. Simulation of the mold filling shows metal flowing evenly into the part.