Case Study

Simulation Aids in Impeller Redesign

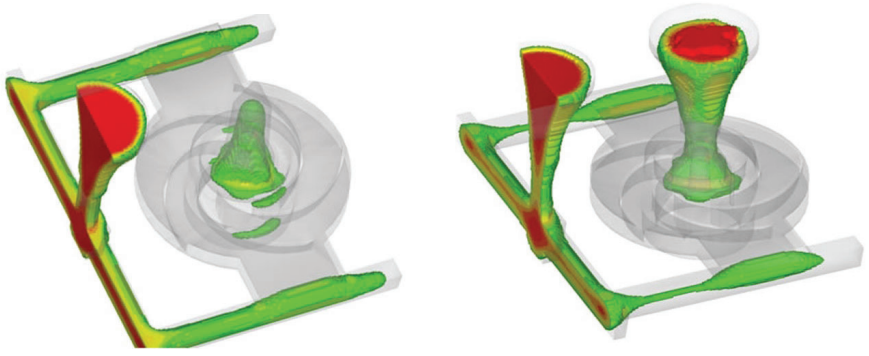
JWalter Miller Co., Lancaster, Pa., produces brass and bronze castings for the fire protection, pumping and valve industries. When the company converted from manual green sand molding to fully automated molding, many of the casting jobs required design changes.

Impellers represent a particular challenge because of the wide variation between the heavy and thin sections. The metalcaster was experiencing problems in the early transition from manual to automatic molding patterns, and the process was becoming costly.

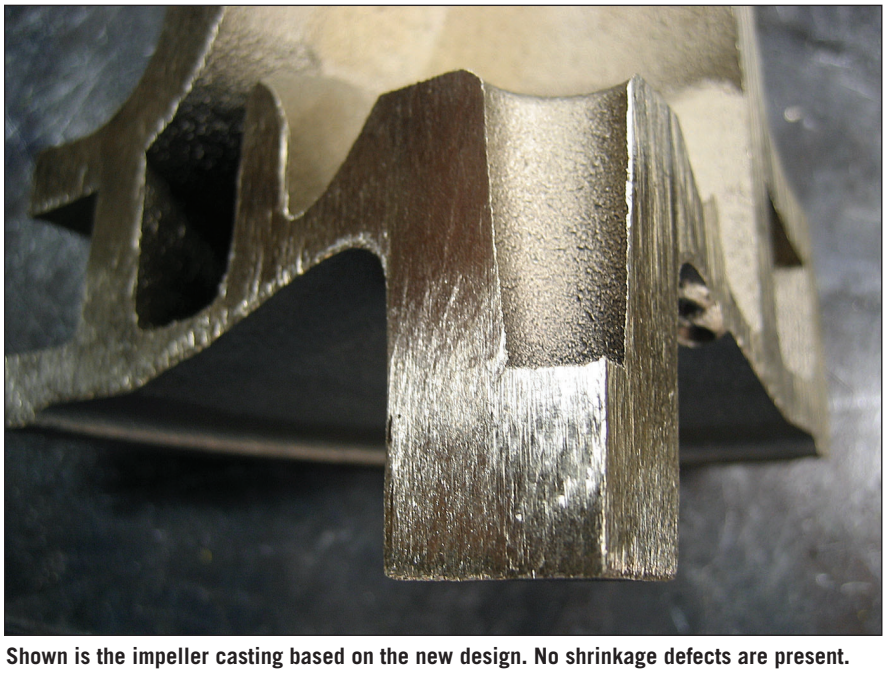
"This part was becoming a serious problem," said Dan Rudolph, quality engineer for J. Walter Miller. "We had spent about eight weeks and $5,000 trying to fix the problem and did not seem to be making progress."

The metalcasting facility turned to the QuikCast software from ESI Group, Bloomfield Hills, Mich., to perform solidification modeling.

One particular impeller was produced in a squeezer mold using an open riser fed by a large overhead mass of molten metal. This configuration was not possible with the automatic molding machine, which uses fixed riser or sprue locations with a maximum contact diameter of 1 in. The open riser was replaced by a 1-in. sprue, reducing the contact area. When the new configuration was tried on the automatic machine, the impeller castings exhibited voids in the hub caused by the contraction of metal. These voids were discovered when the parts were machined.



Prior to the use of Quikcast simulation, J. Walter Miller Co. used a closed riser and cored hub design, which produced a shrink pocket in the wear ring (left). Using solidification simulation, the metalcaster determined that a design incorporating a solid hub and open riser would eliminate the shrink pocket in the wear ring.



Shown is the impeller casting based on the new design. No shrinkage defects are present.

Prior to the use of QuikCast software, the metalcasters added a core in the hub to reduce the amount of liquid metal required to feed it during solidification. The open riser was replaced by a tall closed riser. After casting and boring, the hub of the impeller exhibited no defects, but a new shrink defect began to appear in the wear ring section, a heavy circular rib about an inch from the hub.

"By viewing the [QuikCast] simulation results, I was able to determine that the new shrink defect resulted because the hub section was now solidifying much more quickly," Rudolph said.

J. Walter Miller applied design changes to the CAD model of the casting that included removing the core in the hub to allow a feed path to the wear ring. Subsequent simulation showed the new design eliminated the shrink in the wear ring while the shrink porosity in the hub was confined to the center-most region that was removed during the machining process.

"This problem would have taken about 12 weeks and $6,000 in pattern changes plus countless hours of machine time to solve using conventional trial and error methods," Rudolph said. "With casting simulation, we can easily solve similar problems in two weeks and produce a good pattern the first time." ***MC***

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