Safety spool in zinc alloy

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ProCAST helps Umicore tune the manufacturing process of a thin-walled zinc safety spool

The Challenge

Thanks to ProCAST, Umicore tunes the manufacturing process of a thin-walled spool, made of zinc alloy.

The Story

"Using the foundry simulation software package ProCAST and based on various internal tests and studies made in the past, Umicore was able to propose to its customer a new solution made of zinc alloy (Zamak), which successfully met the required technical specifications at a very competitive price. ProCAST allowed us to validate the production tooling of this new component produced in more than one million pieces using high-pressure die casting."

Mr Didier Rollez, Head of Market development and R&D development

The Benefits

- *Validate the manufacturing tool of a foundry component and successfully move to production*
- *Investigate the feasibility of a difficult thin-walled component while ensuring in-service performance of the product*
- *Cost savings for tool development and production*
- *Allow decision-making early in the design phase*

The Company

Umicore is an international metals and material group. Its activities are centered on five business areas: Precious Metals Services, Precious Metals Products and Catalysts, Advanced Materials, Zinc and Copper. Each business area is divided into market-focused business units.

Umicore focuses on application areas where it knows its expertise in material science, chemistry and metallurgy can make a real difference, be it in products that are essential to everyday life or those at the cutting edge of exciting, new technological developments. Umicore's overriding goal of sustainable value creation is based on this ambition to develop, produce and recycle metals in a way that fulfills its mission: materials for a better life.

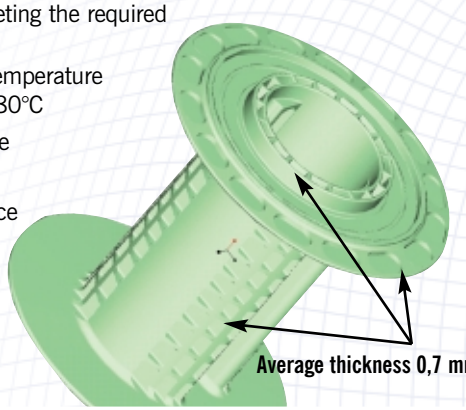
The Umicore Group has industrial operations on all continents and serves a global customer base: it generated a turnover of €4.7 billion in 2003 and currently employs some 11,500 people.

The Solution

Back in the seventies, the spool, a safety component integrated in the safety belt mechanism, was previously made of zinc weighing between 230 and 270g. Since the mid eighties, aluminum replaced zinc because of its lower weight. However with higher operating temperatures, the lifetime of the casting mold did not exceed 50,000 cycles and resulted in expensive post-machining operations and increased production costs.

From the initial design of the part's tooling based at that time on trial-and-error, Umicore successfully developed a new spool weighing less than 120g and meeting the required technical specifications:

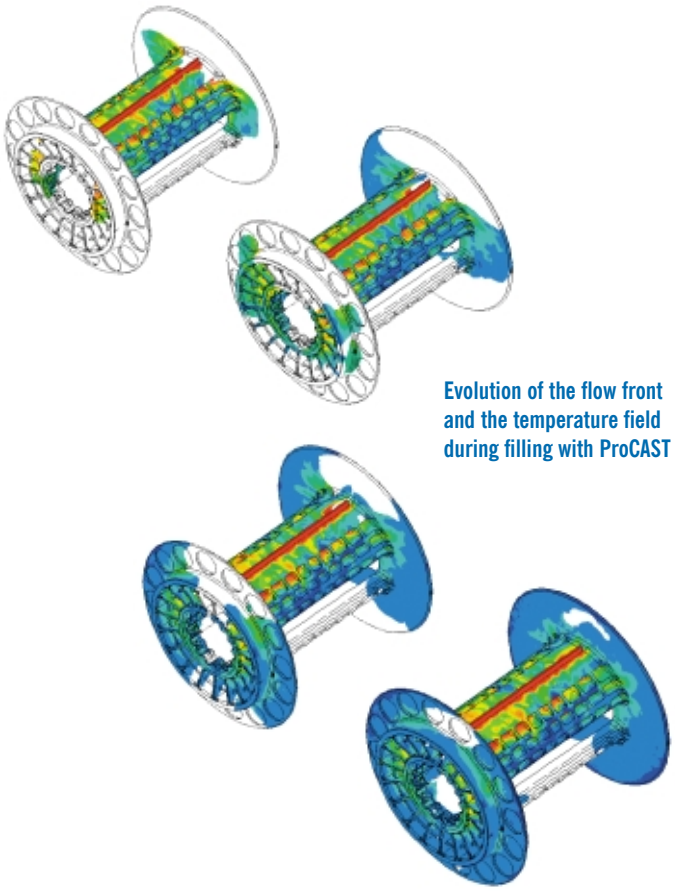
- Extended operating temperature range from -35°C to 80°C
- Minimum part lifetime of 12 years
- Crash test performance



Thin-walled spool

SUCCESS STORY

To successfully manufacture the part in high-pressure die casting, two major difficulties had to be addressed: significantly reduce the overall part thickness for weight reduction, and position spokes to guarantee in-service performance. To meet this challenge, various internal tests and studies were conducted but important decisions were also based on casting process simulation with the Finite Element casting process simulation solution, ProCAST. Umicore performed several simulations to optimize the mold design. With the help of ProCAST, the first initial prototype mold proved successful for mold filling; however, several additional modifications of the part geometry were necessary to satisfy in-service performance.



Evolution of the flow front and the temperature field during filling with ProCAST

Optimizing die design with ProCAST

The spool is a complex, non-symmetrical component including numerous small internal geometrical features with an average thickness not exceeding 0.7mm. To successfully develop the high-pressure die casting process, the following issues need to be addressed:

- define the optimal piston velocities,
- design the runner geometry for optimal mold filling,
- determine the position and thickness of the gates,
- prevent the risk of misruns,
- define the size and position of the overflows.

Based on simulation results and using an iterative process improvement approach, all of these issues were investigated with ProCAST. Gate and runners can be optimized so as to provide the most regular flow inside the mold. Misruns or incomplete filling, resulting from excessive alloy temperature drop, can easily be identified from predicted alloy temperatures during the filling phase. The progression of the metal front inside the cavity can be simulated and overflows can be dimensioned and positioned from the last filling areas to evacuate oxides appearing at the metal front caused by the contact of the alloy with air. Also, metal front junctions combined with temperature fields can be visualized so as to avoid weld lines inside the component, which often result in local defects with poor mechanical resistance.

Casting process simulation with ProCAST enabled Umicore to develop and optimize the manufacturing process of a new zinc spool with very thin walls and stringent technical requirements in terms of in-service performance. The part is now being produced, at a very competitive price, in different countries for production series of over one million units. Another significant competitive advantage of the new zinc spool is linked to the reduced operating temperatures. Because of the lower melting point of zinc, the die lifetime is 10 times longer than what was obtained with the aluminum spool.

About ESI Group

ESI Group is a pioneer and world leading provider of digital simulation software for prototyping and manufacturing processes that take into account the physics of materials. ESI Group has developed an entire suite of coherent, industry-oriented applications to realistically simulate a product's behavior during testing, to fine tune the manufacturing processes in synergy with the desired product performance, and to evaluate the environment's impact on product usage. ESI Group's product portfolio, which has been industrially validated and combined in multi-trade value chains, represents a unique collaborative, virtual engineering solution, known as the Virtual Try-Out Space (VTOS), enabling a continuous improvement on the virtual prototype. By drastically reducing costs and development lead times, VTOS solutions offer major competitive advantages by progressively eliminating the need for physical prototypes.

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