The global magazine for pump users and suppliers

COVER REPORT:
Using MAGMASOFT for the design and procurement of pump castings

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Evaluating Casting Design

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Pump Engineer spoke with Roy Stevenson, the Ferrous Applications Manager at MAGMA Foundry Technologies, Inc. about the benefits of using casting process simulation software for the design and procurement of common pump castings. Casting defects at the foundry level can equate to hidden costs for both manufacturers and end users of pumps and pump parts. A software such as MAGMASOFT®, however, not only reduces costs, but can also decrease lead times and casting defect-related failures.

Minimizing risk
To help illustrate the motivation behind using casting process simulation software to those who may not be familiar with the technology, Roy Stevenson of MAGMA Foundry Technologies, Inc. in Schaumburg, IL likes to use an analogy that compares the use of casting process simulation to how airline pilots in training make use of flight simulators. “A flight simulator helps minimize risk during the complex process of learning to fly an airplane. In the same manner, the metal casting process is also complex and risks are involved. For example, if a defect is created during the metal casting process, the foundry may have to scrap the product and start over again, which can dramatically increase lead times and costs for the foundry, the foundry’s customer, and the end user of the product containing the casting.”

“The annual MAGMASOFT User Group meeting is just one of the many educational opportunities offered by MAGMA Academy.
MAGMA’s objective

“We aim to continue to set the standard for casting process simulation technology by utilizing our casting and development competence to realize products that benefit the metal casting industry and those that use metal castings. This is not only because we are fascinated with the casting process, but because we still see a large potential in using simulation to make casting more productive, more reliable, and more profitable.”

A closer look at casting process simulation

For pump manufacturers and pump end users that want to reap the benefits of using casting simulation, the required inputs for the software include both the geometry and the process parameters used in the casting process. The geometry includes both the casting design being produced, as well as other features of the tooling that are used to create the casting. The casting and tooling geometry must be available as 3D computer-aided design (CAD) models that are loaded into the CAD interface of MAGMASOFT®. Once the casting and the mold that surrounds it have been properly arranged in the software, material properties can be assigned to the casting and mold by selecting those materials from a database of commonly used materials. The software then allows for process parameters to be considered, such as the pouring temperature or the pouring rate used in the casting process.

With the geometry and materials all set up, the software begins the calculations as the mold cavity begins to fill, and then solidifies. The calculations include all of the thermodynamics and fluid dynamics that occur. “The casting process is extremely complex and simulation provides valuable insight,” says Stevenson. This understanding begins for the simulation user after all of the calculations have completed and the analysis process has begun. Analyzing simulation results involves the viewing of various 3D images, such as predictions of porosity and microporosity, or voids in the solid structure of the casting that may have formed during solidification. During the analysis process, movies

Danger beneath the surface

Stevenson points out that in addition to the costs created by casting defects, unidentified defects created during the casting process can even be a safety concern if they get unintentionally passed onto pump manufacturers and end users. “Because most of these casting defects lie beneath the surface of the metal casting they can be extremely difficult to identify. There are different techniques to search for these subsurface defects, such as radiography (x-ray), ultrasonic testing, and pressure testing, but none of these methods are without their difficulties and limitations,” explains Stevenson. “For example, a pump casing could have a subsurface defect that is too small to show up using x-ray or ultrasonic testing and as a result this defect may get unknowingly passed on to the pump manufacturer and end user, only to later create a through-wall leaking scenario while in service. When such a casting fails in service, the costs and safety concerns can be huge and in some cases even catastrophic. This is one of the main reasons why both pump manufacturers and end users can benefit greatly from understanding casting process simulation technology, should insist that it is used on their products, and should be using it in the design of their own products.”

Erik Johnson at Northern Stainless Corporation using MAGMASOFT on a pump casing design.
of the mold filling with metal and the solidification of the metal can be created. “This is where the real power of this technology can be seen. The closed mold on the shop floor that, in the past, was just a ‘black box’ surrounded by mystery and speculation, is now made transparent in the software so that everything that happens inside can be observed by the simulation user. By analyzing simulation results, potential problems can be identified and avoided, along with the costs associated with these problems.”

Not just for the foundry
While the application of casting process simulation is obvious at the foundry, it may come as a surprise to some in the pump industry that other OEMs have been utilizing this same technology in their design and procurement process for many years. MAGMA has OEM customers all over the world in the automotive, agricultural, construction equipment, and rail road industries that have acquired MAGMASOFT® and use it to analyze their casting designs to improve manufacturability. Often, this process involves working closely with the foundry while viewing simulation results. In some cases, very minor changes to a casting design could result in a geometry that is much easier to cast, and as a result it can be produced faster, with less costs, and at a higher quality level.

Educational services through MAGMA Academy
Even if a pump manufacturer is not ready to begin running their own MAGMASOFT® simulations, it can still be extremely beneficial to become educated on casting process simulation in order to work more closely with the foundries. By understanding the capabilities of the software, insisting that it is used, and checking to make sure it is used effectively, the pump manufacturer and end user can benefit greatly.

MAGMA Academy, which is MAGMA’s educational branch, offers classes on a wide array of topics. “We have classes and certifications that are aimed at the engineers and technicians that will be running the software, but we also have classes for people that may never run a simulation, such as those focused on metal casting defects, metallurgy, and the metal casting process”.

Classes touch on design principles that help designers improve casting designs for manufacturability. “We have seen numerous instances where large OEMs have benefited by educating their design and supplier quality engineers on the casting process and simulation. Understanding this complex manufacturing process is key to working effectively to ensure that castings are designed and sourced effectively.”

Committed to casting excellence
MAGMA doesn’t just encourage others to learn about the metal casting process, they are driven by the desire to learn. This thirst for knowledge and understanding has guided the company since it was first founded in Aachen, Germany in 1988. MAGMA’s motto is, ‘Committed to Casting Excellence’.

“We are motivated by a desire to understand the science involved in the metal casting process,” says Stevenson. “Since the very beginning, we have had
MAGMASOFT® case study: Northern Stainless Corporation

Northern Stainless Corporation is a stainless steel pump and valve shop located in the USA. At 44 employees strong, the Wisconsin-based company embraces the use of technology to improve quality and responsiveness to their varied customer base. Northern Stainless purchased MAGMASOFT® in 2013 to help reduce scrap, costs associated with repair welding, and lead times for first sample approvals. Foundry Engineer Erik Johnson of Northern Stainless reports, “The software has an amazing track record within the metal casting industry, and from our experience, the implementation of the software was smooth and the results were instant. We are now making cleaner castings quicker than ever. The side effect is more time and confidence to try new and different techniques for future projects with the help of MAGMASOFT®. All in all, it has been an extremely beneficial tool for Northern Stainless Corporation.”

Johnson concludes, “At Northern Stainless Corporation, we use MAGMASOFT® in the development process for all of our new products that go into the pump industry. Casting process simulation helps to ensure that our pump customers are getting castings that will meet their quality requirements and will perform in service as they have designed them to.”

Stevenson concludes, "Large pump companies source billions of dollars of metal castings each year and often face tough technical challenges in getting these components produced efficiently and to a desired quality level. Whether it is the pump manufacturer or the end user, there should be an awareness of casting process simulation technology, its capabilities, and its benefits. By learning about MAGMASOFT® and the metal casting process, the pump industry stands to benefit greatly.”

ABOUT THE COMPANY: MAGMA

MAGMA Worldwide:
- Aachen, Germany
- Shanghai, China
- São Paulo, Brazil
- Singapore, Malaysia
- Seoul, Korea
- Hyderabad, India
- Istanbul, Turkey
- Pardubice, Czech Republic

Website: www.magmasoft.com

a huge focus on the development of technology. We consistently work with university and industry partners around the world on research projects, which are then incorporated into the software.” This approach has allowed MAGMA to establish itself as an industry leader. Since the company was first founded, it has grown to employ over 200 people in nine offices across the world, including Germany, USA, Brazil, Singapore, Korea, China, India, Turkey, and the Czech Republic.

Ensuring success

Stevenson works out of the USA-based office in Schaumburg, Illinois, which handles all the sales and support of MAGMASOFT® in North America. “My main focuses are customer service and education, and making sure each of our customers clearly understand all the capabilities of the software, and are able to use it to its full potential,” he shares. “My colleagues and I work very closely with each of our customers to ensure that the benefits of this technology are being realized.”

New software technology on the market

MAGMA’s latest software, MAGMASOFT release version 5.3, is a prime example of the innovation that comes from endless research and development activities. Stevenson explains, “In release 5.3, we have incorporated a new technology called autonomous optimization. Traditionally, simulations are run using one set of geometries: one casting design, mold design, and one set of predefined process parameters.

Using this traditional approach, the operator sets up the one simulation, runs it, and analyzes it. If changes need to be made, the process has to be done all over again with a change to the geometry or to the process parameters. This may take many unsuccessful iterations before the desired results are achieved, which can be very time-consuming.

With autonomous optimization, the operator will “set up once, simulate many, and assess once”. Instead of setting up one static simulation, the user will set up an experiment where the software can run many simulations from one setup. The user can identify variables for the software to change. From this setup, the software will then schedule all simulations to be run, make changes without further input from the user, and evaluate how successful each simulation was at achieving a desired goal, such as improving quality or reducing production costs.

This may be beneficial when a designer that is designing a pump casing wants to test different wall thicknesses on a volute to see which thickness produces the least amount of casting defects. “Autonomous optimization allows the user to run hundreds of simulations from one set up and quickly identify which design option is best from a quality and cost standpoint using statistical tools that are built into the software.”

Erik Johnson of Northern Stainless Corporation and Roy Stevenson of MAGMA Foundry Technologies, Inc. with a couple of the many pump castings that Northern Stainless produces.