Quality management in casting

MANAGING THE QUALITY OF A FINAL CASTED PRODUCT IS AN ESPECIALLY COMPLEX PROCESS, SINCE IT INVOLVES SEVERAL SPECIALIZED ASPECTS OF PRODUCTION, MANY OF WHICH HAVE PHYSICAL LIMITATIONS. IN THIS ARTICLE, RAYMOND CORDEWENER, AN INDUSTRY CONSULTANT WITH CORDEWENER MANAGEMENT & CONSULTANCY, EXPLAINS THAT THERE IS MORE THAN ONE ROAD TO SUCCESS IN QUALITY MANAGEMENT.

By Raymond Cordewener

For casting, quality management it all starts with accurate chemical Analysis and Metallurgy, which ensures the quality of the product in all cross sections and, when applicable, the metallurgical background of the heat treatment process to ensure the final mechanical properties of the product. There should also be requirements for the weldability of the final product, but this is quite often neglected, since the responsible metallurgist faces enough challenges in ensuring the mechanical requirements. Quite a few castings are repaired by means of welding. In my opinion, weldability of the steel and the harm of multi-layer welding during repair of the product are underestimated. The metallurgical knowledge to improve the weldability of steel is limited worldwide.

Repair welding

In a period in which I was performing research and development for a forging company in Germany and managing their welding department, we had an order to build and test a swivel (see figure 1), for which the customer free-issued a casted duplex stainless steel inner housing. We needed to perform final machining on the swivel, combine it with our forged outer housing in the same duplex stainless steel, weld piping to the inner housing, and finally weld flanges to the outer housing. After pre-machining, we were confronted with a huge number of pores caused by gas or inclusions broken out by machining in the casted part, all of which required local repair welding. They were quite evenly distributed in circumference and concentrated close to mid-thickness. It made us aware of the risk for extra-welding operation, its influence on delivery time, and the quality differences between forged and casted products. According to the customer, this was still the cheaper solution. The risk for fatigue issues during the life-cycle were perhaps under-estimated in this approach.

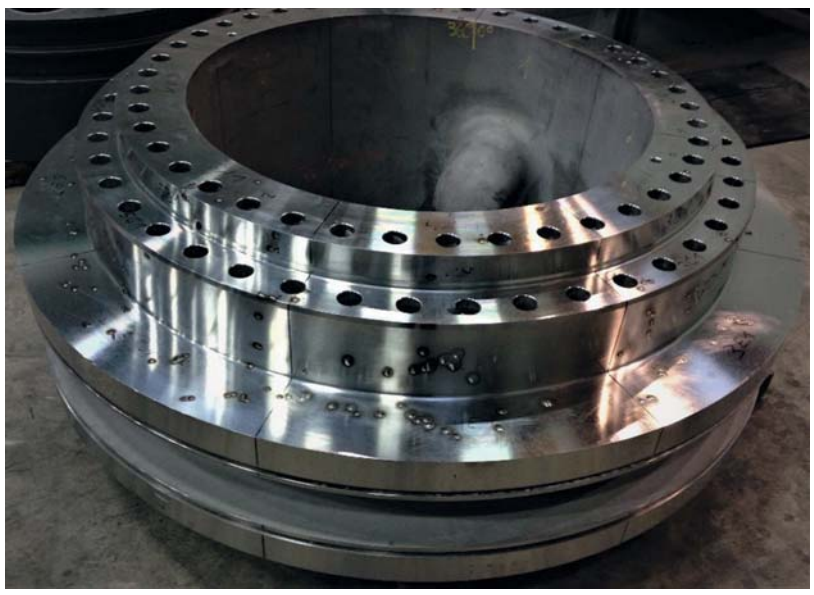

Figure 1 A casted duplex stainless steel inner housing of a swivel.

Pores and Fatigue Issues

It would be a great opportunity to have an open discussion in the near future to learn more about fatigue requirements specified in the casting industry and the actions that are being taken to improve castings. This discussion could be held at the Flow Control Exchange India conference this October and we could happily extend the discussion in order to include all types of steels. I have seen several

Rajkot: Investment Ca

Rajkot, located in the state of Gujarat become an integral part of India's casting began in the middle of the twentieth foundries in Agra. Rajkot's proximity to for new businesses to enter the market, opened in the city. These foundries supply and their high-quality output contributes ings produced by India every year. Today, in the world. Despite such a large market, continuously attracted both domestic and The success of Rajkot's foundries has trans growth in Rajkot has led to a dramatic tional and social opportunities. In 2006, city in the world. This status is set to last until gardless, Rajkot has solidified its place as a

sting Capital

some 700km northwest of Mumbai, has industry. The city's path to prosperity century after the widespread closure of foundry sand made it a prime location and since 1952, over 500 foundries have valve castings to a variety of sectors, to the almost 15 million tons of cast- India's casting industry is the third-largest extremely competitive pricing has international buyers to Rajkot. lated to success for Rajkot itself. Industrial increase in population, as well as in educa- Rajkot ranked as the 22nd fastest-growing 2020, when new rankings will be made. Re- major trade hub for the foreseeable future.

large products like wheels being changed and redesigned from casting into (closed die) forgings by our forge master. This could be one starting point for a discussion.

Analysis of defects

During the last Valve World Conference 2018, I had the honor of serving as chairman of the session "Castings and Forgings." I looked and listened to a fantastic presentation by Mr. Arun P. Sanjeev, from Mira Alloy Steels Private, India, who used statistical analysis to quantify errors and repairs to the type of products in their portfolio. In this way, he learned what type of products were profitable and which kind of products were not ideal for his company, based on their repair requirements. Measuring is knowing.

Simulation Technologies

During the same session at the Valve World Conference, I enjoyed a fantastic presentation by Dr. Ingo Hahn from MAGMA, "Simulation of the Casting Process." It was an integrated approach which visualized various criteria like: fluid flow, heat transfer, metallurgy, oxidation, turbulence, air entrapment, chemistry, phase changes, distortion, solidification, gasses, segregation, expansion and contraction, convection, and stresses. It also showed measured results like: cold tap properties, inclusions, porosity, distortion, microstructure, segregation, air entrapment, mold defects, cracks, core gas, heat treatment and under-riser defects. By using simulation technologies for forging processes and heat treatments, I personally have learned how valuable the technique is. I learned why and when products crack and what the relation is with residual 3D stresses. I also learned why 3D metallurgy exists and how important it is that the software be integrated in chemical composition, phases and all. Most important: I learned that software can assist you in understanding the complexity of the processes, making the pieces of the complex jig-saw puzzle fall into the right place. After some years it brings you, as MAGMA has called it, "From Simulation Autonomous Engineering." It indeed leads you to from process to part design. Another lesson for me was learning that physical limitations can not be beaten and sets boundaries. Of course, it is important to mention that these software packages have a price and the learning curve for them takes approximately 1 to 2 years. It is a big investment but a huge step forward.

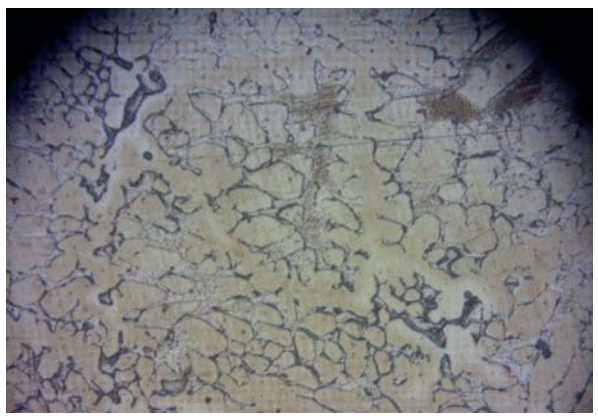

Figure 2 Duplex stainless steel after a poor heat-treatment.

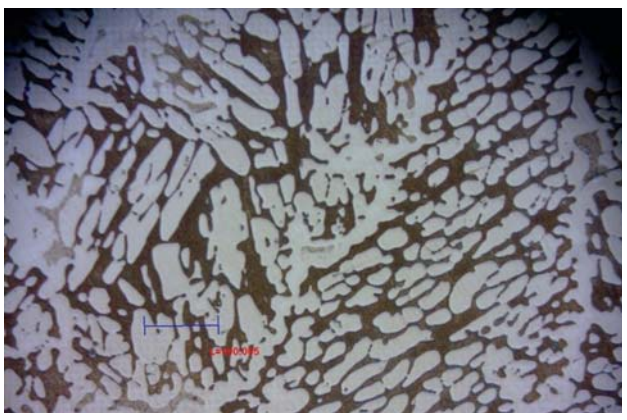

Figure 3 The material after corrected heat-treatment.

Heat treatment

Sometimes I get pictures like figure 2, with the question: can you explain what went wrong? This macro is from a casted duplex stainless steel. Yes, I did manage to analyze—together with the metallurgist—what went wrong, and after a new heat treatment the structure was improved to figure 3. There was still potential for further improvement. The product this time was heat treated at the correct temperature but still not quenched fast enough. But they met the contractual impact properties, so for them the problem was solved. The chemical analysis was also low on nitrogen. From this case I learned again that the metallurgist must be trained and must understand how to measure the correct core temperature. They also must understand that each chemical composition has a unique quenching temperature. Just quenching a product at a general quenching temperature you find in the literature is not enough. Also, the quenching tank should be big enough and the process for bringing a product from a furnace into the tank should be tested.