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Valve MAGAZINE

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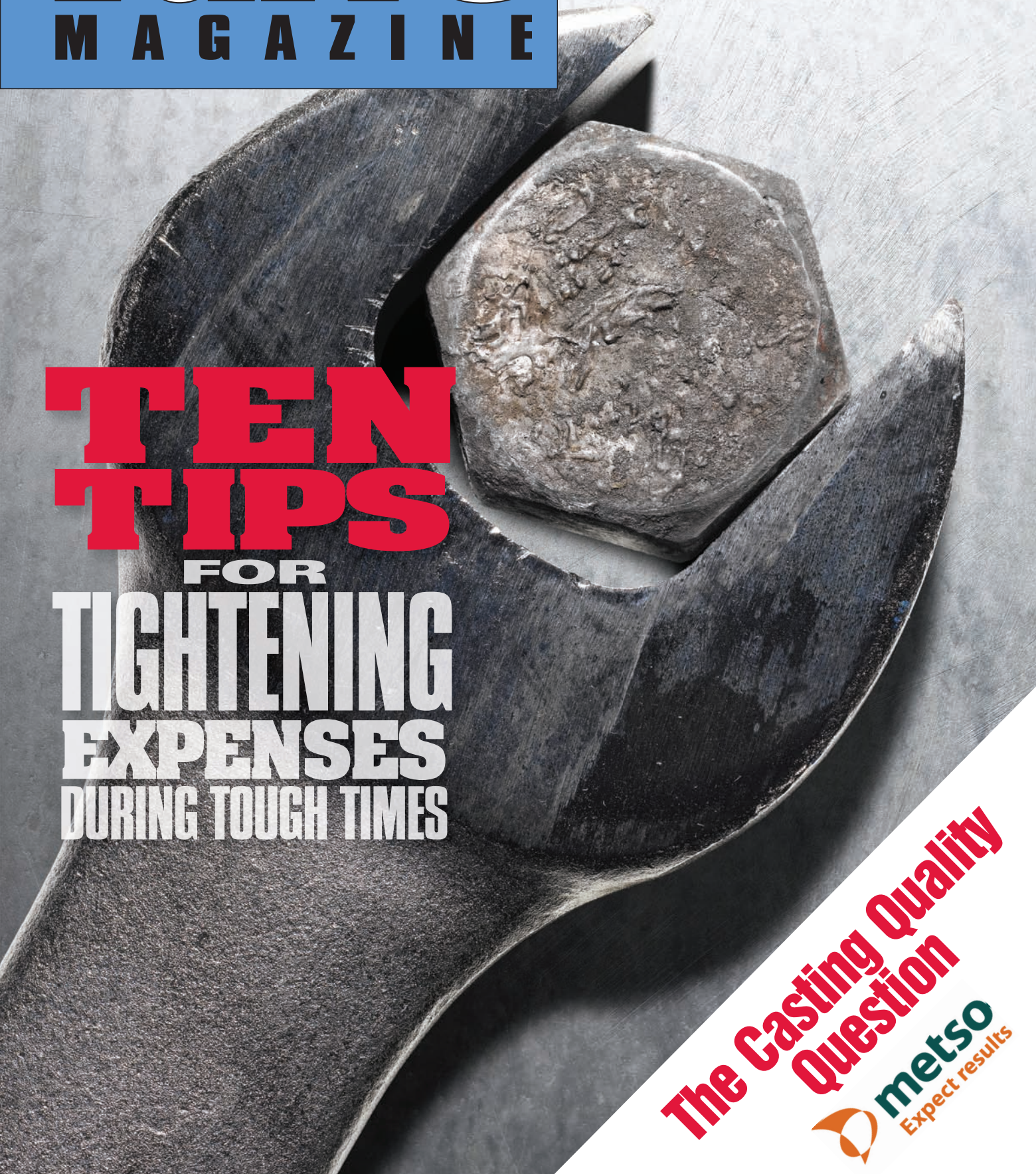
Steam's the Energy Fluid

Ultrasonic Emissions Testing

NACE MR0103 and Duplex Stainless Steels



TEN TIPS FOR TIGHTENING EXPENSES DURING TOUGH TIMES

HOW DO YOU ANSWER THE CASTING QUALITY QUESTION?

AS GLOBAL SOURCING OF MATERIAL BECOMES THE NORM, THE NEED FOR QUALITY BEYOND THE STANDARDS TAKES ON INCREASING IMPORTANCE. HOWEVER, WE CAN ONLY ENSURE CONSISTENTLY GOOD QUALITY BY GOING BEYOND CERTIFICATIONS AND STANDARDS TO IMPOSE TIGHTER LIMITS TO RANGES IN CHEMISTRY, MORE SPECIFIC REQUIREMENTS FOR TIME AND TEMPERATURE DURING HEAT TREATMENT, DIRECT FOUNDRY VISITS AND ROUTINE MATERIAL AUDITING.

BY LES PELKEY

Valve manufacturers frequently encounter the words, "No Chinese castings" in customer specifications. Why do end users insist on this restriction? Those who were able to attend the recent Valve World conference (held Nov. 4-6, 2008 in Maastricht, The Netherlands), where several sessions focused on end-user problems, can attest that material quality is clearly a problem. And the perception is that the problem exists because of where the castings are made. This article reveals prevalent types of casting defects and identifies the deficiencies that enable them to occur.

The valve manufacturing community bears a large part of the blame for end-users feeling that they need to restrict sources of supply. End users should not have to care about where castings are poured and they should not feel they need to impose this restriction.

PROOF OF QUALITY?

At the forefront of this issue is the fact that the quality of a casting cannot be attributed to the existence of a certificate claiming conformance to a standard. Too often we observe blind acceptance of certificates as verification of quality. But an ISO 9000 certification simply means the foundry has a quality management system for its processes. The certificate does not prove or verify technical competence. Material standards such as ASTM typically list sizeable ranges for chemistry, mechanical properties, and times and temperatures for heat treatment. However, many of the limits in material standards are minimums, and how often do you expect to meet all the requirements if you just meet the minimum? Should we really trust Certified Material Test Reports since these reports are generated from a test coupon—a sample that is not typically representative of the actual casting size?

Simply relying on the existence of certificates as proof of quality exposes the inexperienced to inevitable failure.

As global sourcing becomes the norm, the need for quality beyond the standards becomes increasingly important. But consistently good quality can only be obtained by going beyond certifications and standards to impose tighter limits to ranges in chemistry, more specific requirements for time and temperature during heat treatment, direct foundry visits and routine material auditing.

The following are a few examples of poor casting quality found at end-user facilities that damaged the reputation of the valve supplier:

Chemistry

The high cost of alloys drives foundries to raise residual elements to a maximum and minimize use of higher cost elements. Even though the material meets standards, it still may not be adequate for its purpose. High residual elements combined may act as an alloy with unknown effects. The surge in alloy costs over the last few years has caused some foundries to go below the limits of the standards and minimize the addition of costly key elements. You should question whether your stainless-steel castings contain the proper amounts of chrome and nickel. Do you believe they do because the

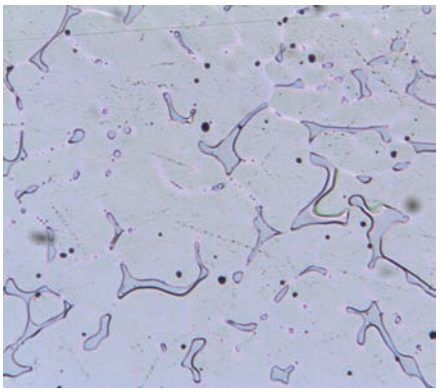


Figure 1

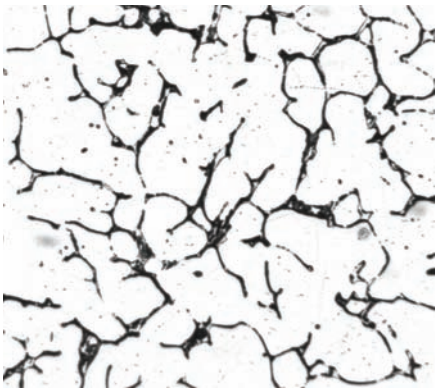


Figure 2

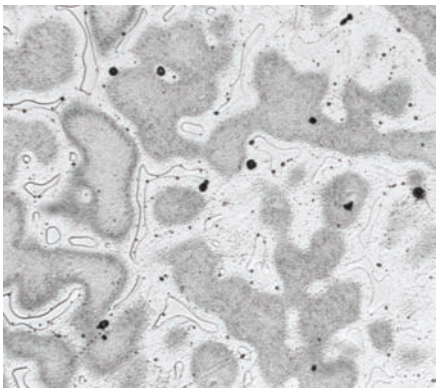


Figure 3

test reports say so, or have you confirmed the test reports are accurate and represent the actual casting that will be used?

Heat treatment

Recommended heat treatments may provide guidance for general corrosion resistance or certain mechanical properties, but they do not guarantee the highest quality. For example, proper solution annealing of cast austenitic stainless steel requires the correct chemistry holding at sufficient temperature and time followed by a rapid quench. If done properly, the resulting microstructure would appear as shown in *Figure 1, contrasting with Figures 2 and 3*, which do not exhibit the appropriate microstructure.

How often do you verify the quality of your cast austenitic stainless steel? *Figure 4* shows a CF8M valve body that was not quenched at an acceptable rate. Note the severe intergranular corrosion that occurred in just three weeks of service in nitric acid.

Repair welding: competence and procedure

It is impractical to expect 100% perfect castings every time; defects are inevitable. Repair of defects at foundries is commonplace, but it is often overlooked. I strongly recommend that you visit the weld repair room whenever visiting a foundry. Are the welders routinely qualified to any standard? Do they have weld procedures to control their processes? Do they follow those procedures? Is the equipment in good shape and appropriate for the types of repair being done? Are the filler metals the correct ones and are they stored properly? Are defects fully excavated before welding? This plenitude of questions, when left unanswered, puts you at high risk for low quality. *See Figure 5.*

Stainless-steel passivation

There are many ways for free iron to embed into the surface of stainless steel. In sand castings, reuse of sand previous-

Figure 4

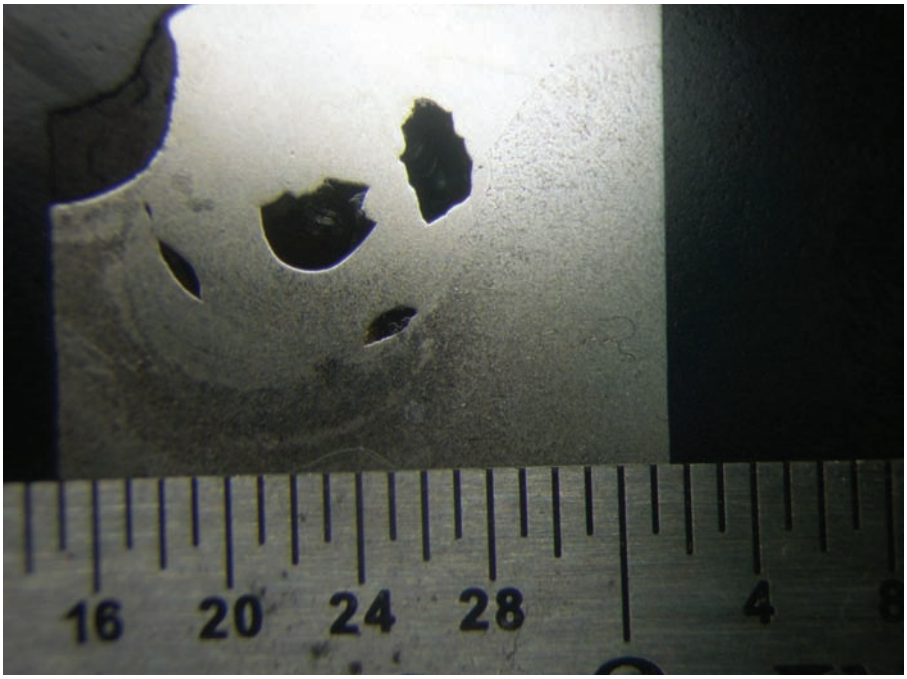


Figure 5

Figure 6

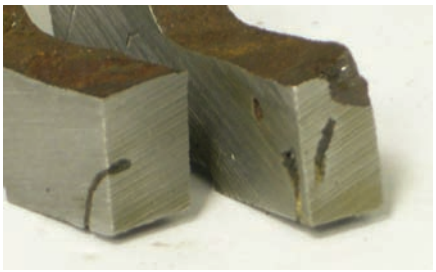


Figure 7

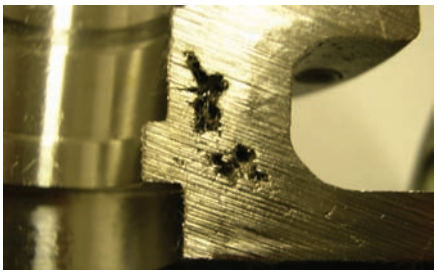


Figure 8

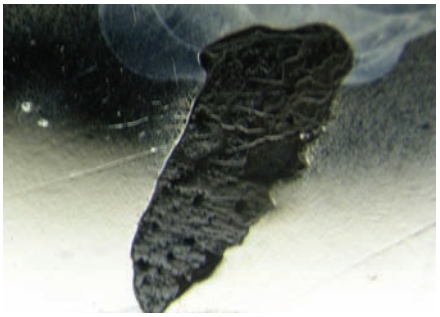


Figure 9

Figure 10

Figure 11

ly used for carbon steel, cleaning of stainless castings with carbon steel shot or carbon steel wire brushes are examples. If no steps are taken to check for and remove the free iron, your stainless steel casting can rust on the exterior. Passivation is one way to remove this free iron. *See Figure 6.*

Porosity and shrink

Porosity and shrink are both voids in the casting caused by inappropriate rigging or sloppy pouring of molten metal into the mold. When discovered, they can usually be eliminated by improving the process. The problem is: how do you discover them? Radiography can determine the existence of such defects but it has its limitations and is too costly to invoke for every casting. Very small porosity may not be visible in a radiograph and may not leak through the wall during a short duration shell test with water. However, it will leak through the wall when tested with gas. What steps do you take to limit your risk of porosity? *See Figures 7 and 8.*

Pattern cleanliness

Any debris within the ladle, mold or shell can become entrained within the molten metal as it fills the cavity. When visiting a foundry, watch to see how personnel clean the molds and equipment handling of the molten metal. But even if an effective process is in place, will the mold remain clean until it is used? Figure 9 shows an investment casting where a piece of the shell nearly projects through the wall of the casting. While difficult to discern from the picture, a foundry weld repair was done over the top of this defect. This illustration further stresses the points on weld repair.

Heat treatment furnace loading

Here are two easy steps for checking heat treatment if you periodically visit the foundry: Before castings are placed in the oven, are they neatly stacked so they receive uniform heating throughout the lot? Are test coupons placed so they represent all of what is heat treated or are they at the edge of the load, far away from the castings? *See Figures 10 and 11.*

WORDS OF CAUTION

I have a large collection of pictures depicting casting defects and failures accumulated over many years. The images shown here are only a few of the common problems that can occur—there are many more potential problems with equally damaging results. Pictures used in this article represent products from several companies and were selected to avoid identification of any particular manufacturer or foundry. However, a few casting failures this year in Europe were openly broadcast through a notified body in the European Union. The claim was that the castings violated the Pressure Equipment Directive, and the specific valve manufacturers, not the foundries, were listed in the notice. This notice is openly available on the Internet and more than 900 valves had to be replaced.

My last two questions to you are these: Have you taken sufficient steps to ensure this cannot happen to your company? Are your castings of the highest quality? **VM**

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