DEFECT PREVENTION IN MOLTEN METAL PROCESSING

MOLTEN METAL EQUIPMENT INNOVATIONS

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ARTICLE TAKEAWAYS:

- Defect prevention is a multilevel proposition, start at the beginning
- Introduce quality improvements at the optimal point in the process
- Defect-free outcomes require a system approach

The old adage that metal casting is a blend of art and science certainly rings true. At virtually every stage of the process there are opportunities to create what will ultimately become a defect in the part you are making.

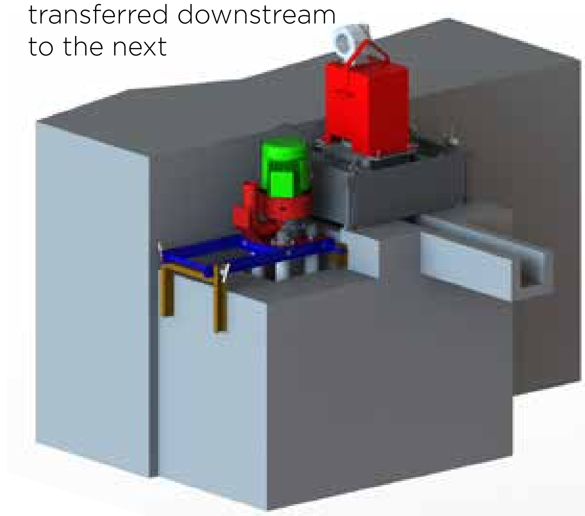
In many cases, the defect may have been created much earlier in the process than where it ultimately manifests itself, which is a recipe for spending extra money on what is already a bad part. If it were simple to avoid doing this, we'd all be doing it, and no one would generate any scrap and all of us would have extra cash coming out of our ears. So, like most things it is a question of focusing on the right elements of the process so that we can eliminate defects when and where they are most likely to occur and then maintain the process across time and production runs. By way of lessons learned having worked on this for many years, here are some concepts and examples that I hope can be of value and applied more broadly to situations specific to your operations.

START AT THE BEGINNING

Ultimately, we will see the defect in the final product. We will be out of spec with a material or dimension or have porosity that provides a leak path or leads to structural concerns. The key to effective elimination of the defect is to determine at what point is it occurring and why. For that reason, we have to start at the beginning of the process in order to eliminate root causes and avoid the potential for compounding effects downstream. An example of this would be an alloy that includes contaminants that are getting through to the final stages of the process. If you are only focused on the end of the process, you can waste lots of time and money trying to fix the problem when the root cause is far upstream. We have been able to address this issue as part of our filtered launder transfer system so that these contaminants are filtered out of the process, effectively eliminating the root cause early in the process. By filtering the metal using ceramic foam filters that can be selected based on the specifics of the alloy and the potential contaminants, we can be sure that we are sending clean metal downstream to the casting machine.

LOOK AT EACH STEP

It is always tempting to skip ahead in life, and in the world of molten metals, this is always a mistake. Following along with the process from our example above, it would be easy to think that we've solved our problem and can now skip down to the end of the process. While it may be that we have indeed solved the problem, it is more likely there are other process steps that will impact the metal in a way that can reintroduce a defect. A good example of this might be how the metal gets transferred downstream to the next



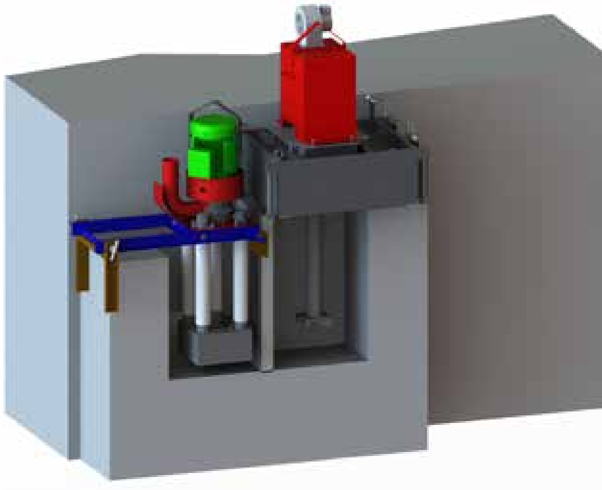
MMEI Filtered Launder Transfer System with Rotary Degasser points in the process. It has been our experience that if we do not do all we can to eliminate the exposure of the metal to the air, or to introduce turbulence in the process, we will once again increase the likelihood of defects that won't be discovered until later on in the process. By using a launder transfer pump that allows the metal to be transferred in a sub-surface manner we can control this aspect of the process and avoid the likelihood of oxidation, which will create new quality issues for us downstream not to mention metal loss that will be very costly. Combining a filter with the launder transfer pump and then a well-designed launder that virtually eliminates oxidation, we can see how each step of the process becomes equally important in the goal of delivering clean metal to the mold and avoiding compounding problems given the multilevel processes common to all of our operations.

WHY SEQUENCE IS IMPORTANT

In our operations there are decisions as to how to sequence steps and where to introduce quality impacting processes. Where to filter, where to degas and when and if to apply additives are all questions that need to be addressed in relation to the potential for certain types of defects. Sticking with our example of using a filtered launder transfer pump to transfer metal either to a holding furnace, crucible or more directly to the point of casting, the sequence of where we introduce quality-focused activities is key. A good example would be an in-line process where as part of the transfer process we can introduce a degassing process so that we can eliminate unwanted trapped gasses that can be a source of porosity as the last process step prior to the metal being delivered to the casting machine. This allows us to eliminate yet another potential cause of defects by minimizing the time during which the metal can be exposed to new sources of hydrogen or other non-desirable gasses that can lead to porosity defects.

LOOK AT THE WHOLE SYSTEM

Similar to our earlier discussion as to why it's vital to start at the beginning, if follows that we have to take the whole system into consideration. In many foundry environments, we have to work with what we already have from a space and layout perspective. The reality is that there are always competing objectives, and so at times we are forced to compromise. If capital was never an issue, we could just replace any of the system elements we don't like and upgrade or start over. In most cases we don't have this luxury and so we need to identify the parts of the system that are fixed in place and determine how to overcome issues they may present. This is where experience really pays off, as over time we tend to see similar systems and can more effectively identify potential areas of defect creation and work to eliminate them. In the case of our filtered launder transfer system, one of the key impacts will be elevations and how high we will need to raise the metal level to accomplish the transfer in the manner that will result in the greatest overall benefit to the process and the financial results. While we have come a long way in this area, there are still some limitations, and so understanding this early on is a big advantage. The overall amount of metal flow will also be an important consideration at this point in the process. Ideally we want to maximize the flow while preserving the benefits of the filtered metal that flows



MMEI Filtered Launder Transfer System with Rotary Degasser: Cutaway view

quiescently over the launder. The interrelationship between these various factors we need to consider to make the process defect free keeps all of us on our toes and highlights other basic elements of good process like communication, timely feedback and effective measurement tools.

SUMMARY

While our example focuses on a process with which I am familiar, the concepts can be applied broadly within our industry. Any time we are adding value to a process or part that already has a defect, we are compounding a bad situation and will see scrap increase and cash flow decrease. It is vital to look at the entire process prior to drilling into the necessary level of technical detail required to prevent complex defects. In the case of molten metal and the casting process the variables can be nearly limitless, emphasizing the need for a robust process that builds on previous experience. Companies committed to continuous improvement with good documentation processes will get to root cause, see defect rates and scrap decrease and thrive as they build forward.

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