

ask the expert...

IMPROVING PERFORMANCE IN FURNACE MELT TREATMENT PROCESSES



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Quality is generally defined as conformity to mutually agreed customer specifications, a definition that matches well with any discussion on aluminium melt quality and the related molten metal treatment process. A range of questions commonly posed by customers on the melt treatment processes, including alloying and furnace melt refining, are addressed here by Pyrotek's specialist, *Jonathan Prebble**. In-line degassing and filtration, which are important components in achieving final melt quality, will be addressed separately in subsequent articles in this series all with a specific focus on "Improving Performance."

Q: What are the main reasons for poor casthouse quality metal?

A: The five main melt quality culprits for the casthouse are the following:

- Trace elements, causing off specification or inconsistent casts
- Alkali metals, causing cracking and missed specifications
- Hydrogen, causing porosity and density complaints
- Inclusions, causing downstream processing complications, and
- Product inconsistency due to either chemical or thermal variations during casting.

The process of melt treatment starts with the requirements of the finished product's end user. These requirements

vary widely and need to be understood, agreed upon and documented so that melt quality processes can be managed to deliver this specification with zero defects at the lowest possible cost. While it starts with consistently meeting customer specifications, it does not end there. Other critical factors in managing melt quality processes include operational costs/cycle times, operational health and safety, and environmental impact/compliance. The key step is to carry out an initial comprehensive process audit and analysis of the customer's specific operation.

Q: How is casthouse performance optimised?

A: To realise optimum casthouse performance in all these critical areas, it is important that the production team clearly understands the marketing and operational objectives involved. These defined objectives measure the effectiveness of the melt quality processes and practices upon the final cast product. Typical challenges include, but are not limited to, how to achieve the same level of product quality consistency time in and time out, combined with how to achieve optimum performance in a practical manner while, at the same time, both minimising costs and maximising productivity.

These challenges and issues vary greatly depending upon whether processing primary or secondary metals. It is important to understand the melt quality and source of impurities at the beginning of the casting process in order to establish successful operational processes that will deliver consistent metal quality to the casting station.

Q: How can Pyrotek support optimum metal quality?

A: Pyrotek's mission is to work with

casthouse managers to develop a coordinated, holistic approach to a sustainable operations plan for melt treatment. The company brings all these operational elements together in a synergistic way that optimises the performance of each step of the melt treatment process. Pyrotek's approach includes a process audit and situation analysis with the customer to jointly understand and document the customer's operational objectives, historical operating performance, casting pit capabilities, end user requirements, environmental objectives and safety. Once these are understood and agreed upon, a prioritised list of performance improvement projects (PIPs) are identified. A Pyrotek technical team is then organised to work with the customer to execute, track and evaluate each project's results against previously established targets and world-class operational norms for similar operations, targeting similar melt quality specifications.

Q: For PRIMARY and SECONDARY processing, what are the different impurities?

A: Primary smelting can introduce the following impurities:

- Elements such as Si, Fe, and traces of Ti, Ca, V, B, etc arise from the refined alumina.
- Further traces of Ti, V, Ca, Si, Fe, etc are picked up from the coke blend used to make the anodes.
- From the carbon plant operations, traces of Si, P, Fe and Mn are attracted—mainly from the anode but also from the cast iron thimbles and the steel stubs on the anode rod assemblies.

Dissolution of these impurities takes place in the cell/pot at around 960°C and the chemical bath also introduces

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alkali metals from the salts used—K, Na, Ca and Li. Some cells operate a high Li bath chemistry for added current efficiency. Carbides and oxides are also generated by the turbulent electro-magnetic and chemical activity in the cells and the reactions with the cell lining materials. The bath is frequently tapped along with the metal in the crucible delivered to the casthouse. Turbulence during the transfer leads to oxide and dross inclusions in the metal. Refractory wear in transfer ladles also leads to a risk of increased inclusions.

Feedstock from secondary melting can introduce an even wider range of impurities depending on the material combination used to charge the furnace. Recycled Secondary Ingot (RSI) cast from metal recovered from dross, saw chips, saw fines and thermal fill scrap, can contribute alkali metals as well as TiB_2 and aluminium oxides. Recycled scrap from internal or external sources is an additional source of hydrocarbons, paints, lacquers, surface treatments, oils and lubricants. Fumes, dioxins and furans can be produced in large amounts depending on the quality and quantity of recycled material that is melted. Customer returns and in-house

scrap can add Li and Zn in 7000 series, Cu in 2000 series, Mn in 3000 series, Si in 4000 series, Mg in 5000 series and Fe in 8000 series.

Q: Can alloy additions be a problem?

A: Alloying elements such as silicon can introduce dusts, as well as high levels of iron and calcium. These can be slowly absorbed into the solution. Magnesium additions can contribute magnesium oxide, Fe and Ca. Boron waffle, when added to the furnace for EC grades, fades in as little as 90 minutes developing into TiB_2 , which settles and turns the furnace bottom into a sticky sludge. Tibor rod, when added to the trough outside the furnace in route to the casting table, can have a tendency not to mix well in the trough, developing into coarse TiB_2 particles, which can affect degassing efficiency and/or clog the downstream filtration systems in use.

Q: What about contamination in downstream processing?

A: Processing practices are a constant source of contaminates. Poor handling and metal flow arrangements, for example, can generate metal turbulence, which in turn, generates dross and oxides. Iron pick up can come from uncoated metal tools. Poor housekeeping

allows dirt, inclusions and dusts to become entrained in the metal flow as inclusions to the next cast. Waste burner gases and poor burner efficiency allow hydrogen to be absorbed. Open doors and/or improper burner adjustments can contribute to hydrogen pickup and to melt loss due to direct flame impingement. In-line degassing can be an unintentional source of contaminates from rotor speed too slow (large bubbles), rotor speed too fast (vortexing), rotor particulate, oxide build up and broken baffle plates.

Pyrotek has the expertise, technology, experience and the global resources to optimise the performance of your aluminium melt treatment systems.

**Jonathan Prebble, Pyrotek's Manager of Aluminium Process Technology is a specialist with over 30 years experience in the management and operation of aluminium smelters, including over two decades of casthouse experience, and many years as a quality assurance expert. The emphasis is on customer metal quality improvements and plant process reviews, based on innovations in casthouse and smelter technologies.*