Safe, Autonomous, and Energy Efficient Furnace Tending, Minimizing Waste

James Tomkinson[1] and David Roth[2]
1. Sales and Marketing Manager
RiA Cast House Engineering, Leipzig, Germany
2. President
GPS Global Solutions, Downingtown, Pennsylvania, USA
Corresponding author: james.tomkinson@ria-che.com

Abstract

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With casthouses looking to melt higher quantities of post-consumer scrap to lower the CO_2 footprint of their finished product it is even more critical to have reliable, safe and efficient furnace charging and skimming practices.

Automation of furnace charging, skimming and alloy charging operations gives a set of advantages that are unique, especially in a potentially hazardous casthouse environment where keeping well trained operators can prove difficult in today's competitive labor market.

Keeping the operator out of the dangerous situation in front of the furnace has many advantages on top the operator safety. Automated skimming with video optimization, has a significant impact on melt yield, energy use, CO_2 generation and final amount of salt cake waste created in the dross recycling process. Taking the skimming out of the hands of the operator, makes total dross removal a thorough practice every time. Automation of the process allows for no dross to remain on the furnace between cycles, eliminating the generation of more dross and lowering recoveries. Whilst also protecting furnace refractory lining from accidental collision through operator error and therefore reducing furnace down time, increasing furnace productivity.

Automated alloy charging and stirring distributes the alloy elements more evenly throughout the furnace with automated stirring to quicken the alloying procedure. Automated skimming and alloying shortens furnace cycles, further reducing door open time and wasted energy.

All advantages of these areas will be discussed in detail this paper.

Keywords: Charging, Skimming, Safety, Automation.

1. RiA Casthouse Engineering GmbH

RIA was established as a local maintenance service and special equipment supplier for the German Aluminum industry in 1997, RIA over the past twenty six years became an important international partner for aluminum billet cast houses, now with over 75 charging and skimming machines supplied to major aluminum companies around the globe. Building on high quality standards and continuous evolution has helped RIA to design the most reliable, robust, maintenance friendly and custom-made autonomous furnace tending equipment on the market. Recent success has seen RIA look at expansion into the sheet ingot and primary aluminum casting facilities.

RIA has worked with air-cooled in-furnace camera manufacturer Fioscope GmbH since 2014 and are Fioscope's exclusive supplier to the global aluminium industry, with RiA recognizing the value of Fioscope's machine learning, smart camera technology in providing autonomous furnace tending machines to the global aluminium industry.

2.   Purpose of Automating the Furnace Tending Process

Trained reliable manpower is becoming hard to come by throughout the world. Yet, highly trained operators are the key to achieving efficient furnace practices with low cost production standards. Automated charging and skimming allow for this to be the norm in todays labor market. Using the best available technology allows for a significant reduction of energy consumption, shorter cycle times and lower furnace refractory maintenance cost as well as a safer environment for the operators. The latest generations of charging and skimming machines utilize full artificial intelligence (AI) to charge and skim aluminium melting and holding furnaces using cutting edge technology. These results can now be achieved with little or no operator input. New automated charging and skimming solutions achieve the lowest possible operational cost and the safest operating environment for this important part of the aluminium remelting process.

Operation of the automated systems can save up to 50 % in furnace cycle times by minimizing the door open periods. Saving energy cost and reducing greenhouse gas generation. Utilization of these systems also keeps operators away from the very hot, dangerous and uncomfortable environment in front of the furnace door, maximizing safety for casthouse personnel.

Combining savings on energy and .3 % metal loss, each 500 tonnes of production using an automated charging machine can :
- Reduce 27 tonnes of CO_2-e
- Eliminate 2.4 tonnes of saltcake waste
- Save 1.5 tonne of aluminium.

3.   Key Tools in Automation

Latest generation machine mounted and air cooled in furnace camera systems are a key component of achieving fully autonomous operation of charging and skimming equipment. These new camera systems have smart capabilities, combining professional high resolution image acquisition with latest digital image processing technologies for accurate identification of process parameters. Typically video images are relayed to an off-site image processing device to train a neural network. This software is able to detect conditions like the height of the scrap heap or recognize dross on the molten bath and produce a PLC signal to indicate a certain action to the operating system computer or the Cast House operator, such as "Furnace Ready to Charge" or "Furnace Ready to Skim". This leads to obvious productivity benefits as the furnace may have been ready to receive more material or to skim earlier, however the operators were unaware or uncaring. All this is done, whilst maintaining a door closed operation, offering the safest environment to operators and saving energy.

Charging and Skimming machines are utilized in conjunction with smart cameras to charge and skim furnaces without an operator needing to be on the machine, the process can be watched safely from an operator pulpit or a remote desk in a safe location.

New camera systems are constantly developing with new and innovative features, smart camera technology, for example can monitor the burner flame for changes in shape, colour, size. It is also capable of monitoring refractory for signs of damage and wear as well as monitoring the combustion chamber for anomalous and potentially dangerous conditions to alert operators.

4.   Autonomous Furnace Charging

In typical operations, the melt cycle cannot be observed without opening the door and losing heat and energy, as well as the associated safety risk to the operators. Therefore, valuable minutes can be lost if the furnace is ready to receive the next charge, but the operators are unaware since the