AL21 - Fully Automated Furnace Skimming and In-Furnace Dross Processing Increasing Production and Saving Cost

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Abstract

A new development for primary aluminum plants in the area of furnace skimming is the fully automated skimming machine with the In-Furnace Dross Processing function (IFDP). Full automation of the skimming process provides some key advantages: safer operation by keeping personnel out of the danger area in front of the furnace; shorter door open times, shortening furnace cycles and saving energy; elimination of refractory damage and the down time for refractory repairs.

Enhancing the automated skimming machine, with In-Furnace Dross Processing (IFDP), becomes a game changer with regards to total dross generation and over metal recovery: reducing dross generation by as much as 45 % by leaving the aluminum in the furnace instead of in the dross; preservation of alloy integrity by elimination of secondary recycling on much of dross; increased recovery by rapid cooling of the dross and elimination of secondary melting of recycled ingot; recharacterization of the remaining dross, allowing for in house mechanical secondary recovery, potentially eliminating landfill products from dross. These technologies have been widely used in the aluminum extrusion industry and are now becoming available to the primary aluminum industry. The paper will describe in detail the equipment and its use in aluminum, melting and holding furnace skimming. [1]

Keywords: In-furnace dross processing, aluminum recovery from dross, fully automated aluminum furnace skimming machine.

1. RIA Systems - General Comments

Efficient furnace practices with low cost production standards start with automated charging and skimming. Using the best available technology allows for a significant reduction of energy consumption, minimum cycle times, and lower furnace refractory maintenance cost as well as a safer environment for the operators. RIA Cast House Engineering has been focusing on the development and manufacturing of charging and skimming equipment since 1997 and is focused on the development of innovative automation and process optimization solutions, continuing our development of the safest and most efficient systems possible. The latest generation RIA charging and skimming machines utilize full artificial intelligence (AI) to make charging and skimming cutting edge technology. RIA solutions achieve the lowest possible operational cost and the safest operating environment for this important part of the process.

RIA was established as a local maintenance service and special equipment supplier for the German aluminum industry. RIA over the past twenty plus years became an important international partner for aluminum billet cast houses, now with over 50 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 furnace tending equipment on the market. Recent success has seen RIA look at expansion into the sheet ingot and primary aluminum casting facilities. The RIA systems are best suited for operations with several furnaces lined up together.

Operation of the RIA automated systems can save up to 25 % 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.

2. Skimming Machines

Leaving dross on top of the liquid bath between cycles causes more dross to generate in the next cycle, increasing operational melt losses. Quickly removing all the dross is better for overall metal recovery, bath temperature control, and energy conservation. The goal of the RIA automated skimming process is to minimize these effects on operation costs as much as possible.

The standard automated machines are laser guided, the same as the charging machine, and are programmed with the exact furnace geometry for quick movement across the bath to remove the dross. Typical cycle times are 8-12 minutes. The latest generation AI (Artificial Intelligence) skimming machines from RIA achieve the goal to fully automate the skimming machine and improve the process at the same time. This unit, with an air-cooled camera system using digital image processing, helps to automate the skimming process. The cameras are installed to overview the bath area at all stages of the skimming process. The video images are processed in real-time and distributed to the machines' PLC. These data are compiled in movement commands to allow a full autonomous skimming process without an operator, removing the dross only where it sits on the bath and knowing the precise metal depth so that the skim tool is placed optimally into the bath reducing metal splashing and removal. Typical cycle times are shorter with autonomous skimming (see Figure 1). [2]

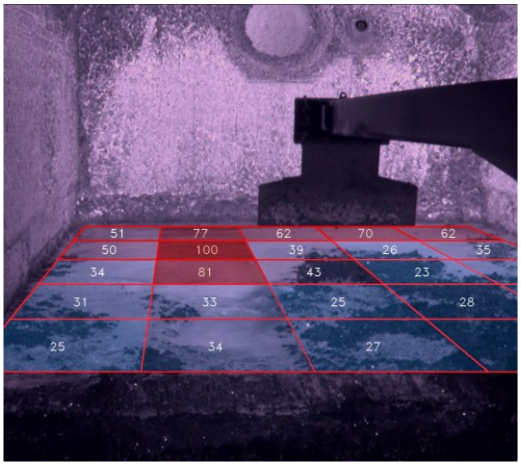

Figure 1. Camera - PLC grid for dross removal.

RIA skimming machines are rail-guided (see Figure 2). The robust base frame is equipped with driven wheel blocks for movement. Additionally, the base frame accommodates the operator cabin which can be used when manual furnace floor or wall cleaning is required. The electric cabinet and the hydraulic unit are mounted on the electrically driven carriage.

This carriage runs with a rack and pinion system, which guides the skim boom into the furnace. The boom is pivoted on the carriage by a hydraulic cylinder. This simple, but solid design assures consistent and accurate performance and builds the base for the In-Furnace Dross Processing option. Multiple styles of skimming, cleaning, and alloying tools are available with quick change capabilities.

Figure 2. RIA skimming machine.

RIA's next innovation in the skimming area is a game changer in the area of dross processing. The process of In-Furnace Dross Processing (IFDP) is a joint development patented with GPS Global Solutions.

3. In-Furnace Dross Processing (IFDP)

The concept behind the IFDP is to compress the dross whilst still hot and in the furnace, before removal, when it can either get too cold and freezes or too hot and thermites, in both cases preventing effective recovery of the entrapped aluminum by secondary hot processing (see Figure 3).

The removal of the dross is enabled by a special skim blade coupled with the cold stationary plate (see Figures 4 and 5). In-Furnace Dross Processing is achieved in harmony with the skimming cycle adding only a 1-2 minutes to the cycle. The dross will be dragged onto the furnace sill and squeezed against the cold plate. The liquid aluminum flows back into the furnace through openings between the skim plate and the furnace sill. After the squeezing action is finished, the remaining dross will be transferred to specially designed cooling dross pans in front of the furnace. The cold plate is used for a precise positioning of the dross cake. The procedure will be repeated until the dross is completely removed from the furnace.

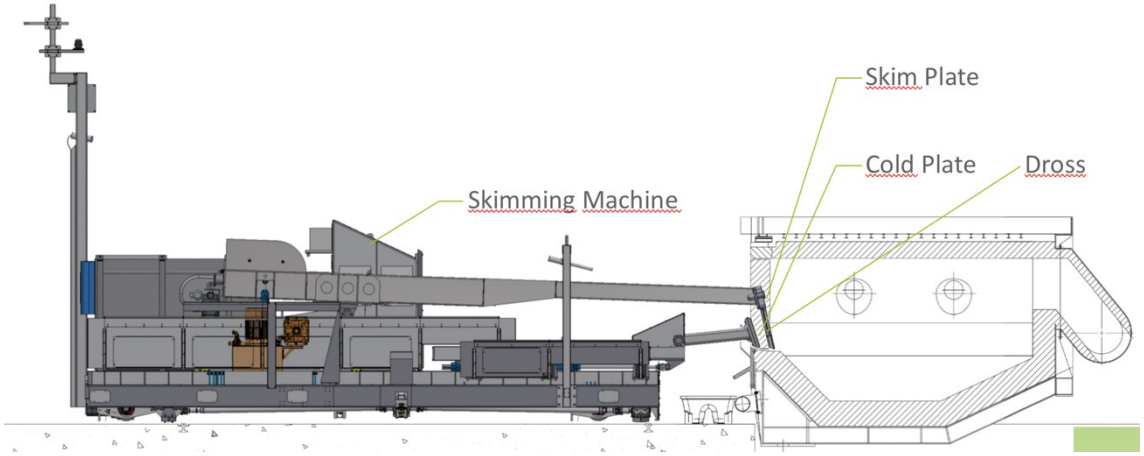

Figure 3. Schematic of IFDP process. [3]

RIA In Furnace Dross Processing gives a lot of advantages compared to traditional technologies:

- It foremost allows up to 2-3 % more of the metal charged to be cast into product every cycle, reducing overall cast house cost and increasing overall cast house recovery.
- By leaving 70-80 % of the molten aluminum normally contained in the dross in the furnaces, overall dross recovery increases by about 5 %. There is no remelt recovery loses from secondary processing of the metal that has remained in the furnace.
- Decreased dross generation means less secondary recovery cost for processing the remaining dross. These processing costs go down by as much as 45 %.
- Retained higher alloy value because the metal in the dross is not mixed with other alloys of dross. The value of that metal is higher than dross secondary ingot.
- Secondary ingot remelt energy savings because the metal now remains in the furnace and fewer secondary ingot need remelting.
- Reduced material handling for 45% less dross being removed from the furnaces and moved to secondary processors.
- Reduced greenhouse gas emissions due to reduction of secondary remelting.

The dross is always hot for processing for maximum metal drain back into the furnace but can be cooled immediately during skimming for later mechanical processing. This maximizes metal recoveries within the furnace and from the remaining dross that is removed. The process with a simple modification can also allow the dross to retain enough heat such that when used in conjunction with standard dross pans, the dross can be prepared for hot dross processing or can be conventionally pressed, further enhancing in-house recoveries.

The precise machine movements that have been programmed with the refractory contours as well as the adjustable plate's pressure against the refractory eliminate collisions with and damage to the refractory lining. This in turn reduces maintenance on the refractory significantly.

Figure 4. In-furnace dross processing skim and cold plate.

Figure 5. IFDP in melting furnace.

Using an RIA skimming machine increases the occupational safety in all modes of operation, because even in manual mode the operator is protected by an insulated operator cabin.

The AI and IFDP features in combination with the known advantages of the RIA skimming machine make this the best technology for furnace skimming.

4. Conclusions

RIA Cast House Engineering provides tailor-made rail-bound cast-house-proven charging and skimming equipment for aluminum cast houses worldwide. The design and development of all machines takes reliability, durability, maintenance and occupational safety into account. Adding the innovative features of full AI camera-based charging and skimming, In-Furnace Dross Processing assures the best equipment maximizing productivity and lowering cost in the casting operation.

5. References

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