COMPARATIVE STUDY BETWEEN THE LATEST GENERATION DROSS PRESS TECHNOLOGY AND THE INERT GAS DROSS COOLER

Alan M Peel, C.Eng and James Herbert, C.Eng
ALTEK

Abstract

In cast houses worldwide, the two most prevalent technologies used to cool dross and prevent valuable metal units within the dross from oxidizing away are the Dross Press and the Inert Gas Cooler. Over the past decade the dross press has become the most used dross cooling technology within the new primary aluminium smelter cast houses. As an example in the 6 primary aluminium smelter cast houses located in the Middle East, there are 24 dross presses used today for cooling their drosses.

This paper presents a recent, rigorous study at a U.S. billet casting facility comparing the operational results of these two technologies by simultaneous processing of dross from the same furnace over a period of four months. Both in-house drain and secondary metal recoveries (through a Tilt Rotary Furnace) were considered and reported separately in the study, and both economic and environmental/facility issues are addressed.

Introduction

Dross is an inevitable by-product of the aluminum industry and can typically account for between 1 -5% by weight of a facility's total production. When skimmed from a furnace, dross can contain up to 80% of aluminum[1] which, if neglected, can diminish quickly through oxidation and be forever lost from the metal stream.

There are a number of different technologies that have been developed over the years to try and address both the economic and environmental issues associated with handling dross.[1][2][3][4][5] Each technology will have its own advantages and disadvantages but generally, to be successful, the equipment must have the following characteristics:

- The technology has to be safe. Older technologies incorporated water as a cooling medium which while efficient, has inherent safety risks.
- The system should have minimal impact on the cast house and not interfere with the day to day operations. The technology should be easy to use and require minimal maintenance.
- The system should be environmentally sound and meet all local environmental standards.
- The system should maximize the amount of metal that can be recovered. Recovered metal will come in two forms: metal that is capture at the generator's facility and metal that can be recovered at a secondary processor. Overall metal recovery (in-house and secondary) is important; however, it is generally desirable to recover as much metal in-house as possible since the alloyed material can be easily introduced back to the melting furnace.
- The system should be capable of handling a wide variety of dross types including white, black and heavily thermiting dross.

Two technologies that are generally considered to meet the above criteria and used extensively around the world are the Dross Press and the Inert-Gas Cooler.

The Principles of The Inert Gas Cooler

The Inert Gas Dross Cooler (IGDC) was developed by Alcan in the mid 1980's. The basic principal involves skimming the dross into compartmentalized cast steel or ductile iron pans. These pans may contain drainage holes to allow molten metal to drain into a collecting pan below. Once skimmed, the pan is transferred as quickly as possible into a cooling station which consists of a base together with a hood, which is lowered to provide a seal once the pan is placed inside. Once the hood is sealed the chamber is purged with an inert gas such as argon for several minutes displacing the air inside. The pan is kept in the inert chamber for typically 4 to 7 hours until the temperature of the dross falls below 400 deg C which is considered by the manufacturer to be the temperature below which thermiting will cease.[1]

Fig. 1 Typical Inert Gas Dross Cooling System[6]

The Principles of Dross Press

The dross press was developed and introduced to the aluminum industry by ALTEK in the mid 1990's. Today's dross press technology bears little resemblance to the early systems and has evolved over the years to meet the demands of the modern cast house and recent environmental legislation.

The dross press is based on the principle that a liquid placed under pressure will separate from a solid and flow to the areas of least pressure. The press system consists of a steel frame, hydraulic unit, a pressing head and a skim pan set. Dross is skimmed into cast alloy steel dross pans that are designed to both cool dross and maximize the metal drain. After the skimming operation, the pans are transferred into the press and the head is slowly lowered into the dross, squeezing trapped metal into the sow mold under the skim pan. This drained metal is the same alloy as that of the metal being processed in the furnace, and can be charged immediately back into the furnace in the form of an ingot if desired. [7]

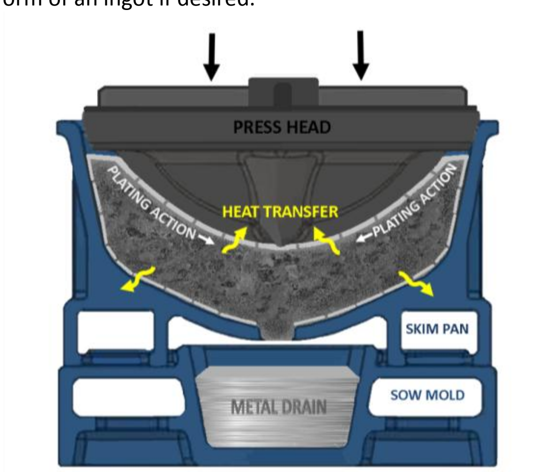

Fig. 2 Dross Press head and pan set Combination

While both the above technologies are well established, recently, ALTEK has made significant improvements to its Dross Press through the amalgamation of both the ALTEK and Tardis technologies. These improvements have enabled the Dross Press to be effective on a wide variety of dross types as well as provide a system that is more user-friendly and robust.

There is a great deal of information and data published detailing the results and merits of each technology at individual facilities; however, no reliable published data exists comparing the two technologies operating side by side.

ALTEK recently had the opportunity to participate in a four month side by side comparison of both technologies at a U.S. billet casting facility. During this rigorous study, dross from the same furnace was simultaneously processed through each technology. Both in-house drain and secondary metal recoveries (through a Tilt Rotary Furnace) were recorded and both economic and environmental/facility issues were considered.

Trial Facility and Dross Press Installation

The company sponsoring the study operates a very efficient billet remelt facility in the USA. Accurate data collection would be an important part of the study and the facility already had experience with operators recording the weights of dross pans as part of their standard working practices.

The facility operates a single stationary 130,000 lb melting/holding furnace which generates approximately 4,800,000 lbs of dross per year. The company has successfully operated several Inert Gas Cooling hoods for many years and was happy with the performance.

Based on the size of furnace and the amount of dross generated per skimming, ALTEK selected its TARDIS Generation II model #500 machine. Several cast alloy steel dross pans with a capacity of approximately 700 Kg were also supplied.

The Dross Press was equipped with many of the latest design features including the latest generation air cooled press head, hydraulically operated guillotine door and updated PLC and HMI control system. The updated controls incorporated a pressure feedback system that enables more efficient and consistent pressing (previous dross press systems have utilized timers).

The ALTEK Dross Press was fully assembled and tested prior to shipping to the test site. The system was shipped pre-assembled as much as possible in order that installation and commissioning times were kept to a minimum. The system does not require any special foundations and can be placed on a standard cast house concrete floor. This made installation extremely quick and inexpensive.

Fig. 3 Latest Generation Tardis II Model #500 Dross Press

Testing Protocol

Dross is a variable material by nature and many factors can affect its properties and metal recovery at a particular facility. Previous studies conducted by ALTEK have shown that furnace operators alone can have a significant effect on the consistency and metal recovered from dross and it is important that any comparative study takes this into account.[8]

In order to conduct the most reliable and accurate comparative study, ALTEK and the facility management met to discuss how such a test should be conducted. The following procedures were adopted:

- During each furnace skimming, the dross was skimmed simultaneously into the pans supplied for both technologies (see Fig. 4).
- Once skimmed, the Inert Gas Cooler pan(s) were placed in the hood(s) and left to cool under the inert atmosphere. Simultaneously, the Dross Press pan(s) were processed through the dross press system (see Fig. 5 and 6).
- Once processed through each technology, every dross pan was weighed to establish the weight of dross as well as the amount of metal captured in the drain pan below.
- When cooled, the dross from each technology was placed in separate dross bunkers in order that the secondary recovery could be determined at the dross processor.
- The dross was shipped to a separate facility where it was processed in a Tilting Rotary Furnace. The secondary facility was aware that a comparative study was being conducted and the loads of dross were segregated accordingly.

Fig. 4 Skimming into both dross pan types

Fig. 5 Dross pan being placed in the Inert Gas Cooler

Fig. 6 Dross pan being placed in the Dross Press

Results

The Dross Press was well received by the operators and the fully automatic features enabled the operators to easily incorporate its use into their other cast house activities.

The average time to press each pan of dross was approximately six minutes. Once pressed, the dross was allowed to cool in the pan for a further one hour before being dumped into the appropriate dross bunker. In comparison, the average time taken to process the dross through the Inert Gas Coolers was six hours before it was cool enough to be removed.

In-house Metal Recovery (Metal Drain)

The amount of dross in each skim pan was weighed along with the metal drain collected in the drain pan below. To account for differences in the amounts of material processed through each system, the metal recovery is expressed as a percentage of dross skimmed in each pan as per the following equation:

$$In\ House\ \%\ Recovery = \left(\frac{Total\ Metal\ Weight}{(Total\ Dross\ Weight + Total\ Metal\ Weight)}\right) * 100$$

In house recovery data was collated each week as shown in Fig. 7.

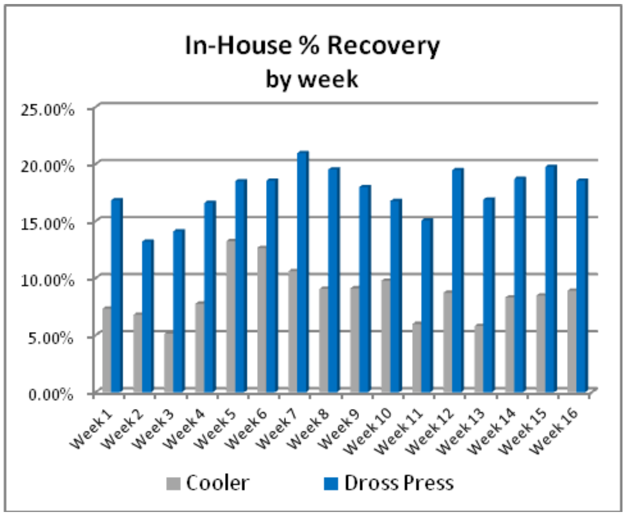

Fig. 7 Comparison of in-house metal recovery by week

The above chart shows that the dross press consistently provides a higher in-house recovery. Averaging the sixteen weeks of data shows that the Dross Press provided approximately double the amount of metal recovery compared to the Inert Gas Cooling System as shown in Fig. 8.

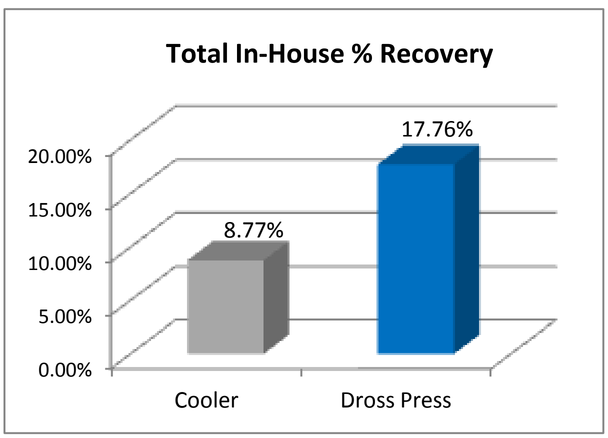

Fig. 8 Average compassion of in-house metal recovery

Maximizing in-house recovery is typically the priority of any cast house since the alloyed metal is generally considered to be worth more than the off spec Recycled Secondary Ingot (RSI) received back from the dross processor. Maximizing in-house recovery will also reduce the amount of transportation costs and tolling fees charged by the secondary processor.

It can be seen from Fig. 7 that the in-house metal drain varies considerably from week to week. While the reasons for this were not investigated as part of this study, the lower recoveries experienced at the beginning of the study coincided with the furnace electromagnetic pump being off-line.

Applying a trend line to each data series shows a consistent difference in recoveries between the two technologies. The similarity between the two trend lines indicate the cast house operations (operator practices, charge material, equipment etc..) had an equal affect on both technologies. It is also believed the similarities provide a good indication of the level of accuracy in the data.

Applying a linear trend line to each data series also reveals that throughout the study, the Inert Gas Cooler recovery remains very constant while there is a slight improvement (2 – 3%) with regard to the amount recovery experienced with the Dross Press. It is felt this may be associated with the operators becoming more experienced using the Dross Press system and over time this would be expected to level off.

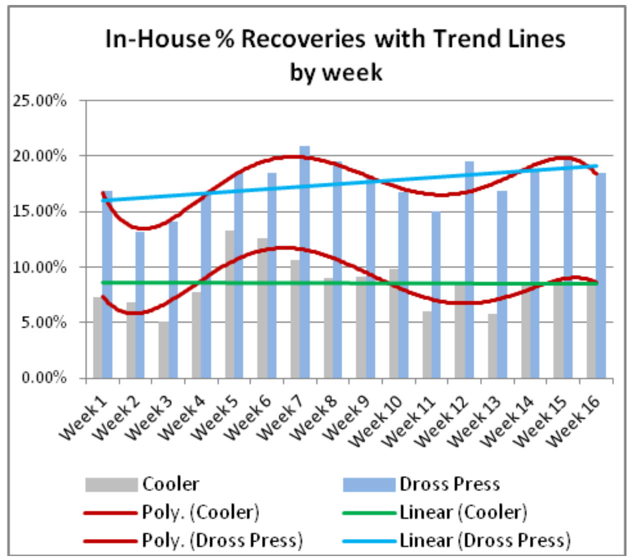

Fig. 9 In-house recovery trend lines

Secondary Metal Recovery

As described above, the dross processed through each system was segregated and sent off site to a secondary dross processor and recovery data on each batch was reported monthly. Initially, it was hoped to correlate the in-house and secondary recoveries by week; however, it was not possible to segregate the dross in this manner and instead, the recoveries were recorded by the date each load was shipped as shown in Fig. 9.

As with the in-house recovery, secondary recoveries varied significantly over the sixteen weeks. Again, this is believed to be associated with the functionality of the electromagnetic pump as well as differences in the furnace charge materials.

The secondary recovery data was averaged over the entire trial as shown in Fig. 10. The results show the Inert Gas Cooler provided a higher secondary recovery compared to the Dross Press with a difference of 1.4% at the end of the trial.

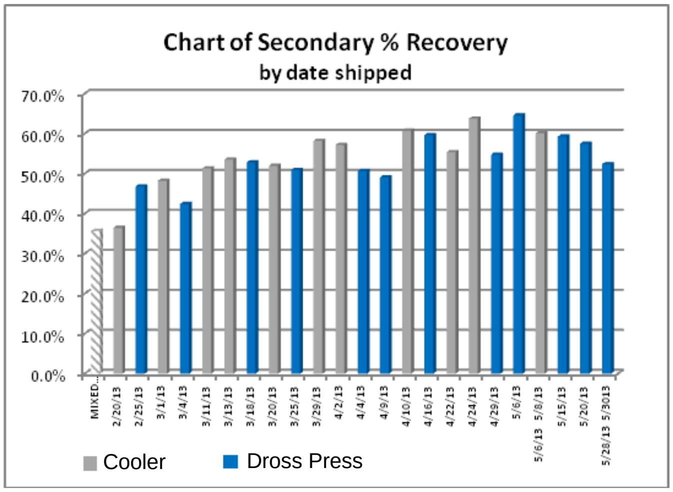

Fig. 9 Secondary recovery by ship date

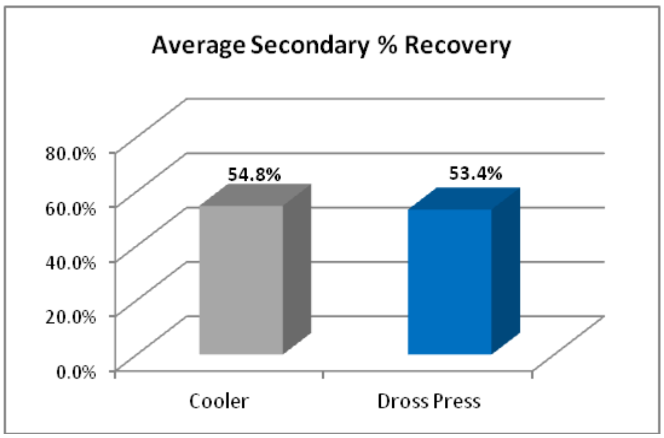

Fig. 10 Average of secondary recovery

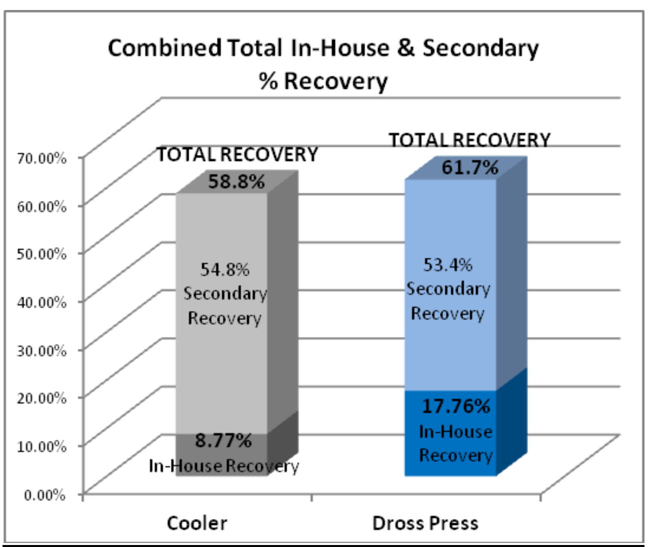

Fig. 11 Overall metal recoveries

Fig. 11 shows the combined overall metal recoveries (in-house and secondary) for both technologies. On completion of the four month trial, the Dross Press provided approximately three percentage points improvement in overall metal recovered.

Economic Comparison

Ultimately, the goal of any dross processing technology is to minimize metal units lost through oxidation. Even a small change in recovery can have a significant effect on the bottom line of the business. Economic return on investment models will vary depending on geographic location of the facility as well as the current metal pricing, local tariffs, transportation, and secondary dross processing fees.

In order to determine the economic effect the Dross Press would provide if installed permanently at the trial facility, the above recoveries were extrapolated over a twelve month period. The following assumptions were also used as part of the economic model:

Value of Midwest Premium: $0.95/lb
Value of metal recovered in-house: $0.92/lb
Value of RSI: $0.82/lb
Dross Tolling Charge: $0.12/lb

Value of metal recovered from Inert Gas Cooling System

In-house recovery:

4,800,000 lb x 8.77% x $0.92 = $387,283

Secondary recovery:

Tolling charge: 4,379,040 lb x $0.12 = ($525,485)
4,379,040 lb x 54.8% x $0.82 = $1,967,765

Total Value of Metal: $1,829,563

Value of metal from Dross Press System

In-house recovery:

4,800,000 lb x 17.76% x $0.92 = $784,282

Secondary recovery:

Tolling charge: 3,947,520 lb x $0.12 = ($473,702)
3,947,520 lb x 53.4% x $0.82 = $1,728,540

Total Value of Metal: $2,039,120

Based on the above comparison and assumptions, the Dross Press provided annualized savings of approximately $210,000 per year.

It should also be noted that the Inert Gas Cooler requires a continual supply of inert gas (Argon or similar) which can cost several thousand dollars per month. This additional cost has not been included in the above economic model.

Summary

Both technologies functioned well throughout the trial and provided metal recoveries in-line with what is expected from a facility operating with good furnace practices.

Both technologies easily meet current environmental legislation and neither process agitates the dross which can cause fines and additional emissions that are inherent with other dross processing technologies such as Rotary Coolers and Dross stirring systems.

The Dross Press and Inert Gas Cooler are both designed to be scalable depending on the size of the facility and dross generation. For the Inert Gas Cooling technology, this can mean larger facilities would require many cooling stations taking up a great deal of floor space. This is in contrast to the Dross Press where a single machine can handle multiple dross pans in a relatively short period of time. Thus, another advantage of the Dross Press is that considerably fewer dross pans are required. And, the system does not require the use of inert gasses which can become costly. Instead, the Dross Press utilizes the plating action or aluminum skin, which encapsulates the dross during the pressing sequence, to protect the dross from further oxidation. An example of the plating action can be seen in Fig. 11.

Fig. 11 Plating action generated by pressing

The data collected over the four month trial indicates that the Dross Press provides higher in-house and overall metal recoveries compared to the Inert Gas Cooler. Even for a relatively small operation, it has been shown that this can equate to several hundred thousand dollars a year in savings.

Very little thermiting was observed throughout the trial. It is expected that a facility that routinely generates hot or thermiting dross would experience greater benefit from using the Dross Press compared to the Inert Gas Cooler. Relatively rapid cooling times would significantly reduce the oxidation of metal units providing improved secondary recoveries.

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