Initiatives to Minimize Dross Generation in Casthouse

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Abstract

Dross is a mixture of oxide films and aluminium. Aluminium-oxide is wetting; it absorbs molten aluminium like a sponge, creating fine aluminium droplets encapsulated by aluminium-oxide. Some of the primary factors causing dross generation and melt loss include disturbance of the clean aluminium surface, turbulence, contaminants on the scrap, burners ingesting air, burners improperly adjusted to fire either too much gas or too much air and overheating the scrap. This study is focused on reducing dross generation and recovering metal from dross.

Some of the initiatives have been implemented to reduce the dross generation in the cast house by implementing some of the actions related to the furnace practice, increasing siphon operation, improving dross cooler efficiency, reducing the door open time, usage of fluxes, and modifying the dross pans. As a result of implementing the initiatives and actions, the dross generation was minimized to the required targets.

Ma'aden also installed a new environmental friendly dross recovery technology DROSRITE™ in the casthouse. The metal recovery project helped to minimize the dross inventory in the casthouse and to improve the casthouse yield. The recovered metal is being reused in the casthouse furnaces as scrap for producing value-added products.

Keywords: Dross generation, Metal from dross, Hydrogen removal, DROSITE furnaces, Siphon operation.

1. Introduction

1.1 Dross and Chemical Composition

Dross arises primarily from the oxidation of molten aluminium and can be divided in two different types:

1. "White dross" or primary dross, from smelter and remelt operations, which is characterized by a very low or no salt content.
2. "Black dross" or secondary dross, from scrap recycling operations and having a high salt content.

To a large extent, the chemical composition of a metal determines its oxidation rate. The ratio of the volume of oxide to the volume of metal from which it is produced is particularly critical. This ratio is known as the Pilling-Bedworth ratio (P-B ratio). The metal oxide P-B ratio [1] can be described as the ratio of the metal oxide volume produced by the oxygen and metal reaction to the consumed value of metal. This can be further defined in the equation:

The PB Ratio is defined as:

$$R_{PB} = \frac{V_{oxide}}{nV_{metal}} = \frac{M_{oxide}\rho_{metal}}{nM_{metal}\rho_{oxide}} \tag{1}$$

where:

M Atomic or molecular mass,
n Number of atoms of metal per molecule of the oxide,
ρ Density,
V Molar volume.

Using the P-B ratio as the basis for gauging protective films, the following can be assumed:
If the P-B ratio is less than 1, the oxide film is too thin and will most likely break down, such as in magnesium.
If the P-B ratio is greater than 2, the oxide film chips off and offers no protection, such as in iron.
If the P-B ratio is greater than 1, but less than 2, the oxide film is passivating and offers protection from surface oxidation such as in titanium, aluminium and chromium.

During aluminium melting dross is generated, typically 15-25 kg of dross is produced per metric tonne of molten aluminium. Dross is classified into three different categories based on the metal content i.e., White, Black, and Salt cake. The main constituent of dross is aluminium metal, which varies from 10-90 % depending upon grades. Apart from aluminium metal, dross may also contain other chemical compounds e.g. Al_2O_3, AlN, Al_4C_3, MgF_2, $NaAlCl_4$, $KAlCl_4$, SiO_2 and MgO etc.

Table 1. Typical dross chemistry.

SNO	Component	Percentage (%)
1	Aluminium oxide (non-fibrous)	10 - 90
2	Aluminium	10 - 90
3	Metal Chloride salts	0 - 40
4	Silicon	0 -23
5	Zinc	0 - 11
6	Copper	0 - 11
7	Metal Nitrides	0 - 10
8	Metal Carbides	0 - 10
9	Magnesium	0 - 10
10	Magnesium Oxide	0 - 10
11	Iron	0 - 10
12	Tin	0 - 7
13	Nickel	0 - 5
14	Manganese	0 - 2
15	Chromium	<1

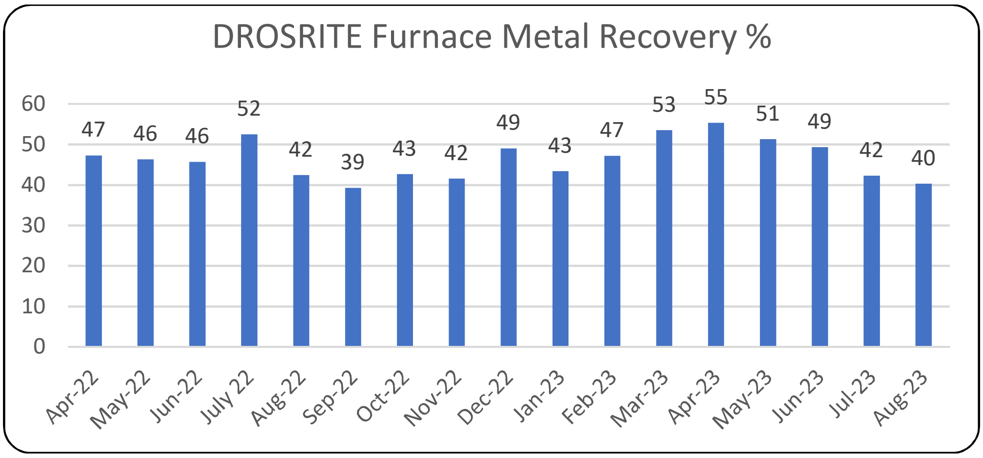

Figure 9. DROSRITE recovery.

5. Conclusion

- Dross is one of the highest single cost factors in a Casthouse and often, one of the least controlled costs. Through collective team effort and continuous improvement in the casthouse, dross generation is minimized through a collection of operational practices: in furnace operation, metal pouring, stirring, and skimming, as well as investment in state-of-the art sustainable dross processing technology.
- Dross generation is reduced from 1.5 % to 1.03 % over a period of two years (Figure 10).
- A new Dross Recovery Plant is operational with an average of 45 % metal recovery across all alloys.

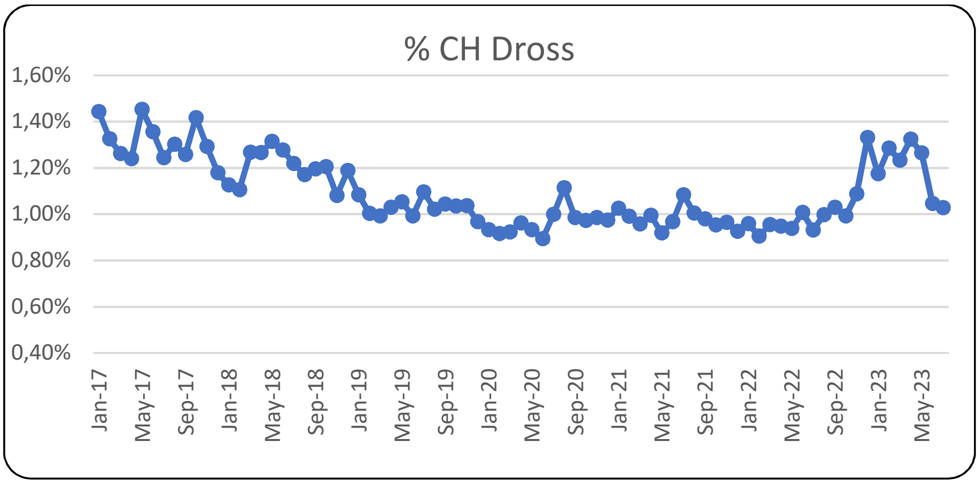

Figure 10. Casthouse dross trend in percentage

6. References

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