ALUMINIUM WASTES FROM FOUNDRY

In-House Recycling Optimizations for Dross, Chips and dirty metallic waste.

In Aluminium Foundry, the raw material is the most important factor in the cost of the casting; reducing metal waste and optimising its recovery is the key to improving the cost of the process. Internal recycling, minimising external management, allows greater metal recovery and reduces waste storage.

Enrique Uriarte – Sales Manager

INTRODUCTION

The recovery of metal waste in the Aluminium Foundry is key to optimising production costs.

The objective of the Foundry is to manufacture parts with quality and reduced costs, which allow it to offer a final product at competitive prices.

The raw material is the most important factor in the final price of the part; however, the transformation process generates metal waste that we must optimise.

Today, the most common situation is to store and sell them, to process them externally through a waste manager.

Aluminium foundry dross

Machining chips Aluminium parts

FACTORS TO CONSIDER

The factors to be taken into account that justify waste optimisation are:

- Internal waste recovery
- Elimination / Reduction of waste storage
- Increased metal recovery

Depending on the quantities generated, there are various alternatives for metal recovery, with technologies that improve performance, integrating the process within the Aluminium Foundry.

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TYPICAL WASTE

The metallic wastes that are normally found in the aluminium smelting plant are:

- Melting dross and foamed creams
- Machining shavings
- Injection moulding waste (flashes), impregnated with lubricants and oils

1. RECYCLING DROSS

Dross is the oxide of aluminium (Al_2O_3), which is generated during the smelting process at high temperature and in the presence of free oxygen. Depending on the facilities and skimming practices, the values of the metallic residue are very variable. Typically, the generation of dross in the foundry is between 2 and 5% in total values of raw dross, with an aluminium content between 20 and 40%; which is what our external manager actually recovers or values, for the dross that we send him.

We call Gross Dross the amount of material that we extract from the Furnace (Oxidizes + Aluminium), the material actually lost being the Net Dross generated and, recovering or valuing the Aluminium contained. It is true that a high temperature in the Furnace provokes thermitic reactions, difficult to extinguish, which burn the residual aluminium metal in the dross.

Prevention to avoid thermitic effect

In order to minimise the thermitic effect of dross, it is advisable to establish guidelines to reduce metal losses:

- Avoid overheating of the Furnace
- Effective skimming practice
- Effective practice adding fluxes (little or no fluxes)
- Frequent skimming of the furnace.

The objective is to minimise dross generation and recover maximum aluminium.

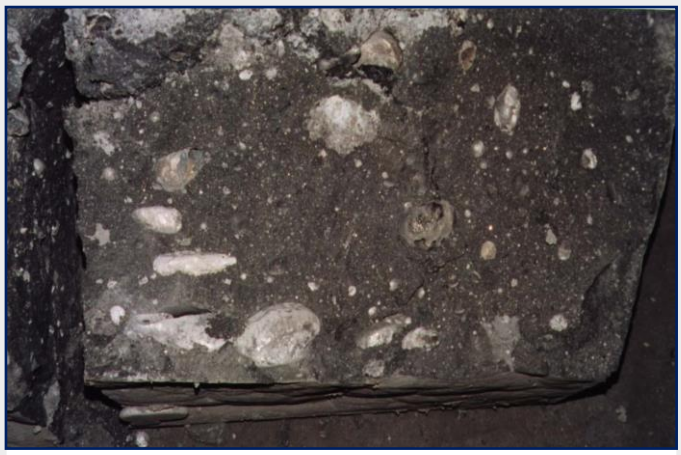
In the skimming process, the dross has a high metal content (60-70%), which is lost depending on the subsequent process and the time elapsed before its final recycling.

Aluminium Thermitic Dross

1.1.- DROSS TYPES

Depending on the de-scaling process of the Furnace, 2 types of dross are generated:

- **White dross,**
  Dross without the addition of fluxing elements (Fluxes). This type of dross is easier to separate the aluminium in further processing and higher overall metal recovery is achieved.
- **Black dross,**
  With the addition of fluxing agents. It is a drier dross, with less aluminium, but at the same time, the additives react thermally.



Foundry black drosses

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1.2.- HOT DROSS RECOVERY

The alternatives for hot dross recovery are as follows:

1. **Collecting the dross in containers and/or spreading on the ground**
   This is the most common option, as it requires no additional equipment costs, with minimal operation / labour required.
   This option generates dust and tends to thermitic reaction of the dross, where there is no internal recovery and causes metal loss.

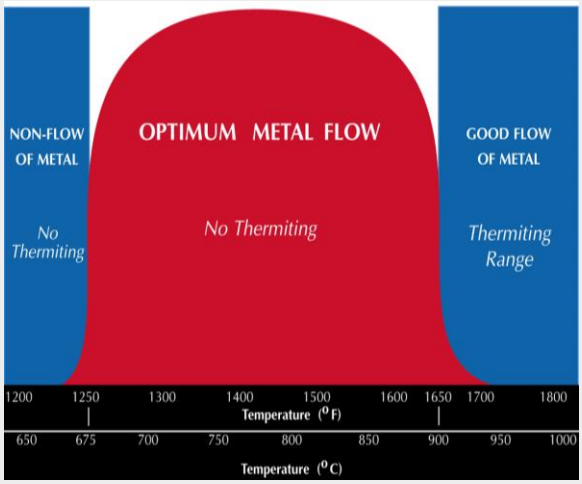
2. **Dross beating for draining**
   Internal recycling by beating the dross to separate aluminium, without controlling the thermitic process (similar to above).

3. **Rotary coolers**
   Internal recycling that allows the aluminium droplets and dross to be separated, controlling the thermitic process.
   Requires environmental control and water, with high maintenance costs.

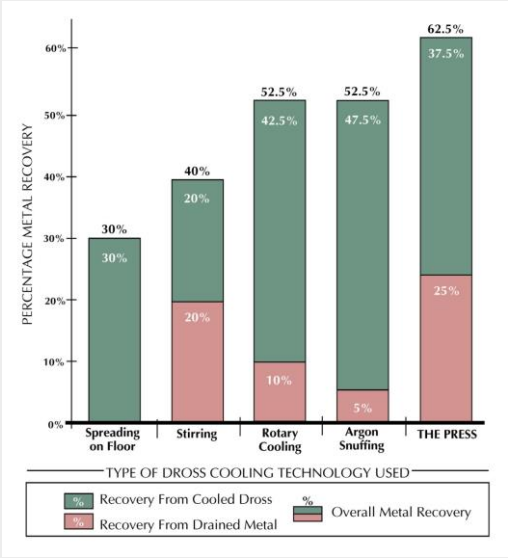
4. **Inert atmosphere cooling**
   No internal recovery, but maximum metal recovery is achieved from the dross.
   Long cooling cycles with high cost of inert gas (Argon).

5. **Dross press**
   - ✓ Increases internal recovery by pressing and generating an ingot.
   - ✓ Supports the thermolytic process
   - ✓ Separates metal droplets and encapsulates the dross

6. **Rotary kilns**
   - ✓ Maximum recovery in 1 single step
   - ✓ Requires additional installation and uses salts
   - ✓ Generates waste, salt dross, with low metal content <5%



Temperature range for hot dross recovery



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1.3.- DROSS PRESS

The function of the press is to recover the maximum amount of metal in the smelter itself, and at the same time to rapidly cool the dross and reduce its oxidation process, thus allowing for greater metal recovery in secondary processes.

The working principle of the Press is to extract liquid aluminium from still hot dross, applying the necessary pressure, draining the liquid aluminium and rapidly cooling the dross, causing a rolling effect on the shell during the pressing process. In other words, the small metal particles still residing in the dross coagulate in the pressing process in the form of sheets, forming what we call a dross crust or dross shell. The fact that the aluminium still residing in the dross is coagulated in this way makes it possible to obtain higher percentages of aluminium recovery in the secondary processes, and therefore provides added value to these drosss.

The pressing effect of the hot dross generates a triple effect:

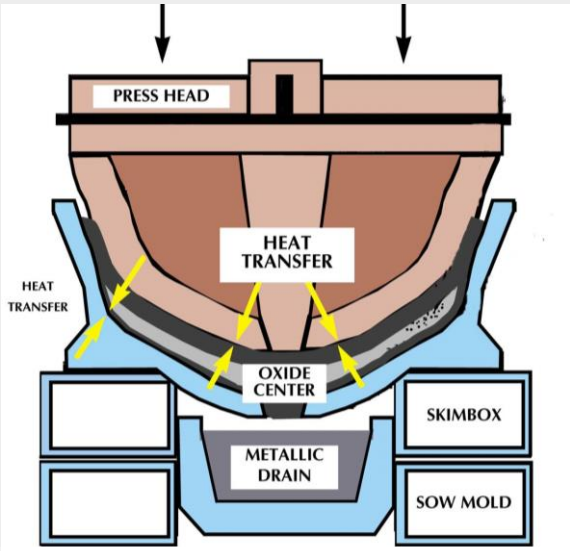
- It recovers aluminium metal by pressing effect and draining to a mould at the bottom: Aluminium ingot.
- It quenches the thermitic effect of the dross, drowning it by the pressing effect.
- It generates a metal shell containing the dross, being a pressed package with the oxides, which facilitates its handling

This process recovers part of the metal in the smelter (20 to 30%), and minimises the oxidation of the aluminium that remains in the dross. We still have a residue, but we have recovered the dross, extracting part of the metal, leaving a dross rich in aluminium (35 to 40%).

Press Advantages

- High recovery with rapid cooling, avoids additional oxidisation and reduces the possibility of thermitic reactions.
- Increases recovery from 5 to 40% depending on practices and alloys.
- Improves recovery in secondary recycler by 10-20% (if today <50%)
- Reduces waste storage and facilitates handling
- Minimises fume generation

Another advantage of the formation of this solid dross crust is the reduction in the amount of dust generated, which can be easily handled and stored.



Dross press effect, present one skull and drain molten metal remain in one ingot mould.

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2. CHIP RECYCLING

Chip from machining has a large surface area in relation to its unit weight. In addition, lubricant residues have an important impact on metal recovery.

2.1 Briquetting

Briquetting machines are used to compact short chips at high pressures inside a mould to obtain semi-rigid bodies in order to reduce the volume of the chip.

Typical loose chips have an average density of 0.20 to 0.50 kg/dm3. With the compacting process, we achieve densities between 2.0 and 2.20 kg/dm3, with a storage reduction of 75% in volume.

For correct briquetting, it is recommended that the shavings have been previously crushed and centrifuged, otherwise we do not achieve good compaction.

The lubricants are not only extracted by compaction, but part of them remain inside the briquette.

Briquetting is a good process for compacting, reducing space and handling, valorising the waste, but it is not recommended prior to melting, as we do not extract all the volatiles.

If the briquettes are subsequently subjected to an immersion melting process, a good metallic yield is achieved, but it generates uncontrolled fumes from the remains of lubricants.

Briqueting Chips □60x60x65L mm (506 gr)
Average density 2,16 kg/dm3.

Loose, Shred and Briqueting Chips

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2.2 Pretreatment and Chip Drying

The most efficient chip recycling process is in continuous mode, with 3 Steps, that includes:

1. **Pretreatment**
   - Shredder, to obtain a uniform chip size, which is easily transportable.
   - Centrifugal separator to minimise lubricants and soluble elements.
   - Magnetic separator to remove free ferrous parts from the swarf.
2. **Chips Dryer**, to remove volatile components, with afterburner and fume treatment.
3. **Sink Vortex Melting** process

After having prepared the chip, in stable conditions of uniform size (without fines <1 mm) and eliminated the content of soluble elements, a high metallic yield can be obtained in its recovery, with a melting process immersing the swarf in metal in recirculation.

Uniform & Shred Aluminium Chips

2.3 ALUSWIRLER® Melting System

The optimal aluminium swarf recycling and melting system is carried out by immersing the chips in a continuous process, in a sink vortex on molten metal recirculation, to obtain

- High metal yield
- Melting without exposure to direct flame
- Vortex immersion technology
- Continuous process
- Uniform bath temperature
- No use of fluxing salts

The residue of this process is still foundry dross, but the generation of dross is very low compared to other conventional processes.

ALUSWIRLER Melting Process, by sink vortex with molten metal recirculation

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3. ROTARY FURNACE RECYCLING

Both, chip and dross can also be recycled internally in rotary furnaces and is currently the only efficient process for recycling aluminium dross.

Companies that generate large quantities of metal waste optimise their internal recycling process, including dirty and contaminated scrap.

The main advantage of the tilting Rotary Kiln is its versatility in multi-product, which applies recipes to optimise the performance of the materials, with minimum preparation. It achieves maximum recovery in a single step, with a residue of very low metal content <5%.

- Combustion system and fumes outlet in the door, generating a double passage of gases.
- Bi-directional rotation and adjustable speed.
- Tilting for emptying aluminium and waste.

These intrinsic characteristics of the Rotary Furnace improve the melting speed and optimise metal recovery, which, together with the specific design of the Furnace, reinforce its simplicity of design and efficiency.

The Furnace and its combustion system are designed according to the latest state of the art technology and operates on the basis of the "dry dross" melting concept.

This variety in the processing of scrap and dross substantially reduces the required percentage of salts equivalent to traditional furnaces, as well as the final volume of saline residues to be disposed of, increases the useful volume of the furnace and reduces the amount of energy consumed.

The double flue system inside the kiln (the flue gas inlet and outlet are in the same single door) reduces energy consumption by up to 35%, compared to traditional single-pass rotary kilns.

Recycling with Tilting Rotary furnace

The design of the main drum has been optimised and incorporated:

- computerised controls with rotation speed and fume temperature
- closing door with labyrinth,
- dross trap and,
- combustion control

The loader is based on a vibrating table with a hopper, arranged on a driven carriage. It allows a pre-preparation of new charges while in the melting phase of the previous cycle.

The charging machine is designed with a capacity equivalent to the volume of the furnace, to introduce the charge in a minimum time, eliminating the painful task of working in front of the furnace and with the door open during the charging phases, with the furnace hot.

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4. CONCLUSIONS

Today it is necessary to analyse the internal recycling of metallic waste in Foundries, considering the establishment of guidelines for improvement, in order to obtain the maximum use of their metallic waste.

The facilities or equipment that may be needed depend on the quantity and type of dross and chips that are generated.

Dross

The recovery of residual metal in smelting dross must be optimised from the moment it is generated in order to achieve maximum metal recovery and to

- Avoid thermitic reactions of the dross
- To recover aluminium from the de-drossging phase.
- To valorise the residual dross, with controlled cooling.
- Its final recycling is only viable with Rotary Furnaces.

Chips

Chips must be properly processed to avoid contamination of lubricants, with

- Efficient pre-treatment, which contributes to better metal utilisation
- Briquetting is another option to reduce volume and valorise the residue
- Melting is optimal with loose and dry pre-treated material, with dipping processes in liquid aluminium in recirculation.

Final Waste Recycling

The final recycling of the last metallic waste must be done with Rotary Furnaces, which is currently the only valid technology for extracting the maximum metallic yield from the dross.

It is also valid for processing scrap contaminated with volatile elements or metal inserts, separating the aluminium and discharging the ferrous parts with the residual salt dross.

The main advantages of processing aluminium waste in a tilting rotary kiln are as follows:

- Flexible installation, for a wide range of materials to be processed, with minimum material preparation.
- Fast and efficient loading of the material
- Low salt consumption
- Low maintenance
- No use of consumables
- High energy efficiency
- Compact installation with low footprint
- High productivity ratio
- Low direct labour costs

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