

## METAMAG® RECYCLING SYSTEM

**“Solutions For Your Recycling Needs”**



# MAGNESIUM SCRAP CLASSIFICATION:



## TYPE 1A:

High grade clean scrap  
(e.g. scrap castings, runners, biscuits,  
etc.)

## TYPE 1B

Clean scrap with a high surface area  
(e.g. thin walled castings, flashings, etc.)

## TYPE 2

Clean scrap with steel / aluminum inserts.  
NO COPPER OR BRASS CONTAMINATION.

## TYPE 3

Scrap castings, painted, with/without inserts of Fe/Al.  
NO COPPER OR BRASS CONTAMINATION.

# MAGNESIUM SCRAP CLASSIFICATION:

## **TYPE 4**

Unclean metal scrap, (e.g. Oily, wet, contaminated)

May contain: Silicon contamination, (e.g. Tumbling beads, sand etc)

-Al alloys; Cu contaminated alloys.-Non-magnesium sweepings.

## **TYPE 5A**

Chips, swarf, machinings. Clean/dry uncontaminated.

## **TYPE 5B**

Chips, swarf, machinings. Oily and/or wet.

## **TYPE 6A**

FLUX FREE Residues (e.g. Crucible sludge, dross etc.)

Should be dry and silica free. (E.g. free of sand)

## **TYPE 6B**

FLUX CONTAINING Residues. (e.g. Crucible sludge, dross etc.)

Should be dry and silica free. (e.g. free of sand)

(Classification from Elecktron)

# DEMAND FOR HIGH PURITY ALLOYS

- Magnesium is a highly recyclable material, consuming only 5% of the energy required to manufacture the primary metal.
- This is a key element in determining the costs competitiveness of using this material.
- As magnesium becomes specified for an increasing number of applications, the recycling will play an important role in the supply of magnesium in the long term.
- In today's marketplace, recycled alloy ingot is required to meet the same quality criteria as primary metal in terms of chemical composition and oxide content.

# MATERIAL UTILIZATION

- The process of Magnesium die casting uses a high percentage of process scrap metal, 40%-60% of the total cast (shot) weight.
  - Process scrap is in the form of runners, overflows, and large biscuits
- .Quantity of process scrap produced and recycled and the volume of primary metal purchased is dependent on the following:**
- (indent)**
- Scrap ratio for a single shot.
  - Metal losses during the melting cycle.
  - Production efficiencies in terms of the percentage of reject parts cast.
  - Quality of process scrap.
  - Efficiencies within the recycling operation.

# MATERIAL UTILIZATION

- The die casting foundry has Three (3) options in terms of managing this quantity of process scrap:

(indent)

## 1. **Sell the material onto the open market.**

- Selling process scrap onto the open market will down grade the classification means less money

## 2. **Recycle the material internally.**

- Type 1A and 1B is by far the largest portion of the process scrap produced.
- By sticking to this classification, recycling internally is easier and affordable

## 3. **Recycle the material externally.**

- Sending all of the process scrap out for recycling is a great disadvantage, compared to the companies who recycle internally.

# REMOVAL OF MAGNESIUM OXIDES

- Scrap magnesium from the die casting operation tends to be high grade clean scrap; Type 1 under the scrap classification index.
- The refining process is the basis of a recycling operation.
- Prior to being used into the die casting process,, there is a requirement to refine the metal of dissolved gases and oxides and ensure it is free from impurity contaminants.
- Melting of the scrap is usually carried out in a continuous basis using a fluxless protective atmosphere to ensure the molten magnesium does not react with air.
- This atmosphere is created using a main oxidant gas such as SF<sub>6</sub>, SO<sub>2</sub>, HFC 134A, Novec. These carrier gases are dry air, N<sub>2</sub>, Co<sub>2</sub>, are mixed with a combination or by themselves to create a protective atmosphere.

## Once molten, the oxides in the scrap can be removed using two (2) techniques:

### The removal of oxides using the time dispersal method

- This method relies on the time elapsed between the scrap entering the molten bath to the time it is poured into an ingot.
- Magnesium oxides will rise to the surface leaving a “clean zone” in the center of the crucible
- A two-furnace system is used.

### The removing of oxides using argon sparging

- Sparging is done before the metal crosses through a slot in the baffles located on the opposite end of the crucible of the main furnace melting furnace
- Both methods can be used together
- Sparging and time dispersal is used together when there is a “higher than normal” oxide level
- This produces faster through-put and ensures metal cleanliness

# REMOVAL OF IRON

- Iron pick up can be from metal crucibles or tools used to work in the molten bath.
- The removal of iron is done by the addition of manganese.
- Manganese is already present in magnesium alloys as an alloying addition between 0.17%-0.50%.
- Further additions form dense inter-metallic particles combining with the iron, which then precipitate out of the melt, thereby lowering the iron content.
- Manganese additions need to be controlled, too much can lead to excessive “sludging” in the die casting furnace, particularly where lower holding temperatures are used.

# OTHER ELEMENTS

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- There is no method in existence for refining or removing of copper or nickel.
- If these elements are present at levels greater than the maximum allowable under the ASTM specification, then corrosion rates can increase.
- Dilution or removal of alloy from the crucible is the only way to keep these elements under control

# RE-ALLOYING

## Analysis of Metal Chemistry

- A spectrograph analysis of the molten magnesium should be performed every half hour
- This determines if some of the metal compositions are out of specification
- Typical alloying elements that separate Manganese, Beryllium, Aluminum

# KEY FACTORS TO RE-ALLOYING

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- Molten bath must be kept at the same temperature
- Molten bath must be kept homogenous
- Alloy additions must be kept in suspension
- Enough time must elapse to allow alloying addition to reach equilibrium.

# METHOD FOR RE-ALLOYING

- Spools of aluminum wire with 1% Beryllium are available with a de-coiler
- This method takes care of both the Aluminum and Beryllium
- The rate of speed is determined by the deficiency of the aluminum
  
- Manganese also is added to the molten bath in the form of pucks
- Pucks are added at set intervals when system is in production
- A formula determines the percentage of manganese needed to be added



# PROCESS FLOW FOR MAGNESIUM RECYCLING AND REFINING



# PREPARATION OF THE SCRAP

- Segregation of the material
- The quality of the scrap is important in overall throughput and cleanliness.
- This process is best used for recovering Type 1 A and 1B “clean” diecasting scrap consisting of gates, biscuits, and runners, along with defective whole castings without inserts.
- Scrap which is oily, dirty, or finely divided (such as machining chips) is not easily recovered, this will lead to higher melt loss and slowing of overall recycling time.
- The charging of scrap should be reduced in size by crushing.
- This step assures the maximum practical re-melt efficiency by reducing breakdown time, entrapment of air, and resulting melt losses. This step is not absolutely necessary, but the advantages of reduced breakdown time and melt loss should be weighed against the associated costs.

# PREHEATING AND CHARGING SCRAP



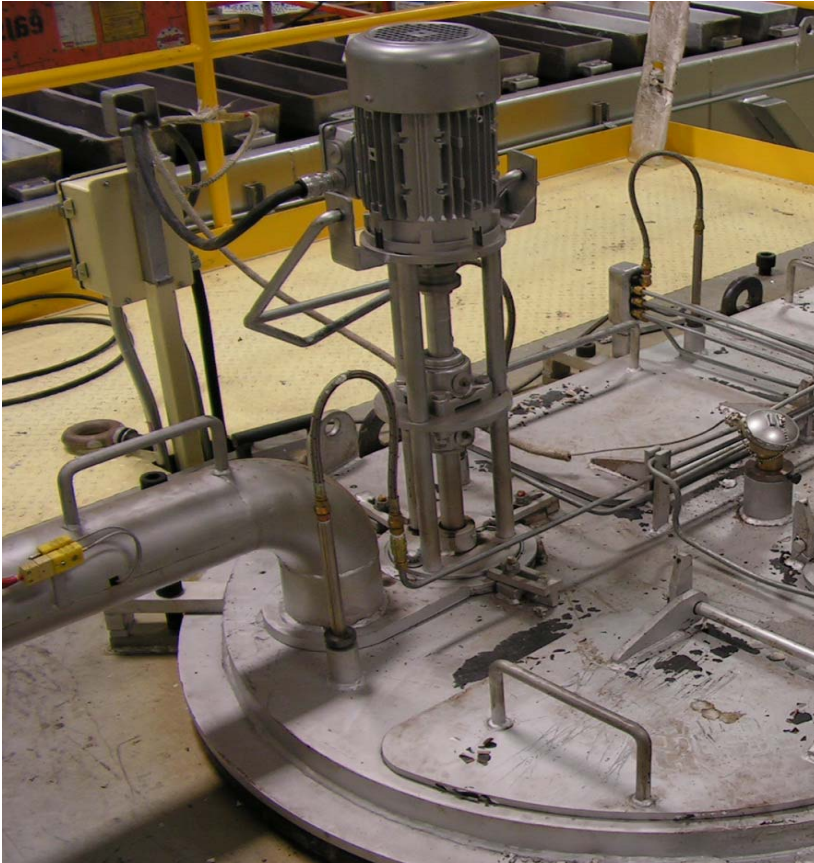
- The scrap is heated in order to remove moisture
- The Preheater should have sufficient heat to match the throughput
- A double-door charging gate should be used
- Pusher plate to totally submerge scrap once into the furnace. (see movie and drawing)

# MELTING THE SCRAP



- The furnace of choice is one that is electrically powered
- Accurate temperature control is an important part of re-melting
- Temperature swings during the melting cycle must be eliminated
- Low melt furnace temperature caused more inter-metallic to separate, especially manganese

# STIRRING THE MOLTEN BATH



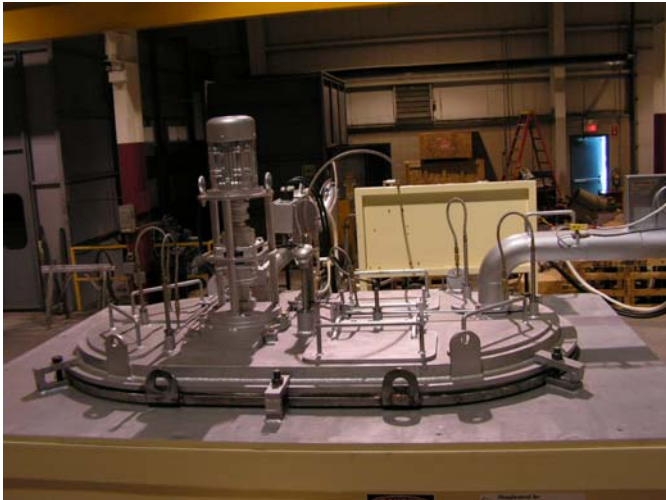
- Speed up the break down of the solid scrap
- Keep inter-metallic in solution
- Assist in raising light oxides to the surface
- Used to dissipate argon bubbles
- Reduces melt loss

# ARGON SPARGING

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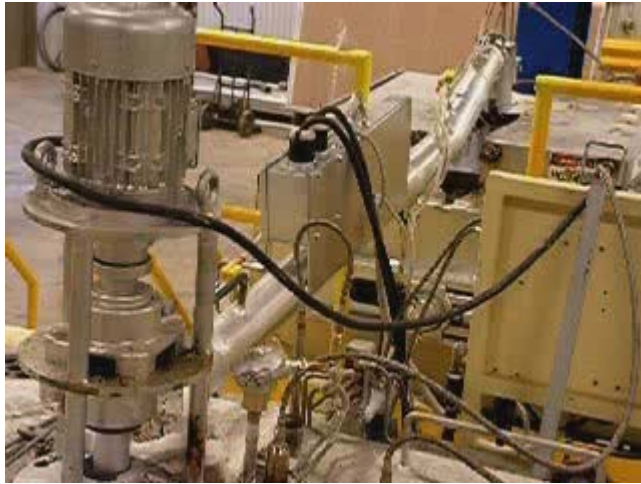
- Argon adheres to non-metallic inclusions and floats them to the surface Magnesium oxides which floats to the top of the melt can be removed with a skimming tool.
- Removes dissolved hydrogen gas
- The amount of argon needed will vary based on the cleanliness of the metal and the concentration

# TRANSFER TO SECONDARY PUMP OUT FURNACE



- The molten magnesium is transferred by a “U” tube (see picture)
- The “U” keeps the level consistent in the primary and secondary furnace
- When an ingot is poured it is immediately replaced by clean refined material
- Capacity of furnace is large enough to add extra settling and dispersal time
- Further alloying can be done
- Transfer Pump also stirs the bath
- Specially equipped with stirring attachments

# PUMPING REFINED MAGNESIUM INTO INGOTS



- Metamag pumping program
- 3 to 4 speed setting
- Improves ingot cosmetic look
- 8 to 12 kg ingots



- Ingot mold preheating
- Speed up quality of the ingot upon start up

# INGOT USE OR STORAGE






- Ingots can be stacked into bundles for storage



Ingots can be stored in baskets to be used at the die cast machine ready to be loaded on the ingot preheater

# METAMAG WORKING FOR YOU

-  **Metamag is looking forward to working with you in developing Solutions that will resolve your recycling issues**
-  **Re-cycling is an affordable and cost effective way to handle your scrap**
-  **Recycling in-house will make you more competitive and contribute to your bottom line**