Maximising revenue streams from dross generation and recycling

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Agenda

• What are the various processes available for dross recovery?
• How much more dross – black and white – will be generated in the coming years?
• How complex are they to collect, transport and process?
• Is on-site processing the best option?
• What outlets are there for the non-metallic residues resulting from reprocessing?
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• What are the various processes available for dross recovery?
Dross Management

- Dross can account for 5% of a facility's total production
- Dross can contain up to 80% aluminum
- 1% aluminum can be lost per minute through oxidation
- The treatment of the dross after skimming is the single most important factor influencing the metal content and the value of the dross
Sources of Aluminium in dross/slag

- **White Dross**
  -> 20-80% Al content

- **Black dross** (side well – low salt)
  -> 5%-25% Al content

- **Salt Slag**
  -> 3%-15% Al content
Dross Management – In the Furnace

• Minimising dross in the furnace MUST be the first priority
  – Type of furnace
  – Burner set up/control
  – Type of scrap
  – Charging/Alloying/Fluxing
  – Electromagnetic stirring
Initial Step

SKIM

COOL

or

HOT PROCESS

LOGISTICS

TIME

LABOUR

ENVIRONMENT
Dross Process - Which way?

• Cooling
  – Disconnects the dross generation from secondary recovery and gives TIME
  – Rapid sealing of aluminium
  – Easier logistics
  – Less environmental impact

• Hot Processing
  – Logistics very important
  – Continued Al burning if dross bins left waiting
  – Difficult if too many furnaces
Dross Management

• Over the years a number of technologies have been developed to address both economic and environmental issues
  – Dross Stirrers
  – Hot Dross Processing in a Tilt Type Rotary
  – Rotary Dross Coolers
  – Inert Gas Coolers
  – Dross Pressing Systems

• Many technologies have not gained universal acceptance
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• How much more dross – black and white – will be generated in the coming years?
How much more dross in the future?

- Move away from primary to secondary/recycled aluminium
- Conversion of smelter cast houses to re-melt or recycling cast houses
- Impact of lower grade aluminium scrap recycling
- Underlying growth in production of aluminium
- Lightweighting and Growth of Car Production
Dross Generation

- Approx 50M TPY Primary Aluminium Production
- Approx 20M TPY Secondary
- Approx 1.5M TPY White Dross Generated
- Approx 3M TPY Salt Slag and Black Dross Generated
- Annual Growth of 5-7%

- Potential Aluminium Content within Drosses and Slags over 1.5MTPY
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• How complex are they to collect, transport and process?
Transport Issues?

- Main problems:
  - Fires
    - Dross or slags re-igniting in shipping containers
  - Reactivity with water or moisture:
    - Gaseous emissions of $\text{NH}_3$, $\text{CH}_4$, $\text{PH}_3$, $\text{H}_2\text{S}$
  - Therefore need to.....cool effectively......
Skim + Press + Tip
Pressing Results
Secondary Dross Processing

- OPTIONS
  - Tilting Rotary Salt Furnace
  - Mechanical crushing/separation

- People say ‘remove the salt’ BUT there is more than just the salt to consider

- You need to consider all the constituents of in dross!
The Dross Processor

Dross Skulls need to be recycled in a Tilt Type Rotary Furnace

ALTEK 16 MT Tilt Type Rotary Furnace
Issues with cooling salt slag

• Typical cooling times are 24 to 36 hours
• Requires large area for cooling
  – special heat resistant concrete floors,
  – or racking systems
  – Many dross bins
• Temperature for shipping < 100°C
• Aluminium in the slag will burn off
  – Losing valuable Al
    • Creating AlN’s – *leads to the Ammonia generation*
• Dealing with the environmental issues
Salt Slag Cooling – Typical

Cooling times typically 36 hours
Salt Slag Cooling with Dross Press

2.5T pressed in 10 mins

Tipped in 3-4 hours

Metallic Recovery increased by over 5% (7-12%)
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• Is on-site processing the best option?
Is on site processing the best option?

• YES ...but....
• Need rotary salt furnace - best recovery of Al from dross
• Need to manage the resulting salt slags
  – If located near to a large salt slag processor – ok but there is a cost to this including transportation
  – Otherwise need to recycle the salt slag locally at site
  – Need to ensure by products are non volatile (BASEL convention for transportation restrictions)
• Good after markets for ALL by products if managed correctly....
Is on site processing the best option?

- Challenge - management of the salt slag and also other compounds within the drosses and slags (its not all down to the salt)
- Need effective way to remove these reactive components to ensure safe shipping
Question?

- Where are these gases after both salt and non salt treatment.
- “Answer is locked up in the solids”.
- If you choose the non salt process and the end product gets wet where do gases go to?
- “Answer atmosphere”.
Typical solid components in dross

- Aluminium
- Alumina Oxide ($\text{Al}_2\text{O}_3$)
- Spinels ($\text{MgO.}\text{Al}_2\text{O}_3$)
- Aluminium Nitride (2AlN)
- Aluminium Carbides
- Aluminium Sulphites (trace)
- Aluminium Phosphates (trace)
Possible Gaseous Components of Dross are:

- \( \text{NH}_3 \) (Ammonia)
- \( \text{H}_2\text{S} \) (Hydrogen Sulphide)
- \( \text{H}_2 \) (Hydrogen)
- \( \text{SO}_2 \) (Sulphur Dioxide)
- \( \text{CO}_2 \) (Carbon Dioxide)
- \( \text{CH}_4 \) (Methane)
- \( \text{NH}_4\text{OH} \) (Ammonium) Hydroxide)
- Phosphine
- Phosgene (possibly)

So its not just the salt slag you have to consider!
Aluminium Metal compound reactions with water

• $2\text{AlN} + 3\text{H}_2\text{O} \rightarrow 2\text{NH}_3 + \text{Al}_2\text{O}_3$ (Ammonia)

• $2\text{Al} + 3\text{H}_2\text{O} \rightarrow 3\text{H}_2 + \text{Al}_2\text{O}_3$ (Hydrogen)

• $\text{Al}_4\text{C}_3 + 6\text{H}_2\text{O} \rightarrow 3\text{CH}_4 + 2\text{Al}_2\text{O}_3$ (Methane)

• $\text{Al}_2\text{S}_3 + 3\text{H}_2\text{O} \rightarrow 3\text{H}_2\text{S} + \text{Al}_2\text{O}_3$ (Hydrogen Sulphide)
Current Salt Recycling Processes

• All large capacity > 80,000tpy
• All use similar process including following steps:
  – Crushing/screening
  – Leaching – manage off gases
  – Washing/Filtering
  – Re-crystallisation

• Several in Europe (Spain, Italy, Germany, France, UK)
Issues with current Salt Slag Recycling Solutions

• Need large capacity to make economics work hence few located geographically around Europe
• Energy intensive with high operating costs
• Transport issues for the salt slag generators
• Variability of input feed – different sources
Project - ALUSALT

- New development project initiated in 2011
- Objective local salt recycling at salt slag generation source
- Demonstration small capacity pilot plant operational Q1 2015
ALUSALT - Key Principles

- To provide a cost effective solution for recycling salt slag at source of generation
  - From 1000tpy to 20,000tpy

- Benefits:
  - Massive reduction in transportation of salt slag around Europe
    - Fuel cost savings
    - Environmental issues reduced
    - CO$_2$ footprint reduction
  - Re-use of own salt (avoids ‘other things’ being in it)
  - Re-use of own aluminium
  - Provide security and viability of recycling operation
  - Re-use of energy released from salt slag at plant
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• What outlets are there for the non-metallic residues resulting from reprocessing
End use of NMP

- Steel Industry as a Synthetic Slag (Al$_2$O$_3$)
- Rock Wool
- Cement Industry
- Bricks/Tiles (additive)
- Sandblasting
- Refractory
- Ceramics
- Flux
- Miscellaneous
Summary

1. Minimise Dross Generation in the furnace
2. Consider dross skimming/cooling logistics
3. Rapid cooling and drain important – to maximise Al
4. Disconnect the dross generation process from the secondary dross processing
5. Remelt the Dross in a Tilt Rotary with Salt
6. Press and Rapidly cool the Salt Slag – maximise Al
7. Recycle Salt Slag locally
8. There are markets and uses for the NMP BUT it needs to be inert
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