Metal Quality and Technology in Europe means Added Value?

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Scope

- The European Industry Landscape
- Evaluating Billet Quality
- Innovative Scrap Processing
- Global R&D Trends
- Managing Knowledge Assets
- Does Europe have a Sustainable Advantage?
EU-25 Aluminium Flow Chart (2005)

Primary Aluminium Regional Balances

Expect more Billet from these regions


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## Extruded Metal Quality

### Geometric Tolerances
- Weight per metre
- Dimensional accuracy
- Bow
- Flatness

### Surface Properties
- Reflectivity ✔
- Topography ✔
- Uniformity ✔
- Anodising Response ✔

### Mechanical Properties
- Strength ✔
- Toughness ✔
- Formability ✔
- Fatigue ✔

### Defects
- Die lines ✔
- Speed tears ✔
- Stains
- Pick-up ✔
- Scratches
- Blisters
- Marks

### Other
- Corrosion resistance ✔
- Welded Properties ✔

✔ Influenced by billet quality
Examples of Composition Control on Quality

Intermetallics

% Alpha

wt.% Si

Exit Speed (m/min)

Surface Pick-up

wt.% Si

Brassard et al
Alcan
ET'04
Metal Cleanliness with Prefil®: Pressure Filtration

CLEAN (High Flow Rate)

Increasing Inclusion Content

High Inclusion Content (Low Flow Rate)

Data Acquisition System

N-Tec
Prefil® Metallographic Inclusion Analysis

Wide Inclusion Band
Many Inclusions

Aluminium

Inclusion band

Filter grains

N-Tec

Smelter
Melter
Transfer
Holder
Launder
Degasser
Filter
Casting

Al₄C₃
(TiV)B₂
Al Borocarbides
Al₂O₃ films & particles
MgO films & particles
Spinel films & particles
AlN
Refractory particles
Fe Mn oxides
Bone ash

Note this is not a comprehensive list
Example of Analysis of Billet Defect - Cracking

- Detailed Metallography
- SEM & EDX
- Fingerprint against defect library
- Root-cause analysis

Grain Structure

SEM SEI

EDX spectrum

MgO Water

Grain Structure

EDX spectrum

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Evaluation of Billet Quality – Intermetallics

Red superimposed image of Mg_2Si

Graph showing the relationship between the application concentration of Si and Fe+Mn, with markers indicating the percentage of Alpha (46%) and Beta (54%) phases. The graph also includes a table comparing the percentage of Alpha phase at different locations: Bottom (70%), Middle (65%), and Top (60%) with corresponding mid-radius and center measurements.
Evaluation of Billet Quality

- Billet is the critical starting point for extrusion Quality
- Expect new Billet Suppliers from developing Countries
- Evaluation techniques exist to measure billet quality
- Technical Audit of Suppliers

Need to insist that billet suppliers are meeting your requirements
Environmental Benefits of Aluminium Recycling

- Aluminium Smelting is highly energy intensive.
- Remelting of recycled aluminium consumes only 5% of the energy required for primary production.
- Recycling is far less Greenhouse Gas intense.
- Alcoa utilises about 20% recycled metal for fabricated products.
- Alcoa is publicly committed to 50% of fabricated products from recycled metal by 2020.

Conference Board Session on Sustainability
Randy Overbey President, Alcoa Primary Metals Development, June 2005
Growth of Old Scrap (Post Use)

Global Aluminium Recycling Committee 2005
Up-Cycling of Light Alloys from Recycled Scrap

- Aim to prevent down-grading of wrought-alloy Old Scrap into casting alloys.
- Deliver Value-Added products for Recyclers
- Based on Melt Conditioning by high shear of liquid metal.
- Family of technologies developed at Brunel University.
- £1.2M over three years from UK Technology Strategy Board
- Innoval is Lead Partner and Technical Manager.
- Started March 2007.
High-Shear Twin-Screw Melt-Conditioning

Feeding DC Caster

Centre

Edge

Mg-alloy AZ31 Φ60mm billet
Examples of Potential of Melt Conditioning

Mg-Alloy AZ91D

- Yield
- UTS
- Elongation

<table>
<thead>
<tr>
<th>Yield</th>
<th>UTS</th>
<th>Elongation</th>
</tr>
</thead>
<tbody>
<tr>
<td>250</td>
<td>300</td>
<td>8</td>
</tr>
<tr>
<td>225</td>
<td>275</td>
<td>7</td>
</tr>
<tr>
<td>150</td>
<td>200</td>
<td>6</td>
</tr>
</tbody>
</table>

LM25 (Al-10.3Si-0.3Cu-0.16Mn)

Quality unaffected by scrap recycling

Fe tolerance increased by 0.37 wt%
<table>
<thead>
<tr>
<th><strong>SME’s</strong></th>
<th><strong>Independent</strong></th>
<th><strong>Global Companies</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Entrepreneurs</td>
<td>Investing in long-term sustainability of their operations</td>
<td>Usually invest most in technology development</td>
</tr>
<tr>
<td>Development usually undertaken in technologically advanced regions</td>
<td>Need to protect and enforce IPR position to prevent copying</td>
<td>Make financially driven decisions to satisfy shareholders</td>
</tr>
<tr>
<td>If necessary, will licence globally to get return on investment</td>
<td>Developer has first mover advantage, but for limited lifetime</td>
<td>Often put plant in lowest cost region regardless of where technology developed</td>
</tr>
</tbody>
</table>

Needs a continuous through-put of ideas and innovations
R&D Policy Response

EU Framework 7
- Collaborative and International
- 50% funding (75% for SME’s)
- Focus on science, technology development and exploitation for benefit of EU

UK Technology Strategy Board
- Collaborative within UK
- 50% funding
- Need supply chain in place for exploitation

University Education
- EU is continuing to invest in producing a high number of science and engineering graduates.
Value-Added Opportunities

- Design
- Die Coatings
- Cost Reduction to enable penetration into new markets

**New Profiles & Processes**

- Product Differentiation
- Technically demanding products

**New Alloys**
- High Strength Aerospace Alloys
- Weldable medium strength 6000-series Alloys
- Metal Matrix Composites

**Finishing Operations**
World Labour Costs by Region

Investing in State-of-the-Art Equipment

Source: CRU International Ltd.

State-of-the-Art Equipment is Not Sufficient

- Realisation that investment in world class equipment does not on its own give world class products.
- Many examples in aluminium rolling mills and extrusion plants.
  - Return on investments taking longer than planned
  - Cannot match quality of world-class products
  - Need expertise that equipment suppliers do not possess

Equipment manufacturers looking to partner with product specialists to deliver a complete package
Managing Knowledge Assets

- Important to maximise the knowledge that exists in existing employees
  - Staff with valuable knowledge which is not exploited
  - Loss of long-serving, knowledgeable employees
  - Share knowledge of manufacturing to improve product quality
  - Determine gaps in the knowledge base (R&D programme)
  - Standardise operations and develop “Best Practice”

Knowledge Management using K-Maps
- Based on ‘The Voice of the Customer’ or QFD (Quality Function Deployment)
- Team-based Workshop approach involving
  - Manufacturing
  - Technology
  - Sales
Knowledge Mapping Matrix

How to Build a K-Map

- Assemble those with knowledge
- Define Product Attributes
- Define the Process Stages
- Define the strength of relationship
- Develop content via Intranet
Effect of Cooling on Strength: Medium

What is happening?

During cooling from the extrusion press it is important to keep the Mg and Si in solid solution so that the section can achieve the required age hardening response without the need to carry out a separate solution heat treatment and quench.

In order to achieve this the section must be cooled to temperatures below about 250°C within a few minutes. If the cooling rate is not sufficient then coarse Mg$_2$Si particles can form during cooling, resulting in low strength after ageing.

The steps within Cooling which affect Strength are highlighted under 'List Steps'.

How are these controlled?

- Ensure that the air hood is correctly positioned
- Ensure there are no blockages in the air jets
- Switch on the air jets and fans
- Adjust the airflow to the required percentage for the profile weight as given on the works order.
  
  Note: the water quench should not be used on 6063
K-Map Case Study - Enthovens Pb Battery Recycling

- Actual Standard Operating Practice captured and agreed by all shifts for the Refinery.
- 14% increase in output.
- 3% reduction in fuel use.
- Improved Team Work throughout Plant.
- Currently using P-Map to compare Key Performance Indicators and develop “Best Practice” across 10 European sites.
Summary

- European extruders currently have a technical advantage

- To keep this advantage we need to
  - Keep a robust manufacturing infrastructure
  - Maintain high quality throughout the supply chain
  - Invest in innovation and new technology
  - Fund dynamic and exciting aluminium R&D programmes
  - Manage highly qualified and innovative European nationals

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