
By

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Energy Intensive Production Processes for Aluminum Industry
U.S. FORECASTED GROWTH OF ALUMINUM INDUSTRY SHIPMENTS
(000 METRIC TONS)

SOURCE: ALUMINUM ASSOCIATION & SECAT, INC. - FORECAST
U.S. ALUMINUM INDUSTRY TRENDS

• **CLOSED:** All bauxite mining.

• **DECLINING:** 3 alumina refineries operating.

• **CURTAILED:** Only 14 smelters operating.
  
  • 7 Smelters are operating at full capacity.

  • 7 Smelters are operating at 63% of combined capacity.

• **REMAINING:** Re-melting/Casting/Fabrication.
NUMBER OF PRIMARY SMELTING PLANTS IN THE U.S.

2003: Fourteen (14) Smelters Operating

Best Case (6)
Worst Case (3)

SMELTERS OPERATING - 2003
• 8 Alcoa
• 2 Century
• 1 Alcan
• 1 Norandal
• 1 Ormet
• 1 Columbia Falls

SOURCE: LIGHT METAL AGE & SECAT, INC. - FORECAST
THE U.S. GROWTH IN RE-MELTING
(000 METRIC TONS)

ACTUAL

SECAT INC. FORECAST

2004

RE-MELTED IMPORTED INGOT

NEW SCRAP

RECYCLE SCRAP

RECYCLE SCRAP  NEW SCRAP  RE-MELTED INGOT

SOURCE: SECAT, INC.

S. K. Das
GROWTH OF RE-MELTING IN THE U.S. (000 METRIC TONS)

SOURCE: SECAT, INC.
## ENERGY REQUIRED
SMELTING VS. RE-MELTING

<table>
<thead>
<tr>
<th></th>
<th>SMELTING (BTU PER POUND)</th>
<th>RE-MELTING (BTU PER POUND)</th>
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</thead>
<tbody>
<tr>
<td><strong>THEORETICAL MINIMUM</strong></td>
<td>10,200</td>
<td>510</td>
</tr>
<tr>
<td><strong>CURRENT AVERAGE</strong></td>
<td>26,000</td>
<td>2,200</td>
</tr>
<tr>
<td><strong>PRACTICALLY ACHIEVABLE</strong></td>
<td>20,000</td>
<td>925</td>
</tr>
<tr>
<td><strong>ENERGY EFFICIENCY SAVINGS OPPORTUNITY (BTUs / LB.)</strong></td>
<td>6,000</td>
<td>1,275</td>
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</table>

*Source: Choate/Green/DOE*
U.S. ENERGY EFFICIENCY SAVINGS OPPORTUNITIES
RE-MELTING VS. SMELTING
(U.S. - TRILLIONS BTUs PER YEAR)

CROSSOVER POINT = 2006
CONCLUSION

Going forward from 2004, the best opportunity for improving energy efficiency and lowering energy consumption in the U.S. Aluminum Industry is by focusing research upon re-melting.
Energy Use
by the U.S. Aluminum Industry

Total U.S. Energy Use Trillion (10^12) Btu/year in Aluminum production

Energy Use by the U.S. Aluminum Industry
Energy Use per Lb. of Aluminum Production for the U.S. Aluminum Industry
Overall (Gross) Energy Efficiency for Aluminum Industry Processes
Use of Electricity and Fuel for Aluminum Production Processes
Four Systems offer major energy saving opportunities in Secondary Aluminum Industry Plants

- Process Heating/Burners: 60% to 80%
- Electric Motor Systems: 10% to 25%
- Compressed Air Systems: 2% to 5%
- Pumping Systems: 5 to 10%

The numbers show the percentage of total energy used for the specific system.
Process Heating in Aluminum Production

Types of Processes where Heat is Used

- **Primary Aluminum Production**
  - Drying
  - Calcining
  - Heating - Anode baking
- **Secondary Aluminum Production**
  - Metal Melting
  - Metal Heating
  - Metal Heat Treating
- **Fabrication and Finishing**
  - Metal Heating
  - Fluid Heating
  - Heat Treating
  - Drying
  - Curing and Forming
Process Heating

Process heating consumes more than 70 % to 85% of the total energy used for the secondary aluminum industry

- Process heating systems are used for melting, heating, heat treatment, drying, smelting, roasting, fluid heating etc.
- Process heating equipment include furnaces, melters, ovens, heaters, dryers etc.
- These equipment use fuel (natural gas, oil etc.) and electricity as source of energy
- Process heating offers significant (usually more than 50%) energy savings through application of new developments through R&D for heating equipment
Process Heating Energy Issues

- Low efficacy of furnaces
- Excessive maintenance of furnace parts (refractories, burners, radiant tubes, recuperators etc.)
- Availability of simple and reliable sensors and controls for flue gas composition (NOx, O2 etc.)
- High turn-down, low NOx burners
- Models and tools to predict heating and soak time for a variety of sizes and shapes in heating/heat-treating furnaces
- Life of recuperators for air heating
Environmental Issues

- NOx emissions from burners and furnaces
- Particulate emissions from furnaces
- Emission from recycled scrap processing (volatiles, inorganic etc.)
- Emissions from coating processes (volatiles, fumes etc.)
- Dross processing and residual disposal
Major Sectors of Aluminum Industry
Areas for Process Heating R&D Opportunities

Bauxite

- Aluminum Refining
- Primary Aluminum Smelters

Alumina (Imports)

Primary Ingot Casting

Ingot, slab (Imports)

Scrap Based Secondary Aluminum Smelters

- Semi-Fabrication Sheet, Plate, Foil
- Semi-Fabrication Other Products (extrusions, bars, wires etc.)

Exports

End Products Fabricators

- Final Consumption

Scrap

Secondary Melting and fabrication

Exports

Final Consumption

Scrap
Research Priorities for the Aluminum Industry

- Most of the research should be done in recycling and remelting areas.
- Develop and design aluminum remelting furnace for the future that minimizes melt loss, increase cost effectiveness, increase safety, improve fuel/energy efficiency, improve melt rates and reduce emissions.
- Develop a low cost process for metal purification of primary alloys from recycled scrap. This includes methods to remove specific impurities such as Mg, Fe, Pb, Li, Si, and Ti to produce high-quality metal from mixed scrap.
- Develop new secondary alloys that better match scrap to specifications for increased utilization. Coupled with this is a goal to develop manufacturing processes for scrap-tolerant alloys, such as spray rolling and other rapid solidification processes.
- Minimize the loss of aluminum to oxidation and dross formation during remelting. Priorities include developing a more complete understanding of oxidation mechanisms and developing processes that more effectively separate metal from dross or salt cakes.
Research Priorities for the Process Heating in Aluminum Industry

- Efficient and long-life waste heat recovery systems for combustion air preheating
- High efficiency, low-emission heating systems
- Improved systems for molten-metal recirculation
- Sensors and control system for melting, heating and aluminum heat treating furnaces
- Emission control systems for furnaces
- Improved metallic and refractory materials for furnaces, burners, radiant tubes etc.
- Low cost oxygen supply
- Fuel or energy source flexibility for heating
- Low dross or near-zero melt loss heating system