Aluminium Reduction – Challenges and Opportunities under changing market conditions

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Current market situation - the bad

Preisverfall: Ex-Siemens-Chef schließt größte Alu-Hütte in den USA

Mit Aluminium lässt sich kaum noch Geld verdienen, das zwingt den US-Konzern Alcoa zu einer Schrumpfkur: Das größte Werk in den USA muss dichtmachen, ein deutscher Manager wickelt es ab.

Spiegel.de, 8.1.2016

38% of Chinese smelters bearish toward aluminium prices this week, SMM survey

38% of the 42 Chinese aluminium smelters surveyed by SMM are bearish toward this week’s aluminium prices. Those pessimists fear that LME aluminium will fall below USD 1.500/mt and that SHFE 1603 aluminium will drop below RMB 10.500/mt. They argue ...

AlCircle Newsletter 29.12.2015

Aluminium futures weaken on overseas cues, shed 0.10 per cent

Aluminium prices were down 0.10 per cent to INR 100.70 per kg in futures trade today as investors cut down their bets amid weak Asian cues and sluggish demand in the domestic spot market. In futures trading at the Multi Commodity Exchange, aluminium ...

AlCircle Newsletter 29.12.2015

Marktbericht

Industriemetalle schwächen zu Jahresbeginn

Zum Jahresbeginn ziehen die schwachen chinesischen Aktienmärkte nicht nur die anderen asiatischen Aktienmärkte mit nach unten, sondern wirken sich darüber hinaus auch negativ auf die Metallpreise aus. So wurden teilweise Kursverluste in Höhe von mehr als 3% verzeichnet.

Trimet Newsletter 5.1.2016

Alcoa Portland smelter under threat of closure as power subsidy axed by Victorian Government

The end of a decades-long power subsidy is threatening the future of Portland’s smelter, putting at risk the Victorian coastal community’s economy.

Abc.net.au - 30.05.2016
Current market situation - the good

Russia's RUSAL to start Boguchansk aluminium smelter in H1

Russia's Rusal Plc plans to start its new Boguchansk aluminium smelter in the first half of 2016, the company said on Wednesday, after reporting a 53 percent slide in its fourth-quarter core profit. Rusal, the world's largest aluminium producer, h ...

AlCircle 10.3.2016

Vietnam looks to build 300,000-tpy aluminium smelter by 2016

Vietnam is building a 300,000-tpy capacity aluminium smelter in Dac Nong province that is expected to come online next year, Murray Lines, ceo, Stratum Resources Australia said at a conference last week.

MetallBulletin 26.10.2015

China unstoppable at 2.69mt; August aluminium output continue growing

China is simply not showing any signs of slowing down. The momentum at which the country has been churning out aluminium in the last several months is still continuing. Analysts at the Shanghai Metals Market (SMM) are of the opinion that aluminium pr ...


Alba sees Line 6 expansion project on track

BAHRAIN, December 14, 2015

Aluminium Bahrain (Alba), one of the world's largest aluminium smelters, said that work on its Line 6 expansion project, estimated to cost $3.5 billion, was on track for completion by January 2019.

Trade Arabia 14.12.2015
London Metall Exchange

Aluminiumpreis Chart in Dollar - 1 Jahr
London Metall Exchange

Aluminiumpreis Chart in Dollar - MAX

Währung: USD  Optionen

1 Woche  3 Monate  1 Jahr  3 Jahre  5 Jahre  Maximal

Finanzen.net 15.8.2016
Compared to main energy carriers

- Aluminium
- Oil
- Coal
LME and Phelix Baseload follow the same trends at the moment, Resulting in acceptable conditions
Globale Produktion
Aluminium production 1999

Total for 1999: 23,721 thousand metric tonnes of aluminium

- North America - 6,169
- West Europe - 3,720
- Asia (ex China) - 1,966
- China Reported - 2,598
- GCC - ND
- China Estimated Unreported - ND
- Oceania - 2,028
- South America - 2,093
- Africa - 1,095
- ROW Estimated Unreported - 468
Aluminium production 2014

Total for Jan 2014 to Dec 2014: 53,127 thousand metric tonnes of aluminium

North America - 4,585
West Europe - 3,596
East & Central Europe - 3,764
Asia (ex China) - 2,429
China Reported - 27,517
China Estimated Unreported - 0
South America - 1,543
GCC - 4,832
Africa - 1,746
Oceania - 2,035
ROW Estimated Unreported - 1,080
Energy source for aluminium production (2014)

World Reported for 2014: 690,170 Gigawatt hours (GWh) (power mix)

- Hydro
- Coal
- Gas
- Nuclear
Latest potroom projects (excluding China) since 2008

- Boguchansk RA-300 600kt; 2016
- Arvida AP60 60kt; 2013
- Kitimat AP30 440 kt; 2015
- Fjardal (AP30) 350kt; 2008
- Qatalum HAL250 585kt; 2011
- Sohar AP30 375kt; 2008
- Ma'aden AP30 740kt; 2014
- Emal DX/DX+ 1.400kt; 2009-14
- THQ AP3X 450kt; 2016
- Alba Line 6 DX+ 514kt; 2019

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WARNING: this data is not complete!
Quantitative development of Al production

China: +18Mtpa
RoW: -0.2Mtpa
The „Virtual Battery“

- Why
- What
- How
Virtual Battery - Why?
Consequence for total energy price

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Energy politics
The Biggest Challenge:
How to keep the power grid stable?
Volatility - an example from 2013

Best Day: 21st July
(20.9% of daily demand came from solar panels)

Worst Day: 18th January
(0.1% of daily demand came from solar panels)
Public view of industry has changed
but everyone wants a car like this
2 Questions

How do we survive financially?
How do we survive socially?
Annual energy demand TRIMET:
8 TWh = 8,000,000,000 kWh

Added costs:
+1 ct/kWh
80 million €
What’s next?

„Marriage“ of Industry and Energy Transition
Virtual Battery - What?
Generation & consumption
Energy-intensive industry as a buffer between volatile energy generation & variable demand
Potential contributions by the energy intensive industry

• *Standard Energy Reserve mechanisms*
  - Primary & secondary reserve
  - Interruptibility (e.g. requested during the 2015 solar eclipse!)

• *Black Start support (after blackout)*

• *Demand-Response mechanisms*
  → „Virtual Battery“ for the integration of volatile generation capacity
Abgerufene Leistung aller Werke

Menge laut Anmeldung:
TAC: Ill + 2.162 MW
TAE: H3 85 MW
TAV: 150 MW
THH: 210 MW
Rheinwerk: 247 MW
TRIMET’s contribution

The „Virtual Battery“
Why is that a Challenge? - Temperature

- Aluminium electrolysis takes place close to 1000 °C
- The electrolyte is a molten salt
- Sole heating is by the electrical current passing through the cell

→ Lowering energy input will lead to partial or total freezing of the electrolyte inhibiting electrical current flow
Why is that a challenge? - Temperature (2)

- The molten salt can also dissolve the refractory
- Thus, the electrolyte is only slightly above melting point (<10 °C)
- A protective ledge forms on the refractory

→ Increasing the heat input will dissolve the side ledge, damaging the cell lining and eventually leading to leakage
Why is that a challenge? - Magnetic field

160 kA
metal upheaval 10cm
ACD 5cm
Why is that a challenge? - Magnetic field (2)

200 kA
metal upheaval 15cm
ACD 0cm
The potentials of the Virtual Battery

Current (conventional) operation:
95 MW Baseload per potline, constant during 8,760 h p.a.

Future:
Flexible Operation within +/- 25% Band for 48 h

Flexibility: +/- 25 MW
Storage capacity: 25 MW x 48h = 1,200 MWh

Storage capacity is equal to that provided by a pump storage!

More than 50% already achieved!
Advantages / disadvantages

+ 
Attractive specific storage costs
No acceptance issues in society
No added environmental impact
No long approval procedures
High storage efficiency
No added land usage

- 
Financing added operational costs
Funding of required investments
Energy efficiency & energy storage

Building bridges to help make Germany‘s Energiewende a success!
Virtual Battery - How?
Operational challenges

1. Thermal
   i. Short term changes
   ii. Long term changes

2. Magnetic
   i. Short term changes
   ii. Long term changes
Stages in the project

3. First prototype SHE developed (2013)
4. SHE roll-out to 12 Booster cells (2014)
Shell heat exchangers („SHE“)
Duct & fan system for SHE

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Magnetic Field Compensation
Magnetic compensation
Challenges of installing additional bus bars

About 6t of additional bus bar were installed per cell

- Steel sheel and potline statics
- Minimal contact resistance
- Welding only during power outage
- Limited number and duration of power outages
- Continued operation
- Time constraints
Magnetic compensation - the results

- Reduce metall upheaval from ~9cm to ~4cm
- Reduce ohmic resistance of the bus bars
- More uniform current distribution in the lining
Change in metal heave due to compensation

Metall heave in cm
red = before
blue = after

9cm
5cm
Cell control system
Early trials
Reaction of temperature & liquidus

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Proven modulation capability
Effect of magnetic compensation

30d running average SpEC:
red = test cells
blue = comparison group
green = difference
Status of trials (July 2016)

Bisher bestätigte Speicherleistung der Virtuellen Batterie (extrapoliert von 12 auf 360 Öfen)

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Next steps

- Push the boundaries to +/- 25% modulation, after confirmed good performance at -13/+25% so far.

- Implement Energy Counter to keep track of cell heat status and improve cell control when modulating.

- Improve bath chemistry control.

- Align work practices with modulation.

- Optimize cell lining design.

- Explore how to make use of extracted heat.

- Roll-out to full potline
“It’s not the strongest of the species that survives, nor the most intelligent. It is the one that is most adaptable to change”

Charles Darwin
Thank you for your Attention!

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