Alumina and its many uses
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Despite a well-documented fall in demand for alumina from the refractories market, other applications such as flame retardants and water treatment have remained stable.

Unsurprisingly, the economic crisis of 2009 sent, not just ripples, but shockwaves through the non-met alumina industry. Levels of production and demand have recovered from the severe dip in 2009, but are still not quite to pre-crisis levels. That said, the industry is preparing itself for a recovery.

Approximately 94% of the alumina market is used in metallurgical applications. The remainder, around 5.5m tonnes in 2012, is used in non-metallurgical markets. The largest producer is in Western Europe (see pie chart).

The largest end use for alumina is the refractories industry, which accounts for around 60% of total non-met alumina produced.

In refractories the main products used are calcined alumina, tabular alumina, white fused alumina (WFA) and brown fused alumina (BFA). All of these aluminas (aside from BFA) are obtained using the Bayer process.

2013* total production of alumina for non-metallurgical purposes (tonnes)

- East and Central Europe: 466
- Africa and Asia (not China): 1,137
- China: 1,321
- North America: 815
- South America: 399

*To December 1, 2013 Total: 5.8mn

Source International Aluminium Institute

Alumina and refractories in 2013

Probably the biggest news in the market in 2013 was Almatis’ purchase of Ormet Corp.’s alumina refinery, which marked a step into vertical integration for the company.

The company first announced its intention to purchase bankrupt Ormet Corp.’s refinery in October 2013, for $35.3m.

Germany’s Almatis, the world’s leading supplier of premium alumina, completed the purchase of Ormet Corp.’s 500,000 tpa alumina refinery at Burnside, Louisiana, US, in December 2013.

This meant the company essentially secured feedstock for the production of its alumina products, which it supplies to the refractory, ceramic and polishing industries.

Documents filed with the US Bankruptcy Court in Delaware, US, revealed that the purchase excluded Ormet’s assets at its idled 270,000 tpa aluminium smelter in Hannibal, Ohio, which had been supplied with material from the Burnside plant.

“This was interesting because after long periods of companies spinning out and doing things separately, this signified a spate of consolidation”, Ted Dickson, an independent consultant, told IM.

However, there have been other opportunities in the industry that are noteworthy. The German based Nabaltec, a specialty alumina producer, signed an agreement in 2005 with Nashtec and Sherwin Alumina, a leading US aluminium oxide manufacturer, to produce finely precipitated aluminium hydroxide (ATH) as a non-halogenated, flame-retardant filler that reaches the US market via Sherwin.

The company also revealed that it is looking for other opportunities for further partnerships elsewhere, including Asia, if the right opening presented itself.

Alteo, the speciality producer and the first to produce industrial scale Bayer alumina, based in Gardanne, France, told IM that it continues to eye new markets outside of Europe.

"With 80% of our turnover outside France and almost doubling outside Europe over the last five years, the development of our presence around the world is a major part of our strategy," Frederic Rame, president, told IM.

"We now have three commercial hubs with 14 sales offices. These are located in the main regional zones (Europe, North America and Asia), with an enhanced network throughout Asia permitting us to develop business in these fast growing markets. Furthermore, in addition to the enhancement of our sales team in China, we are sharpening our focus in the Middle East and India," he added.

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<th>Alumina prices</th>
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<td>Alumina</td>
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<tr>
<td>Alumina, calcined, 96.5-99.5% min Al₂O₃, bulk, FOB refinery, USA, $/tonne</td>
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<tr>
<td>Alumina, calcined, medium-soda Al₂O₃, bulk FOB refinery, $/tonne</td>
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<tr>
<td>Alumina, calcined, ground 98.5-99.5% Al₂O₃, bulk FOB US refinery, $/tonne</td>
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<td>Fused alumina, brown 94% Al₂O₃, FEPA 8-220 mesh refractory (mm): Chinese, $/tonne</td>
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<td>Fused alumina, White, 25kg bags, CIF Europe, €/tonne</td>
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<tr>
<td>Fused Alumina, 94% Al₂O₃, CIF, FEPA Grits Acid washed, China, $/tonne</td>
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<tr>
<td>Alumina, brown fused, 95.5% min Al₂O₃, refractory sized, FOB China, $/tonne</td>
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<td>Brown refractory, Al₂O₃ 95.5% min / SiO₂ 120 max / Fe₂O₃ 0.30 max / Magnetite 0.10 max Lumps 0 - 14 / 14 - 20 / 20 - 30 mm FOB China, $/tonne</td>
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<td>Fused alumina, brown 95% min. Al₂O₃, FEPA F8-220 Grit, FOB China, $/tonne</td>
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<td>Hydrated alumina (ATH): Damp (5-60% Al₂O₃, 5-8% moisture) Bulk FOB refinery, $/tonne</td>
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Source: Industrial Minerals

Different aluminas
Calcined alumina can be used directly in refractory applications, as well as a feedstock to produce higher grade alumina products (for example, tabular alumina). Demand for calcined alumina was expected to be around 2.8m in 2013, according to market sources and roughly equal to levels in 2012. Of this number, approximately 20% was intended for WFA, 16% for tabular alumina and 19% for refractories.

Tabular alumina, so called because the end-product of the sintered alumina balls resemble tablets, has seen a rise in demand over 2012, according to China’s Zhejiang Zili. Zili intends to be the world’s largest tabular alumina producer, a position currently held by Almatis. Other producers include Alteo, Japan’s Naigai and Slovenia’s Alusil.

Demand for WFA stands at around half a million tpa, but use is declining as refractories are starting to use tabular alumina over WFA, which is cheaper and more environmentally friendly.

BFA meanwhile is produced by fusing calcined bauxite, and is therefore lower in alumina and cheaper than WFA. Approximately 2.3m tonnes of BFA were produced in 2012, of which the majority, almost two thirds, was produced in China.

Alteo said that its speciality aluminas had performed “particularly well”, outlining that low soda alumina, zirconia alumina and sintered bauxite had performed particularly strongly.

“We have increasingly better results in the refractory and ceramics markets. We will strengthen this leading position, with ongoing products and service development in these and other growing markets such as flame retardants," Rame said.

Away from refractories...

As well as being used in refractories, alumina is also used, as ATH, in water treatment and flame retardants, as well as in other markets.

These sectors are also marginally more protected from economic peaks and troughs as they represent a need for a material in the consumer market which surpasses the industry.

In water treatment, for example, consumers will continue to drink tap water whether there is a recession or not. However, the recession has meant that developing countries have been slow to incorporate rolling out water treatment in residential areas.

Nabaltec, a leading flame retardant alumina producer, told IM that it has seen growth in its functional filler and ceramic raw materials division over the last 12 months.

“The demand for halogen-free mineral flame retardants is globally still high. Here we are very well established in the cable and wire market with our fine hydrates,” Johannes Heckmann, technical affairs board member at Nabaltec, told IM.

Flame retardants in focus
Aluminium trihydrate (ATH) is used as a raw material in the aluminium chemicals industry, which is used in glass and glazes, in
catalyst production, as a flame retardant, a smoke suppressant filler in plastics, as a raw material in fertilisers and as a polishing agent.

The ATH market is divided into chemical applications and flame retardants.

"Between 600,000 and 700,000 tonnes of alumina a year are used in flame retardants", Johannes Heckmann, board director at Nabaltec, told IM.

"Of that figure, approximately 280,000 tpa of alumina is used to make ‘fine hydrants’," he added.

"This is our focus. We see ourselves as well positioned and try to move forward as one of the leading manufacturers of fine precipitated hydrate," Heckmann told IM.

About 80% of fine hydrants are used in cables, wiring and thermoplastics.

Untreated materials tend to be used in carpet underlay or sheeting.

Approximately 150,000 tpa of alumina is used in ground or milled flame retardants which is used in poxy resin, electronic components, wall sheets on the tube and other transport applications, such as the backrests of seats.

New products

Other markets are also being investigated as new developments and products become available. Nabaltec has worked to develop a new product which aims to substitute lead in PVC. This is a carbonate aluminium hydroxide mix and is a patented material called Actilox CACH.

"This is a very different market. We came up with this as we work with a company that approached us and we have the materials," Heckmann told IM.

"It is our goal to diversify not only our product portfolio, but also look for new applications," he added, making a point of the companys’ entrance into the PVC market in 2011.

"As we see new trends in electromobility, we have invented a new product for the Li-ion battery. We are also entering the catalyst market, which is of course a long existing market, but has been, up to now, limited to a few raw materials," Heckmann said.

"The flame retardants market and other products are being looked in to by Alteo," Rame told IM.

"We are working on innovative products for technical ceramics and flame retardant markets," Rame added.

"A good combination of our special hydrate together with specific grinding could be a substitute to the fines, or complementary to that."

"Another product, FLO-2, improves flowability in refractories," the company said.

This product came after Alteo presented an R&D study on low-cement castable refractories.

Substitution

In refractories and ceramics markets the high price of zircon has led to alumina being used in markets where zircon was previously used. Elsewhere, bauxite is being used to substitute high alumina clays and some fused aluminas, according to market sources.

Alteo said it developed its ARZ® alumina range to replace zircon in ceramic tile applications, as it saw an opportunity in this market.

"The zircon market has been very volatile in the last few years (...) And there are some clear benefits from a specific alumina which we have developed and can substitute part or all of zircon in the tile market," Rame said.

"We have been working extensively on this," he added, "We have a good position on the tile market from our aluminas."

Prices

In terms of outlook, Nabaltec admitted that 2014 would ‘certainly be a year full of expectations’. Overcapacity remains an issue, Heckmann told IM, which has created some pressure in the industry, but he admitted that there were ‘some hopes for Europe’ as the world economy grows.

Alteo, meanwhile told IM, that it anticipates some growth recovery in the year ahead.

"While the economic environment remains uncertain, and our visibility limited, we can still anticipate some growth recovery for 2014. In North America, we anticipate good business levels and in Asia, growth should remain attractive. Europe meanwhile starts to show some more positive signs, even though we are still cautious for the near future," Frederick Rame told IM.

"In the meantime, with a constant upward pressure on raw material and energy costs, it seems inevitable that alumina prices will rise in the near future," he added.

Room for opportunity

The alumina market then is growing with the needs of the wider industrial minerals industry. Higher prices in zircon markets, for example, have prompted the development of a substitute alumina product. And the desire from refractory producers to improve flowbility has also led to some innovative new products. Equally, as lead becomes less commonplace in the use of new technologies such as in li-ion batteries, research has shown that alumina can be used here also.

Red mud waste for road construction?

Red mud hit the headlines in 2010 when Hungary’s Magyar Aluminium’s (MAL) Ajka alumina plant saw a torrent of toxic red sludge burst out of an alumina reservoir and tear through local villages. The disaster left nine people dead, more than 150 injured, many tens of houses destroyed and hectares of land contaminated.

Australia’s Curtin University engineers demonstrated that bauxitic red mud waste could be a sustainable material used in road construction.

Red sand, previously an unusable, unsustainable waste product, is derived by washing and carbonating granular matter leftover as residue from the Bayer alumina refining process.

The Sustainable Engineering Group at Curtin University carried out trials using red sand as a subbase and subgrade on a section of road.

“This study demonstrated that triple bottom line analysis of economic, social, and environmental performance indicators for replacing virgin sand and crushed limestone with Red Sand for subbase and subgrade road construction applications and top dressing has significant sustainability benefits,” the report following the study pointed out.

The company used the waste from Alcoa’s Western Australia alumina refineries. Approximately 30,000 tonnes of fine bauxite residue (red mud) and 18,000 tonnes of a coarse sand fraction (residue sand) are generated daily at the company’s three refineries.

“Replacing virgin sand and crushed limestone with Red Sand has been found to be financially feasible from both Alcoa’s and builders’ perspectives due to construction cost savings and potential carbon tax savings,” the report added.

The global inventory of bauxite residue is estimated to be around 3bn tonnes at the end of 2010 (Power et al, 2009) and growing at approximately 120m tpa, making it one of the largest industrial waste streams in modern society.