



Prices for fused alumina, particularly BFA, have dramatically increased over recent months, due to supply problems and shipping costs, as well as the costly nature of fused alumina production itself . Courtesy Washington Mills.

Uphill struggle

A melting pot of supply related factors heralds an uncertain future for the global fused alumina market

by Rachel Backus, *Assistant Editor*

Although the main end-user market for fused alumina, abrasives, is steady, supply of fused alumina worldwide is short. This includes supply from major producer, China, where a shortage of brown fused alumina (BFA) in particular is having a knock-on effect on fused alumina prices.

However, the crisis doesn't end there.

Rising electricity costs, environmental regulations and a shortage of container ships from Asia is compounding the problem. Could this spell a murky future for fused alumina, or a potential opportunity for western producers?

Stable market applications and possible new applications suggest a continued demand for fused alumina, painting a somewhat brighter picture;

however, in all of fused alumina's market applications, there are alternative raw minerals, so the future of fused alumina appears to depend on whether its benefits are not outweighed by its availability and cost.

Supply overview

China's capacity, which accounts for half of the world's supply, has been increasing in recent years, while fused alumina production in the rest of the world has decreased. Many western producers are now venturing in China (*see accompanying table for main producers*).

Hans-Georg Leitner, sales manager for Germany minerals for abrasives division at Treibacher Schleifmittel told **IM**: "In early 2007, Treibacher Schleifmittel took over another plant in China, as it

wants to be presented on the Chinese market and end user markets. In China, Treibacher Schleifmittel only produces BFA, a commodity product. This is produced partly for the domestic market and partly for export. All Chinese tax increases have been passed on to the customers."

However, while China's capacity is increasing, there still appears to be problems with supply from China. Furthermore, the quality of Chinese products seems to be less reliable than that of the western producers.

A non-Chinese BFA producer added: "Material from China is becoming increasingly expensive and also the quality of what is available is often unreliable. Now customers want to reduce risks by increasing purchases

from local European producers even if that means paying more”.

Industry consultant, William McCracken, formerly with Harbison-Walker Refractories Co. and F&S Alloys and Minerals commented: “With the steadily-increasing pressure being put on all mineral raw materials in China, it is proper to anticipate that there will be supply problems with such a bauxite-related important key material as BFA”.

Leitner continued: “There is a general direction towards higher quality products and applications; therefore Treibacher Schleifmittel opened a new R+D centre at the end of 2004. Treibacher Schleifmittel’s main capacities are still in Europe. Treibacher Schleifmittel Europe produces higher quality products than its Chinese counterpart for the world market.”

Anne Williams, manager of marketing services at Washington Mills, told **IM**: “In response to this turbulent and unpredictable environment, customers find value in the quality and certainty of supply from a North American “safe haven” producer like Washington Mills. These trends of a rapidly developing China are likely to continue and intensify in the future. This suggests that today’s lean manufacturers will want to rely more on vertically integrated domestic suppliers that can provide stability to their critical manufacturing processes.”

China’s supply problems are, according to Washington Mills: “The most significant recent development in the global fused alumina market”. This problem has increased the cost and reduced the availability of BFA and

Fused fundamentals

Fused alumina – formed in electric arc furnaces – comes in various forms, the most common of which are white (WFA) and brown (BFA). Fused alumina is a granular material with a high density, low porosity, low permeability and high refractoriness. In general, fused alumina has a melting point of approximately 2,500°C and a Mohs hardness of 9. Additionally, pink and black forms are produced by a small number of companies.

BFA

BFA is both the most common form of fused alumina, making up around two-thirds of all output, and probably one of the most widely used abrasives. To make BFA, the electric arc furnace is charged with bauxite, as well as additives to increase the amount of alumina. It is used in a wide variety of applications but mainly in bonded abrasives, particularly grinding wheels for high tensile materials, and coated abrasives such as paper, discs and belts for wood and metalworking.

Grains of abrasive BFA may be calcined before use to increase hardness, or to set ceramic coatings applied to improve the roughened surface and increase the adhesion of the bonding media to the grain. China produces over 50% of the world’s capacity of BFA.

WFA

WFA is the purer (higher grade) form, which consequently is used most readily in refractories. WFA is made from Bayer process alumina and is a friable product. Like BFA, WFA is used in the manufacturing of grinding wheels (both vitrified and resin bonded) and coated

products. These grains are also used for shot blasting purpose and as polishing media; refractory grade WFA is used as raw material for high alumina refractories.

Other fused aluminas

Pink and red fused aluminas are produced by the addition of chromium oxide to WFA, which increases the toughness of the finished product. Pink fused alumina contains less than 2% chromium oxide and has a Knoop hardness of 2,150 compared to 1,950 for WFA. Small amounts of titanium oxide are also added to increase toughness. Pink fused alumina (PFA) has medium sized sharp or blocky grains, which make it suitable for precision broad surface and tool room grinding of hard alloy steels.

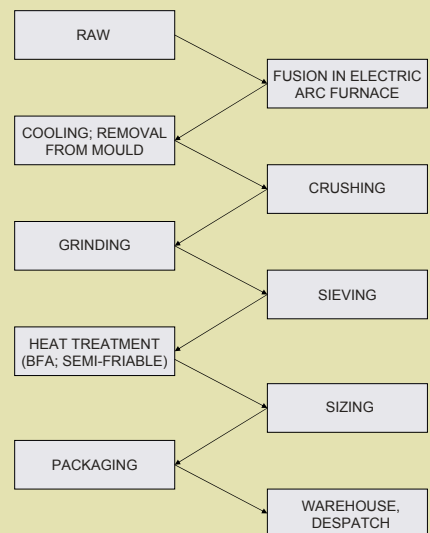
Red fused alumina has a higher chromium oxide content of around 3% with small quantities of silicon oxide, ferrous oxide, sodium oxide, calcium oxide and magnesium oxide. This fused alumina has blocky, sharp edged, friable grains and is tougher than pink grades

Production

- during fusion, bauxite or alumina is transformed at temperatures of above 2,000°C into a liquid state by electric arc furnaces
- cooling of the fused alumina ingots takes more than one week
- following fusion and cooling, the ingots are ground
- the classification in sieving towers, arranged in cascade order
- sedimentation tanks for classification
- additional refining steps to further improve the properties of the grain
- final sieving inspection before packaging
- weighing and packaging

Fused alumina production capacity, 1995, 2000 and 2003 ('000 tpa)

	1995	2000	2003
Australia	100	50	50
Austria	60	60	60
Brazil	100	50	50
China	400	450	600
France	45	40	40
Germany	150	80	80
India	20	40	40
Japan	55	50	25
Ukraine	90	90	80
USA & Canada	220	220	88
Others	150	80	80
Total	1,390	1,190	1,110



Major fused alumina producers (> 50,000 tpa)

Company	Plant location	Products	Capacity
Rio Tinto Alcan	Gardanne, France	WFA, BFA and brown semi-friable fused alumina	
Boksitogorsky Glinozem (Rusal)	Boksitogorsky, Russia	WFA	110,000 tpa
C-E Minerals (Imerys)	Newell, USA	BFA	
	Puerto Ordaz, Venezuela	WFA	
	Xiwen and Zhanjiang, China	BFA	
China Qisha Group Co.	Qingzhen, China	WFA, BFA	100,000 tpa
Elfusa Geral de Eletrofusao Ltda	Sao João da Boa Vista, Brazil	BFA, WFA, PFA	120,000 tpa
Henan Mianchi Great Wall Corundum	Mianchi, China	WFA, BFA	50,000 tpa
Motim Electrocorundum Ltd	Mosanmagyaróvár, Hungary	WFA for refractories, abrasives and ceramics	50,000 tpa
Nanchuan Jingshan Fused Alumina	Nanchuan, China	BFA	50,000 tpa
Saint-Gobain	Japan Abrasives Co., Sakai City, Japan	WFA	
	S-G Abrasivos Ltda	BFA, WFA	30,000 tpa
	S-G Abrasivos, Huntsville, USA	BFA, WFA	
	Chippawa, Canada	WFA, WFA, Al-Zr	
	S-G Abrasivos, Kolo, Poland	BFA	10,000 tpa
Taiyuan Twin Towers Aluminium Oxide	Taiyuan, China	BFA	60,000 tpa
Treibacher Schleifmittel AG (Imerys)	Villach, Austria (headquarters)	Bonded abrasives (BFA, WFA, PFA, semi-friable fused alumina and special fused alumina) Coated abrasives (BFA, WFA, PFA, semi-friable fused alumina and special fused alumina) Refractories (BFA) Ceramics (WFA) Dust collector fines (BFA, WFA, PFA, semi-friable fused alumina and special fused alumina) Blasting media (BFA, WFA) Specialised applications ((BFA, WFA, PFA and semi-friable fused alumina)	300,000 tonnes
	Domodossola, Italy		
	Ruse, Slovenia		
	Laufenburg, Germany		
	Sokolov, Czech Republic		
	Niagara Falls, USA		
	Andersonville, USA		
	Guiyang, China		
	Kaili, China		
	Zschornowitz, Germany		
	Puerto Ordaz, Venezuela		
Salto, Brazil			
Washington Mills Electro Minerals Corp.	Niagara Falls, Canada	BFA, WFA.	120,000 tpa (including 50,000 tpa capacity BFA tilt furnace in Canada)
	Niagara Falls, USA		
Zaporozhsky Abrazivny Combine	Zaporozhye, Ukraine	BFA and silicon carbide	90,000 tpa
Zunyi Jingshan Brown Fused Alumina	Zunyi, China	BFA	50,000 tpa

good quality bauxite feedstock for fused alumina production.

Chinese fused alumina supply problems are mainly owing to:

- increased Chinese domestic demand
- tighter Chinese environmental controls that restrict the supply of alumina as plants are closed or operate less frequently
- increased Chinese power costs and availability
- efforts to divert scarce bauxite and power resources in China to other more strategic industries
- increased cost of domestic Chinese transportation
- increased sea freight cost and scarcity of bulk ocean vessels

Traders have reported that moves to control production have intensified lately. Chalco, China’s leading producer of aluminium, is pursuing an aggressive strategy of purchasing raw bauxite from mining areas and individual mines nationwide. The Shanxi government permanently closed all shaft and round kilns in June 2007, and some of these were demolished shortly after, thus reducing production capacity of calcined bauxite. Moreover, many rotary kilns are producing at low output levels.

Another industry source added: “The Chinese government wants to control all minerals and completely stop exportation eventually. They have set specific bauxite export reduction targets already and that theoretically ought to help BFA producers but the reverse is true as the bauxite will all go to the aluminium metal producers.”

One Chinese producer stated: “They [overseas consumers] are not going to be able to get bauxite from China.”

This may encourage and provide justification for bauxite operations outside China to start up and/or export in order to produce more BFA in the countries surviving furnaces.

Prices skyrocket

Prices for fused alumina, particularly BFA, have dramatically increased over recent months, owing to supply problems and shipping costs, as well as the costly nature of fused alumina production itself.

Leitner stated: "Fused alumina is a very complex product. Treibacher Schleifmittel has not witnessed many changes over the last three years, but prices are generally increasing due to raw material availability and costs as well as environmental costs. Prices are increasing in double digits: the cost of energy is increasing and raw materials are in short supply. With regards to freight, there is a shortage of containers from Asia to Europe, which is causing freight costs to increase dramatically."

Additionally, producing fused alumina with an electric arc furnace itself is a very energy intensive process, requiring 2,000 kWh of electricity per tonne of product (at standard industry price, the cost of electricity comprises approximately 12% of the product's market value).

Leitner continued: "Treibacher Schleifmittel and other producers are also experiencing problems with exchange rates for the Japanese yen and the US dollar."

Williams stated: "Washington Mills does not expect to see prices come down in the near future and we expect demand to flatten in North America. We do, however, expect the demand for exports to continue to grow as a result of a weaker US dollar."

The large differential between Chinese and USA/European prices led to a decline in the production of crude BFA in the USA and Europe, and to the introduction of a 134% antidumping duty in the USA on processed BFA in late 2003. The duty and a growing shortage of alumina in China resulted in a relative equalisation of prices, which settled at \$700-\$900/tonne FEPA 8-220, European/USA; and \$580-\$600/tonne FEPA 8-220, FOB China in October 2007.

Chinese producers dominate the production of non-metallurgical aluminas, especially BFA. The supply of low cost Chinese fused alumina has, over a period of years, forced producers in the USA and western Europe out of the market. With reduced world production capacity and buoyant demand, the price of both refractory and abrasive grade BFA is forecast to continue rising. This may, however, bring some of the producers in the



China's supply problems have increased the cost and reduced the availability of BFA and good quality bauxite. Courtesy Washington Mills.

developed world back into the market, thereby subduing prices.

Prices for WFA, which is favoured by producers in the developed world, will continue to be largely under the control of producers. With stable Bayer process alumina prices, production costs are unlikely to increase significantly in the medium term, and will remain stable.

Chinese BFA producers are forecasting that prices for the refractory BFA could increase by \$200/tonne to reach \$800/tonne before the end of 2007, before stabilising. Prices for BFA jumped by as much as 35% during July/August 2007, and have not stabilised since, probably due to higher coal, cast iron and bauxite prices.

Sources within China have reported that prices have also risen due to agreements reached between the country's largest producers. In July, producers gathered in Zhengzhou, to strike an agreement to allow ex-works prices of abrasive grade BFA finished grits to rise significantly to RMB4,000/tonne (\$533/tonne). Since then, it is understood that producers have had at least three more meetings to set higher prices.

Commenting on Chinese electricity price increases, and forecasting future problems, Mike Sanderson, purchasing director of Vesuvius Advanced Ceramics Co. told **IM**: "BFA is a nightmare following the electricity increases in Henan province...In my opinion I can see a problem when we get closer to

the Olympics as China battles with the pollution problem and I would not be surprised at all of drastic measures are brought in like shutting down large parts of the industry in provinces like Shanxi, Ningxia and Gansu a couple of months before the Olympics to reduce the pollution in Beijing over that period."

Market applications

The main use of fused aluminas is in the manufacture of abrasives, although it is also used in refractories (bricks and monolithics), as well as having some more specialist uses, such as in floor tiles.

Abrasives

Abrasives account for about 60% of the demand for all types of fused alumina. In comparison to other abrasive materials, fused alumina has a higher Young's modulus rating than either aluminium nitride or boron nitride, but is weaker than silicon carbide. Fused alumina containing 99% Al_2O_3 is harder than less pure grades, but not as tough.

As it is more friable than BFA, WFA is preferable where a faster, cooler cut is required. WFA is used for the precision grinding of alloys, high speed and heat-treated steels. Abrasive grade WFA contains 99.53% Al_2O_3 , 0.33% Na_2O , 0.10% Fe_2O_3 , 0.04% SiO_2 and 0.03% C. Its Knoop hardness is 1,950 compared with 1,850 for BFA, and it melts at 2,050°C (2,000°C).

Applications and compositions of alumina abrasives

Type	Composition	Market	Applications
BFA	Al ₂ O ₃ (96.6%), TiO ₂ (2.6%) SiO ₂ (0.6%)	Coated	Belts, non woven wheel pads
		Bonded	Grinding wheels, sharpening sticks, hones, tumbling media
		Blasting	Metalworking, surface preparation, cleaning, deburring
		Polishing	Set-up wheels
		Lapping	Creating parallelism, flatness
		Investment casting	Cleaning, stuccoing, removing shell material
		Compound/buffing	Satin finishing, liquid compound
		Non-slip	Floors, ramps, stairs, walkways, paint
		Stone trade	Designing, lettering
		Brakeshoes/clutches	Linings
WFA	Al ₂ O ₃ (99.08-99.5%)	Bonded	Wheels, grinding high alloy heat sensitive steels
		Blasting	Miniature, metals
		Compound/buffing	Automotive
		Polishing	Non-woven pads
		Lapping	Compounds
		Investment casting	Stuccoing
		Brakeshoes	Friction modifier
		Non-slip	Floors, floor tiles
Alumina-zirconia	AZ (75% Al ₂ O ₃ , 23% ZrO ₂)	Blasting	Metal finishing, surface preparation
		Investment casting	Removing shell material
		Stone trade	Blasting, granite finishing, engraving
	ZF (75% Al ₂ O ₃ , 23% ZrO ₂)	Bonded	Organic grinding wheels, cold pressed snagging
		Tumbling	Deburring
	ZS (75% Al ₂ O ₃ , 23% ZrO ₂)	Bonded	Organic grinding wheels for steel conditioning
	NZ (60% Al ₂ O ₃ , 39% ZrO ₂)	Coated	Belts, discs, jumbo rolls, cutsheets

Source: Saint-Gobain

Overall, the market alumina abrasives is stable, despite the number of factors suggesting its decline. There have, however, been some minor fluctuations: substitution by other abrasives in cathode ray tube polishing has led to some decline in demand for fused aluminas.

Furthermore, falling prices for higher performance abrasives have increased their competitiveness with BFA, and new products, such as the diamond and cubic boron nitride super abrasives – viewed as a potential replacement

for aluminas because less grinding and fewer grinding tools are needed – have been and will be developed as demand for high performance abrasives increases.

However, it is thought that BFA abrasive manufacture in China will gradually increase in China due to its lower production costs. China’s advantage has been attributed to the lower cost power, materials and labour, and less restrictive environmental regulation. However, as China’s domestic demand increases, exports are likely to decrease.

In general terms, abrasives are irreplaceable in industrial applications. A leading producer commented: “Despite efforts made by industry to create synthetic and non-mineral based abrasives with some success, the abrasives industry that today is served by BFA has been pared down to essential applications and most of the erosion of these applications by form to fit manufacturing and other abrasive products have ceased”.

Refractories

Refractory BFA’s chief characteristics are high hardness, good toughness and sharp shape in size. Refractory WFA has higher hardness and slightly lower toughness compared with BFA. Among its properties as a high-grade refractory are high purity, acid and alkali resistance, good thermal stability.

The general trend in the refractories market is towards higher purity refractory raw materials, which prolong life, thus reducing replacement frequency. In such a squeezed market, a longer life span is becoming increasingly important to keep operation costs at a minimum.

Leitner stated: “The refractory industry is booming, so there will be no big revolution there. There is a trend in the refractory towards higher quality refractory raw materials. This trend could possibly suggest that in the future, WFA could take over from BFA as a refractory raw material. Whatever the outcome, Treibacher Schleifmittel will follow the rest of the market.”

Other uses

BFA is becoming more popular in abrasive blasting as a replacement for silica sand on environmental grounds.

Leitner commented: “Fused alumina could be an interesting raw material for new applications. There are three main applications for fused alumina: abrasives, refractories and blasting. A growing fourth application is for wear resistance in floor tiles. However, I would not forecast any big changes in the main applications of fused alumina. There are some specific new niche market possibilities arising from heat resistance quality of fused alumina. Treibacher Schleifmittel will look for new applications.”

