

Burning up: A look at the deadburned magnesia market

Vasili Nicoletopoulos takes a look at the global dead burned magnesia market with particular reference to the varying practices being undertaken by companies inside and outside of China.

The supply side

Deadburned magnesia (DBM), also known as 'sinter' and, in the Far East, 'clinker' magnesia, has recently seen a trend towards consolidation in DBM production, with refractory producers worrying about securing captive DBM sources, as well as highlighting the need for DBM producers to develop higher grades to meet the stringent requirements of refractory producers. The sources of DBM are either natural or synthetic. Most natural DBM is made directly from sintering magnesium carbonate ($MgCO_3$) in rotary furnaces - the production method used by Slovenske Magnezitove Zarody (SMZ), Grecian Magnesite, Magnesitas Navarras and Kumas; or in shaft kilns, the route used in China, and by Magnesita, Ma'aden and Kumas's Bommag.

Other natural DBM producers use the intermediate step of magnesite flotation in one of two ways. Single-burning of briquettes made from flotated raw magnesite as practised, for example, in the rotary kilns of Magnesitas Navarras or in the shaft furnaces of Magnesita for their M-10 grade, or double-burning, with an intermediate calcination step, done in shaft kilns, for example, at RHI China, at Magnesita, for their M-30 grade [after double flotation] and at Magnezit. Decades ago, magnesite flotation was also practised by North Korea, Canref in eastern Canada and Fimisco in Greece.

Synthetic DBM is made from seawater or brine, with a third possible route being chemically treating magnesite/dolomite/dolime/serpentine, though this is only used to produce caustic calcined magnesia (CCM) and/or magnesium hydroxide.

The main countries producing synthetic DBM are the Netherlands, the Republic of Ireland, Japan, South Korea, Mexico and the US, with one company in each producing synthetic DBM. In the past, synthetic DBM was also produced by four other Japanese producers as well as other firms in the US and Quigley in Ireland. Synthetic DBM has also been produced by a single plant in each of the UK, India and Jordan, as well as two plants in Italy.

Table 1: DBM producers outside China			
Company/Group	DBM production in	DBM sales to market %	Application
DBM production >200,000 tpa			
RHI N	Austria, Turkey [MAS, Cihan], Ireland, China	None	R bricks, masses
Magnezit N	Russia, Slovakia [Slovmag]	Small	R bricks, masses, W
Magnesita N	Brazil	~10%	R bricks, masses, W, abrasives
SMZ N	Slovakia	Large	R bricks, masses
150-200,000 tpa			
Kumas, incl. Bommag N	Turkey	Some	R bricks, masses, E, other
Nedmag S	Netherlands	100%	R mostly bricks
50-150,000 tpa			
Gmag [Sibelco] N	Australia	100%	R mostly bricks
Ube S	Japan	Nearly 100%	Mostly R
Magnesitas Navarras N	Spain	Very small	R masses, W
Grecian Magnesite N	Greece, Spain [40% of Navarras]	Some	R masses, W, E, other
Ibar N	Brazil	None	R
<50,000 tpa			
Martin Marietta S	US	100%	R, E, other
Penoles S	Mexico	100%	R, E
Ma'aden N No production currently	S. Arabia	100%	R
Asmas [Minteq] N	Turkey	None	R masses
Konya Krom	Turkey	None	R
Total <50,000 tpa: Daehung, Danchon [or Tanchon], Ryong Yang N	N. Korea	Some	R masses
IRPPCO N	Iran	Some	R
Posco Chemtech S	S. Korea		R
<50k each: Dalmia, Burn Standard, Almora, Tamil Nadu etc.	India	100%	R mostly masses
Total 50-100k, N			
Magnohrom N	Serbia	100%	R

N=Natural DBM, S=Synthetic DBM, R=Refractories, W=Welding, E=Electrical, T=Tanning

Source: Author's data base and correspondence with producers, company websites

Individual DBM producers

Table 1 presents the DBM producers outside China and the applications each one serves. Four classes of DBM production levels are used, in thousand tpa: over 200, 150-200, 50-150, and below 50.

Chinese DBM producers

Reliable Chinese figures are not as readily available in (non-Chinese) reports as production figures for other countries and producers. According to Ian Wilson [MagMin 2013], the five largest Chinese natural DBM producers are Huachen, Haicheng Magnesite & Refractories, Xiyang Refractories, Huaziyu Group, and Houying Co. These producers would fall in the >200,000 tpa DBM production class.

Earlier sources [O'Driscoll, Clarke, Wilson] also list the following significant DBM producers in China, all of which have a production level of over 100,000 tpa. They are; Huayin Group, Yingkou Qinghua, Dashiqiao Guantun, Liaonan Magnesite and, of course, RHI Jinding Magnesite. There is also Dongguang and Anle in Northern Xiuyan, Xiuyan Krosaki Steel in southeastern Xiuyan and a variety of other producers including Shandong Hengxin Magnesite in Laizhou.

Chinese companies known to be among the largest refractory producers in the country include, Haicheng Houying, Huayu, Yingkou Qinghua, Jinlong and Liaoning Zhongxing; all of which are in the Liaoning province. The level of Liaoning DBM production and exports are shown in Table 2, and presented in thousand tpa.

In addition to these companies, the output in Shandong reaches 20,000 tpa for sintered magnesia, 70,000 tpa for synthetic magnesia and 500,000 tpa for light burned magnesium oxide; Shandong does not produce fused magnesia.

Table 2: Chinese DBM producers

Liaoning DBM						
Year	2007	2008	2009	2010	2011	2012
Production	4,650	4,400	3,900	4,231	4,786	3,966
Exports	967	638	170	743	579	667
<i>Thus, exports as % of production</i>	21	15	4	18	12	17

Natural DBM, almost exclusively for refractories, in '000 tpa

Source: Wei Tong & Chen Qingming, Rise and sustainable development of Chinese magnesia industry, Mar 25, 2013

The demand side Refractories

It is well known that by far the main market for DBM is basic refractory bricks and monolithics. Steel and cement are the most important sectors consuming basic refractories, followed by glass, non-ferrous, petrochemicals and other industries.

According to Wilson, (Worldforum 2013), “The main refractory markets for magnesite by industry (based on revenue) are steel (70%), cement/lime (7%), ceramics (5%), metals (5%), glass (4%), chemicals (4%) and others (5%). The major producer is China, with over (50%) of the market. It is estimated by *Freedonia* that world refractory demand in 2014 will reach 40.7m tonnes, dominated by China at 55%, other Asia Pacific countries 13%, Western Europe 8%, North America 8% and other regions 16%.” It is believed that basic Chinese refractories account for more than 50% of world production.

Due to industry consolidation that has taken place in recent years, the main suppliers of basic refractories are increasingly large DBM producers themselves, such as RHI, Magnezit JSC, Magnesita SA, SMZ and Kumas, as well as many Chinese DBM producers.

The same is true, on a smaller scale, and mostly limited to monolithics, for Magnesitas Navarras, Grecian Magnesite, Konyakrom, Asmas, Ibar and Dalmia.

Among the independent producers of basic refractories, Vesuvius, Krosaki Harima, Shinagawa and Refratechnik stand out. Many others follow in Russia, China, Japan, India, Germany, Spain, Poland, Italy, Turkey, the US and elsewhere.

According to *Roskill Information Service*, global production of refractory raw materials fell from 42.6m tonnes in 2011 to 40.4m tonnes in 2012, and further still, to 38.4m tonnes in 2013. The fall was due to a lower demand in the refractories market and as a direct result of lower consumption in key end sectors such as iron, steel, glass, cement and non-ferrous metals.

China’s refractories market is also not as healthy as it has been in previous years due to a slowdown in growth rate of the construction industry. According to consultancy group Research and Markets (*IM 3 April 2014*), the market shrank by 4.4% to 28.2m in 2012. Future demand for refractories will strongly depend on government policies for China’s industry, and in particular, for iron and steel. The consultancy report

revealed that magnesia bricks, magnesium carbon and alumina magnesia carbon dropped by 15.9% and 8.4% year-on-year, respectively.

“In 2012, China focused on the production of high-quality and energy-efficient refractories, which exceeded 40% of the market,” the Research and Markets report stated. However, the study indicates that this percentage is still lower than expected with production targets predicted to reach 60% by 2020.

According to China’s Ministry of Industry and Information Technology (MIIT), Beijing will continue to promote joint reorganisation and enhance industrial concentration in the future, forming two to three internationally competitive enterprises. The government expects industrial concentration of the top 10 companies to reach 25% by 2015 and 45% by 2020.

Non-refractory DBM applications

DBM is also used in a wide range of non-refractory applications that include:

- Electrical insulation components for industrial and domestic devices and appliances
- Magnesium metal production
- Aerospace
- Abrasives and car brakes
- Welding electrodes and fluxes
- Leather tanning
- Covering nuclear waste containers stored underground
- Animal feed
- Magnesia boards

More recent DBM applications are in:

- Oil drilling, ie ceramic proppants and expansion in well cements
- Dental, in mag phosphate tooth cement - a very small tonnage
- Road patching, in quick set magnesia phosphate cements
- Additives for float glass, in cases where dolomite is not readily available

In former times, DBM was also used in night-storage heater bricks, as well as two other older uses of DBM in fettling in open-hearth furnaces (with Slovak material being prominent) and fusion-casting (Greek DBM for Le Pontet of France) but these applications should be more properly classified under refractory uses.

European DBM and EFM imports in 2013, by country, in tonnes	
Germany	533485
Netherlands	305833
Austria	219926
France	131653
Slovenia	128456
Italy	105816
Poland	103477
United Kingdom	69843
Spain	61806
Czech Republic	45540
Other 16 countries	156503
Total 26 countries	1862338

Source: intracen

A note on the steel industry

Global steel consumption from 2007

clearly shows the rapid emergence of China and the fall in the EU that has been among the worst hit during the global economic downturn.

In Q1 2014, Asia produced 274m tonnes of crude steel, an increase of 2.6% over Q1 2013. The EU produced 43.8m tonnes of crude steel in Q1 2014, up by 6.7% compared to Q1 2013. North America's crude steel production in Q1 2014 was 29.9m tonnes, an increase 0.8% compared to Q1 2013. The CIS produced 26.3m tonnes of crude steel in Q1 2014, a decrease of 2.8% over Q1 2013.

There are worrying phenomena that spell trouble for refractories producers and those supplying the minerals for refractories. Firstly, the crude steel capacity utilisation ratio for the 65 World Steel Association (worldsteel) countries in March 2014 was only 79%. Secondly, and most importantly, even with this relatively low capacity utilisation, the steel industry worldwide is over-producing and registering losses.

The latest figures from China, the world's largest steel producing country, indicate that the steel industry struggled in Q1 2014. Zhang Changfu, secretary general of China Iron & Steel Association (CISA), told local reporters that: "Q1 2014 has been the most difficult quarter for [the] Chinese steel industry since the new millennium. We have already felt a deep coldness (É) the Chinese steel industry recorded a loss of around \$400m during Q1 2014."

In the US, steel imports rose by 36% in Q1 2014 from Q1 2013, with the Economic Policy Institute declaring the "worst import crisis" for the US steel industry since the mid-2000s.

The problem is that there is massive overcapacity in the world steel industry driven mainly by China and a slowing Chinese economy. Chinese steel is flooding export markets worldwide. China's steel production is at record levels despite a weaker domestic demand, and the country's steel exports cause friction with trading partners.

China's government vowed last year to reduce excess capacity in its state-owned steel industry. However, production has continued apace as Beijing worries about slowing economic growth. The government recently said China's crude steel production in April 2014 rose by 2% to a record daily average of 2.3m tonnes. The previous record was set in March 2014.

Table 3: Chinese DBM 2013 exports, by month in tonnes

Products	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
DBM	71,587	14,456	27,025	51,256	28,193	27,935	49,267	61,669	43,431	32,934

Source: Asian Metal

Table 4: Top 10 Bidding Winners and Their Quotas in the 1st Bidding for Export Quotas of Magnesite 2013

Name of Enterprise	Quota (Tonne)
Liaoning Jiayi Metals & Minerals Co., Ltd.	75,367
Haicheng Houying Trade Group Co., Ltd.	75,134
Haicheng Huayu Group Import & Export Co., Ltd.	47,395
Jiachen Group Co., Ltd.	44,705
Haicheng Xiyang Import & Export Corporation	33,207
Yingkou Guoli Import & Export Co., Ltd.	31,703
Liaoning Huiming International Trade Co., Ltd.	24,429
Dashiqiao New Type Import & Export Co., Ltd.	21,343
Anshan Xiuyan Magnesite Group Co., Ltd.	19,003
Dalian Golden Sun Import & Export Co., Ltd.	18,682

Source: MOFTEC

On the cement industry

A very similar picture to the world steel situation emerges in world cement production by region for 2001-2012. The rapid growth of China and the fall in the EU become clear.

In India, a study by management consultants AT Kearny and the Confederation of Indian Industry has said that the per capita consumption of cement is expected to grow to 385-415kg by 2025 from 185kg at present. According to the study, cement

demand is likely to increase by 2.5 to 2.7 times to 550-660m tpa over the same time period. While the infrastructure segment would lead the growth, the residential segment will continue as the largest consumer, constituting 42-45% of total demand.

Trade of Chinese DBM

For the last 30 years, Chinese DBM has set the price, not only for natural DBM worldwide, but also for a significant part of the international basic refractories market, even though the Chinese export licence system remains in place with mainstream prices for magnesia export quotas currently at Chinese remimbi (Rmb) 600-650/tonne (\$98-106/tonne), VAT included.

Chinese DBM is also an important factor when capacity expansion projects are considered outside China. Thus it is worth examining commercial aspects of this product in some detail.

Exporters from China include: China National Minerals, Dashiqiao Hongyu Refractories, Dashiqiao Huamei Group, Donggang Rongfei Minmetals, Haicheng Fengchi Refractory, Haicheng Houying Trading, Haicheng Huasheng Group I/E, Haicheng Xiyang Group I/E, Huafei International Transport Agency, Huiming International Trade, Jiachen Group, Liaoning Jiayi Minmetals, Liaoning Sancai Minerals (Group), Liaoning Zhongxing Minerals, Yingkou National I/E, Yingkou Port Cargo Agency, Yingkou Qinghua Group Import & Export Liability, Yingkou Ruigu Refractories, Yingkou Yiyang Refractory Materials and Yingkou Zhongkai Minerals.

Regarding prices, **IM** quoted prices for magnesia, dead-burned, lump, FOB China as being for MgO 90% \$240-270, 92% MgO \$410-450, 94-95% MgO \$450-480, 97.5% MgO \$470-490 in May 2014, but these have since been increased (*see p55*).



DBM produced by Magnesita Navarras

Regulatory issues

As is the case with many industrial minerals, the DBM sector is affected, directly or indirectly, by government regulations.

At the national, or even local level in the established market, there are issues of land use, planning and other permitting, environmental regulations, taxation and royalties, including special depletion allowance and/or investment credits as in Spain, or

investment grants as in Greece, research and development (R&D) tax credits as in the US.

China features an export licence system that includes import and export tariffs, programmes of curtailing undervaluing cargos to avoid paying the full export tax, efforts to combat smuggling and curtail ineffective production, and more recently, the establishment of greenhouse gas emissions markets in China.

At the EU/EFTA level, DBM production could be affected negatively by the EU ETS regime. Magnesia is in the list of ETS sectors exposed to significant risk of carbon leakage and a public consultation on the Carbon Leakage Provisions Post 2020 is looming.

On the positive side, the EU has launched the Raw Materials Initiative and several R&D programmes. In the commercial policy domain, an EU anti-dumping regulation against Chinese DBM was in effect from 1992 until May 2011, while there was a brief period in the early 1980s with a provisional anti-dumping duty against North Korean DBM.

Other EU initiatives or regulations potentially impacting DBM are the product's possible characterisation as a 'critical raw material', the revision of best available technologies [BAT] on environmental matters, the energy taxation directive, regulations regarding energy efficiency, waste disposal, nitrogen oxide (NOx) limits and silica levels.

At the supra-national level, the resources world awaits China's reaction to a World Trade Organization (WTO) decision against the Chinese export system regarding rare earths, tungsten and antimony.

IM magnesia prices		
Magnesia/Magnesite	Low	High
Magnesia, dead-burned, 94-95% MgO, lump, FOB China, \$/tonne	350	450
Magnesia, European calcined, agricultural, CIF Europe, €/tonne	240	350
Magnesia, dead-burned, 90% MgO, lump, FOB China, \$/tonne	255	270
Magnesia, dead burned, 92% MgO, lump, FOB China, \$/tonne	320	400
Magnesia, calcined, 90-92% MgO, FOB China, \$/tonne	255	280
Magnesite, Greek, raw, max 3.5% SiO ₂ , FOB East Mediterranean, €/tonne	65	75
Magnesia, dead burned, 97.5% MgO, lump, FOB China, \$/tonne	450	485
Magnesia, calcined 94% MgO lump, FOB China, \$/tonne	435	535
Magnesia, fused, 98% MgO, lump, FOB China, \$/tonne	1023	1100
Magnesia, fused, 97% MgO, lump, FOB China, \$/tonne	890	1000
Magnesia, fused, 96% MgO lump, FOB China, \$/tonne	600	630
Magnesia, fused, refractory grade, FOB USA, \$/tonne	1035	1925
Magnesia, fused, electrical grade, ex-works USA, \$/tonne	1780	2900
Magnesia, fused, European, FOB Europe, \$/tonne	450	720
Magnesia, calcined 96% Mgo lump, FOB China, \$/tonne	480	590
Magnesia, fused, electrical grade, ex-works UK, \$/tonne	1500	2500

Source: IM Prices Database

Future trends in DBM production and sales

On the production side, it seems likely that the current trend towards consolidation in the refractories industry will continue, with a similar phenomenon taking place in DBM production as per the RHI model. Refractory producers will continue to worry about securing captive DBM sources, barring dramatic phenomena like an abolition of the Chinese export licence system on magnesia, a significant downturn in international aggregate demand as well as inside China, or impediments to Russian magnesia exports as a result of economic sanctions because of events in the Ukraine.

In terms of technology, emphasis will be placed by DBM producers into further developing higher grades to meet the stringent requirements of refractory producers.

On the processing side, automation, energy-saving and environmental considerations will be the driving forces. Examples could include installing modern preheaters as

demonstrated by Magnesitas Navarras or utilising waste heat with methods such as pyrolysis.

Using alternative fuels, in the same vein as Kumas and Grecian Magnesite, will also have an immediate impact on the industry's carbon profile. Reducing sulphur oxide/nitrogen oxide emissions will also become an important consideration.

Replacing older plants with more modern and efficient technologies and continually modernising existing plants will result in improved performance. A longer-term solution is carbon capture, with CO₂ being captured at source and then re-used or stored.

The market outlook in the short term, according to Lakshmi Mittal, is that, "The prospects for growth of core steel markets in Europe and the US are encouraging and overall we remain cautiously optimistic about the business outlook for the rest of 2014." Arcelor Mittal said recent data had confirmed a continued pickup in European manufacturing activity and now expects steel demand to grow between 2-3% this year.

In the longer term, the OECD Steel Committee forecast in 2013 that a weak growth over the next seven years will keep apparent steel use in the EU and Japan at levels below the pre-crisis peaks until 2020. A consequent rise in refractories demand will be partially offset by a reduced consumption of refractories per mt of steel produced, as the steel industry has optimised production methods.

Overall, according to *Roskill*, "Refractories demand is forecast to grow at an annual rate of just under 3%, especially for low-grade DBM. Increasing energy costs will be a key issue for the future refractory mineral production."

Refractories in Japan will remain likely as the principal market, however, local DBM manufacturers could benefit from diversifying into non-refractories and growing fields to avoid depending as much on the Chinese product, which has fluctuations in price, quality and supply quantity.

In China itself, government actions against the steel, cement and glass industries to reduce pollution and cut overcapacity would impact on industrial minerals like magnesia.

China has raised its target to close inefficient steel plants to 28.7m tonnes in 2014, impacting refractories minerals suppliers. The country's MIIT said it also wanted to phase out cement by 50.5m tonnes and glassmaking by 35m tonnes, in a bid to cut pollution and tackle industry overcapacity that has hit company profits. Furthermore, China's Ministry of Finance is contemplating subsidies to help cover the cost of meeting the government's new standards.

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Recent news regarding DBM production

Among the many interesting developments in the field of DBM production outside China, it is worth mentioning the following:

- Magnezit JSC [Borzov, MagMin 2011] announced that new DBM capacity in 2012-13 would be 80,000 tonnes in 2012 adding a further 20,000 tonnes in 2013, a total increase of 100,000 vis-à-vis 2011. All DBM 94, 95, 97 grades are from new shaft kilns, in Satka, Chelyabinsk region. On 24 July, 2013, the group announced the, “commissioning of a high-temperature shaft kiln with an annual capacity of 80,000 tpa.” Magnezit will soon issue a press release on the status of their magnesia operations.

- RHI announced the acquisition of Turkish DBM producer Cihan with an idled 60,000 tpa DBM operation in the Erzurum-Erzincan area.

- The Chinese government ordered some magnesite mines in Liaoning province to shut down, resulting in production decreasing in 2013 compared with that in 2012.

- SMZ are participating in EU R&D projects and have had no other new projects completed in 2012-14.

- In 2012, Magnesita of Brazil added a kiln and expanded high grade DBM production capacity from 180,000 tpa to 240,000 tpa. In March 2014, the company announced that, “The issues that the company experienced at its Brumado and Contagem sites in Q3 2014, and that resulted in lower sinter production, were resolved.”

- In 2013 Posrec of S. Korea stopped one rotary kiln

- Grecian Magnesite launched a new refractory product GM 1/2 S in March 2014 for use in high-end shaped or unshaped refractories, including magnesia-carbon bricks and special castables.

- Magnesitas Navarras is pushing ahead with licensing for the Borobia and Zilbeti magnesite projects that will produce DBM for the Zubiri monolithics plant.

- Ma’aden in Saudi Arabia currently has no DBM production.

- Ternamag has announced it could eventually go into DBM production in Euboea, Greece, but so far is concentrating on CCM.

- The National Mineral Development Corporation (NMDC) of India has cleared a number of administrative, environmental and legal challenges regarding a new 30,000 tpa 93-95% DBM project in Jammu and Kashmir and hopes this project will eventually be launched.

- The Nepalese government is trying to revive Nepal Oriend Magnesite Private Ltd via privatisation.

<http://www.indmin.com/Article/3345266/Burning-up-A-look-at-the-deadburned-magnesia-market.html>