

Sampling Chinese dead burned magnesite prior to export to world markets. Image courtesy of Acelor International



Refractory mineral supply in transition

Testing times as new era dawns

Refractory minerals are imperative for steel production, since they are the key constituents of the wide range of refractory bricks, monolithics, and precast components used as insulating linings in all steelmaking vessels.

There are some 20+ different types of refractory minerals required by the steel industry, however, their commercial sources are limited, and supply lines are influenced by a range of factors. A primary factor is that, historically, China has been the primary supplier of most key refractory minerals, but this maybe about to change.

The last two years have been particularly testing. 2020-21 was all about coping with COVID-19 and responding to the pandemic's ramifications and the subsequent recovering market demand.

While 2021-22 has seen a continuation of this trend, also thrown into the mix has been the tragic Russia-Ukraine conflict which has compounded the dire logistics situation further, plus ongoing changes in China, and the fast emerging development of decarbonisation and transition to alternative energy sources by the steel industry – which may well have a profound impact on refractory

use, and thus refractory mineral demand.

In response, there is a sense of a new era of mineral supply apparent, with refractory mineral traders and consumers looking beyond China for security of supply from new and alternative sources.

Logistics remain under stress

The pandemic outbreak in 2020 served to spotlight the vulnerability of the logistics of supply chains, and refractory minerals were no exception. Dry bulk and container freight rates soared as vessel availability shrank.

However, just as consumers were hoping for some stability in the shipping market in early 2022, Russia invaded Ukraine in February 2022. As a result, an already stressed logistics sector facilitating global mineral supply chains and markets faced (and is continuing to face) widespread disruption and uncertainty.

Regarding Ukraine itself, the stand-out minerals which are produced and exported in volume are kaolin (particularly the important and unique ceramic and refractory clays of the Donbas region), the titanium minerals ilmenite and rutile, plus zircon – one of Europe's few sources of these minerals.

Refractory mineral traders and consumers are looking beyond China for security of supply from new and alternative sources

There is also noteworthy production of fused alumina, silicon carbide (centred in Zaporizhzhia), graphite (Zavallya), and kyanite (by-product of titanium-mineral mining at Vilnohorsk) – these minerals are of great interest to the refractories market, and for graphite, also the emerging lithium-ion battery market, though their export volumes have been at small to moderate scale.

Of all the minerals produced in Ukraine, it is the ceramic clay supply sector which has had the most severe impact on European (and perhaps other) consumers (some 4-5 million tpa is exported in 'normal circumstances, about 78% share of world trade).

Generally, across the global shipping market, since 2020 shipping rates have soared, with fuel costs rising and bunker surcharges enacted. There remains continuing unavailability and delays with containers, vessels and stevedoring at loading and discharge.

Port congestion in China, Europe and the USA has been a significant factor in supply delays, eg. Rotterdam vessels may wait five weeks for a berth, then a further two weeks until discharge. Overall voyage times have been extending considerably, to 120+ days, from 22-30 days previously.

As an illustration of the situation, leading world refractories producer RHI Magnesita in its 2021 annual report recorded that sea freight costs rose by €80m, 85% owing to inflation. Much the same can be anticipated for 2022 and 2023.

A leading shipping company reported in July 2022 that more than 20 large container vessels were awaiting berthing in Hamburg, Rotterdam and Antwerp. There is a move by some to shift away from containers to break-bulk in order to mitigate delays and costs.

The low water levels this summer of the Rhine and other waterways leading into Europe's hinterland from northern coast ports have also hindered much needed mineral supply to consumers. All this is mounting pressure on refractory mineral prices and availability of raw material to refractory manufacturers to in turn supply the steel industry.

China: end of an era?

While the COVID-19 pandemic may have eased in parts of the world, China remains affected, mainly owing to the government zero-tolerance policy which enforces immediate lockdowns in response to any rise in cases.

Unsurprisingly, this has led to widespread disruption in refractory

mineral production and exports to world markets owing to continuing intermittent mine, plant and port lockdowns.

The upshot of the above is that Chinese mineral output and export flow has been interrupted as ports have been incredibly congested.

The suspension of port activities has also led to poor loading management (causing delays at Western discharge ports), unsuitable vessels and extended voyage times of 140+ days. In April 2022, it was reported that 24.3% of all container vessels waiting outside ports globally were waiting outside China ports.

In addition, now in the second year of China's 14th five-year plan (2021-2025), President Xi Jinping's anti-pollution drive moves on unabated, with ongoing resource conservation, environmental controls to meet government goals, resulting in mine/plant inspections, disruptions, plus temporary and permanent shutdowns.

For example, during January-mid-March 2022, plants within 600km of Beijing were required to close, forcing refractory mineral processors at the important export port of Tianjin to work only at night, and no production, just bagging. The now annual Oct-March winter shutdown is a major disruption to all energy-intensive operations, including all refractory mineral processing, calcination and fusion. Moreover, any repeat of the sudden power supply restrictions and rationing that was imposed in September 2021, will hit hard the refractory fused mineral sector, eg. fused alumina, fused magnesia and silicon carbide.

There is no doubt that China will remain an important force in industrial mineral supply to world markets, and its domestic mining sector is busy reforming and modernising with green mining and upgrading plants with new processing technology.

Global volume demand for dead burned and fused magnesia for example, the largest consumed refractory mineral, is such that it is expected to be met by continued supply (soon to be internally reformed structurally) from China, but dwindling refractory bauxite supply remains a concern.

Maybe we are seeing the end game for regular low cost Chinese

refractory mineral supply. The adverse factors of the last few years has shaped a future likely to see more of a balanced consumption of minerals between China and non-China sources, as global mineral consumers and traders finally appreciate the risks associated with having all their supply eggs in the one China supply basket.

New source development

So, a positive consequence of the China situation has been the lease of life it has given to refractory mineral project developers outside China, especially those minerals for which China was normally dominant in supply.

In the magnesia market, RHI Magnesita has committed to expanding dead burned magnesia investment and operations in Brazil, as well as creating a refractory dolomite production hub in Europe based around a new mine and plant in Austria.

Other refractory players in Brazil, IBAR Nordeste and Magnesium do Brasil are also looking to recoup market share (previously lost to Chinese exports) with expansions, such as adding fused magnesia capacity, while in Europe Grecian Magnesite has opened a new underground magnesite mine, as well as developing a product based on dunite (magnesia-containing rock).

Refractory bauxite supply, until recently almost monopolised by Chinese companies in China and Guyana, is now seeing two new sources come on-stream: First Bauxite, Guyana (strengthened by its recent acquisition of US Ceramics providing calcination plants) and Bautek Minerais Industriais, Brazil.

Graphite demand, essential for MgO-C refractories, is clearly being driven by the EV lithium ion battery evolution, but again, consumers of refractory grades are wanting to look outside China and finding a lot of action by several players especially in eastern Africa and Madagascar, but also Australia, Asia, Scandinavia and the Americas. Any of these coming to fruition will ease pressure on, and may ultimately replace, Chinese supply of refractory grades.

Northern Graphite of Canada could be on course to be North America's



First Bauxite has recently emerged as a new refractory bauxite supplier producing 340,000tpa capacity, high purity (63% Al₂O₃) raw gibbsitic bauxite at Bonasika, Guyana. Image courtesy First Bauxite



Green mining in Greece: Grecian Magnesite operates fully integrated magnesite mining operations in Greece and Turkey with production capacity of 200,000tpa CCM and DBM; pictured here is its plant complex at Halkidiki, north-east Greece. Image courtesy Grecian Magnesite

leading graphite producer and the world's third largest producer outside China with its investment in Bissett Creek, Ontario, and recent acquisition of Imerys' graphite operations of Lac des Iles, Quebec and Okanjande, Namibia.

Leading refractory mineral traders and consumers are now busy aligning themselves (with offtake agreements/strategic partnerships) with some of these potential new sources of supply.

Refractory recycling to accelerate

In parallel with developing new refractory mineral sources outside China, the market situation has also given a boost to refractory recycling. While refractory recycling has been established as a concept for some decades now, its growth has been limited and is now clearly expanding into a much needed mainstream alternative option for consumers of refractory minerals.

In her presentation at IMFORMED's Mineral Recycling Forum 2022, Sabrina Salmen, VP senior executive recycling at RHI Magnesita, estimated that between 7.6 million and 12.6 million tpa of refractory waste is generated worldwide, and approximately 50% of this is reused in refractories production.

Leading Spanish steelmaker Sidenor has been evolving refractory waste recycling management with the LIFE 5RefrAct Project since 2018. The initiative has developed 9 magnesia-based refractory products in co-operation with Magnesitas Navarras, and 12 alumina-based products in co-operation with Refralia – underlining the importance of co-operation between mineral supplier and end user in recycling.

Other recent examples include the Refratechnik Horn Produktions joint venture (Refratechnik Steel/Horn & Co Minerals) announced in September 2021, reviving Horn's Hünsborn plant, ramping up to 20,000tpa MgO-C brick in 2022, and 40,000tpa in 2026. About 25% raw material is recycled refractories from Horn, the remainder DBM/FM from Refra's wholly-owned subsidiary, QMAG, Australia.

In April 2022, a major new refractory recycling joint venture was announced: Horn & Co RHIM Minerals Recovery, between RHI Magnesita (RHIM, 51%) and Horn & Co Minerals. This combines

the plants of Horn, Siegen, Germany and RHIM, Veitsch, Austria, to process more than 150,000tpa material. RHIM opened a new €7m recycling centre at Veitsch. RHIM is targeting more than 15% refractories recycled by 2030 (compared to 3.8% in 2018).

Energy transition in the steel industry

New and alternative materials and refractory product formulations are also being sought in order to help mitigate mineral supply constraints and changes, such as the increasing development of dolomite, and using less basic, and more enhanced and synthetic minerals.

However, perhaps a new future challenge will be new demands placed on future refractory (and thus mineral) requirements owing to changes in fuel use by the steel industry in its efforts to decarbonise.

In February 2022, ArcelorMittal accelerated its decarbonisation strategy with a €1.7bn investment in France, aiming at carbon neutrality by 2050 with innovative DRI, using hydrogen as fuel.

Likewise, POSCO has started designing a hydrogen reduction steelmaking demonstration plant in a first step in its 2050 carbon-neutral roadmap.

Meanwhile, Danieli with technology partner Tenova has signed a new contract with Tata Steel for a hydrogen-based green steel plant in IJmuiden, the Netherlands.

Just what kind of effect this will have on refractory product selection and indeed lifetime remains to be seen. In any event, the correct choice and security of supply of refractory minerals will be paramount for the steel industry of the future.

Author

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