Energy, mining and magnesia – a look at the industry's power needs and uses

By IM STAFF

The production of magnesia products is highly energy intensive. They then go on to be used in equally power-hungry industries, such as steel making.

By Vasili Nicoletopoulos

There are many reasons why the mining industry should care about energy. First of all, the fuel raw materials, coal and uranium, are mineral products themselves, while hydrocarbons use minerals in their extraction. Second, mining, mineral processing and metallurgy are all energy intensive processes and are thus heavily affected by developments in energy markets and policies and so companies in these industries have a vested interest in keeping energy costs down.

The energy industry is also an important market for products of mining and metallurgy, from proppants and additives used in oil and gas drilling, to rare earths for renewable energy, to magnesia used in nuclear waste disposal products.

Over the last 12 months, a number of important events have shaped the global energy market and, by extension, the mining industry. Most notable has been the dramatic and unexpected fall in international oil prices to around $50/barrel (bbl), at the time of writing, from a peak of over $120/bbl in June 2014. This was exacerbated by, and is now coming back to haunt, the proliferation of hydraulic fracturing (fracking) for shale oil and gas, particularly in North America.

Sanctions against Russia have hit the operations of Russian state oil giant, Rosneft, and others in the region, while faltering Chinese growth, with the country's steel industry potentially entering a pre-contraction "peak zone", has knocked back energy demand in the world's second largest economy. Elsewhere, notably in South Africa, inadequate energy infrastructure and power cuts are threatening mining output.

Regarding energy supply and demand, the International Energy Agency (IEA) has warned that oil supply is growing at "breakneck speed" and the glut in crude could last well into 2016, despite high demand.

Oil

Sector bears have been predicting oil prices could fall as low as $20-30/bbl, while bulls are saying that low prices will lead to increased consumption and lower new capacity investment, sending prices soaring up to $200/bbl.

Much depends on the actions of the Organization of Petroleum Exporting Countries (OPEC) which controls oil production in the Middle East, and whether its members reform their national budgets to accommodate greater flexibility in oil prices.

Coal

Meanwhile, the global coal market is in doldrums, due to excess supply and fundamental shifts in the US energy mix toward gas and renewables. According to a report in the *New York Times* in early August, collapsing prices and heavy debt loads are driving the industry into bankruptcy with recent examples including Alpha Natural Resources, Patriot Coal, and numerous smaller mining companies.

The demise of the two biggest surviving publicly traded US coal companies, Peabody Energy and Arch Coal, may be just a matter of time, based on their recent stock performance, the report said.

Pressure to reduce emissions and switch to "cleaner" and more sustainable forms of energy continues and various types of Emission Trading Schemes (ETS) are being practiced in the European Union (EU) and European Free Trade Association (EFTA) countries, the US, Canada, China and South Korea, among others, although not in some important mining countries like Russia, Brazil, Australia and, unsurprisingly, North Korea.

Table: Energy in MgO kilns by country

	Nat Gas	***LPG, other***	***Coal***	***Petcoke***	***Heavy Fuel Oil***	***Diesel***	***Biomass***
Australia	√						
Austria	√			*Little*			
Brazil					√		√ *[1]*
Canada	√	H_2 *[3]*					
China	*Coming*	*Gas fm coal*	√		√		
Greece		√		√	√	*Little*	√ *[2]*
Ireland	√			√			
Israel							
Japan				√	*Partly*		
DPR Korea		*Gas from coal*			*No more*		
Mexico	√						

Netherlands	√						
Norway	√						
Russia	√				√		
Saudi Arabia						√	
Slovakia	√				*f (price)*		
Spain	√	√	√	√			
Turkey	√	*Little*		√			
USA	√						
[1] Wood, cashew shells, sugar cane bagass [2] Olive kernels [3] MGX announcement							

Fracking

In North America, fracking for hydrocarbons in shale formations has given a huge competitive advantage to the US and Canada's oil and gas industries. Countries including China, Argentina, Russia, South Africa and Australia are looking to follow suit, while Europe seems reluctant to embrace shale resources.

The US is now exporting some distillates, but the real benefits from North American fracking would flow to the rest of the world if the US were allowed to export its shale products. However, there is intense lobbying both for (from shale producers) and against (from companies such as Dow Chemical Co.) these exports.

US and Canadian shale oil and gas operators have been hit by low oil prices, with rig counts dropping to significant low points in H1 2015. For the week ending 7 August, the number of rigs engaged in exploration and production in the US totalled 884, up by 10 on the previous week, but still less than half the 1,908 figure recorded for the same week in 2014 and well down on the industry's 2008 peak of 2,031.

It is important to remember, however, that output per rig has increased over this period. An August report by *Oil and Gas Journal* predicted that US shale oil output was expected to drop 93,000 bbl/day in September.

Crude from Canada's oil sands is another victim of the of the global oil price rout. A combination of steadily rising production, pipeline constraints and an unexpected outage at a US refinery this year have pulled prices for crude oil from Canada down close to $20/bbl, the lowest level in 12 years. "At today's prices, the typical producer is just able to cover variable costs, but they would be losing money for each barrel they produce," said Jackie Forrest, vice president at Calgary-based private equity group, ARC Financial.

Future for fuel

Looking at each fuel source in detail, gas is considered a good interim transmission to a low carbon economy. Oil will always be driven by economic and geopolitical factors and coal will still have a good future in China and India, while elsewhere, clean coal and carbon capture storage initiatives will gain in importance.

Renewables will grow, even without subsidies, but there is a pressing need for R&D into electrical energy storage and also in so-called Distributed Energy Resources – smaller power sources that can be aggregated to provide the power necessary to meet regular demand.

Because processes such as production of FM require a lot of energy, the EU is extending emissions credits for such activities within its member states to give businesses more time to adjust. (Source: RHI)

Biofuels will have to focus on third generation, or non-food, sources and shale production will grow, if oil and gas prices are right, with technological improvements such as waterless fracking.

Nuclear is expected to see very slow, if any progress, except in China, as countries across the world discuss cutting reliance on this type of energy.

On the demand side, low oil prices favour household and industrial consumers, but as a barometer of general economic health and prosperity, the impact of cheap oil on these groups is less positive.

A case study: magnesia

MgO production

Magnesium oxide, or magnesia (MgO), production is an energy-intensive process, regardless of whether magnesia is derived from magnesite (magnesium carbonate, $MgCO_3$) by a dry process or from brucite (magnesium hydroxide, $Mg(OH)_2$), also by a dry process; from bischofite (magnesium chloride, $MgCl_2 \bullet 6\ H_2O$) by a wet process; or from seawater and dolomite, again by a wet process.

CLM BREF, or Cement Lime Magnesia, is the main official reference on energy in the production of caustic calcined magnesia (CCM), deadburned magnesia (DBM) and electro-fused magnesia (EFM) using the dry process. Similarly, the Large Volume Inorganic Chemicals - Solids & Others BREF covers the wet process.

Natural Resources GP has conducted a detailed study of the energy requirements of natural magnesium carbonate production, transporting carbonate, burning to CCM/DBM/EFM, shipping MgO and the production of refractories and other uses.

Magnesia kilns use a wide variety of energy sources. The table below presents a summary of these by country, based on an extensive literature search and bespoke questionnaires.

Energy used in MgO production, other than in kilns, comprises diesel for transport, electricity for fusion – the feed material being CCM or DBM, except in China where $MgCO_3$ is fused directly; and electricity for conveying, screening, crushing, separation, grinding, mixing, water pumping and lighting.

Renewables are used in MgO production only indirectly, as one of the sources of the grids that serve MgO producers, but there is also the new concept of renewables plants being built next to mines/smelters with a long-term electricity supply contract.

Energy saving

Independently of the energy sources already used to power MgO production, the industry will need to make energy saving efforts. Relevant measures could include:

• Optimisation of the entire process;
• Conveyor belts replacing trucks;
• Using fuels with high calorific value and low moisture content;
• Operating in smooth/stable kiln conditions;
• Oxygen enriched combustion air for the firing process to increase efficiency;
• Use of waste heat to preheat the feed to rotary kilns or the water in the flotation circuit, or the fuel oil;
• Producing steam for heating buildings or for co-generation;
• New techniques for co-incinerating waste materials;
• Using power management systems to reduce electricity;
• Employing grinding equipment and other electricity based equipment with high energy efficiency.

The longer-term solution will be improved design of kilns, but the CLM BREF states that "no emerging techniques for the MgO industry using the dry process route have been provided yet".

Uses of MgO

Broadly speaking, MgO is used either because it is necessary in a manufacturing process, or for environmental reasons.

In manufacturing processes, MgO is used as raw material or, more generally, in the process itself. Magnesia is also used for environmental or, more often, health and safety (EHS) reasons.

Uses in manufacturing processes

Examples of energy-related process uses of MgO include refactories, such as DBM/EFM, including to the petrochemical industry, with an older use being night-storage heater bricks due to DBM's high thermal accumulation property. Other process uses of MgO are in insulation, such as CCM for boards or covering steel

baths. Conversely, EFM is used in electrical heaters because it has high thermal conductivity.

Other process-induced applications comprise drilling, such as for borehole stability and/or hydrogen sulphide (H_2S) absorption; oil sands production, where CCM is used for silica removal to allow reuse of water; and MgO-based catalysts in petroleum cracking.

Lastly, indirectly related to energy is the use of CCM to provide a higher recovery of valuable metals from ore extraction, such as cobalt, nickel and copper from acid leach solutions.

Uses for environmental reasons

Environmental/EHS considerations render MgO necessary in coal/oil power plants for one or more of the following reasons. First, CCM is used as a fuel additive for heavy metal capturing. MgO is also used for scrubbing to sequester/remove sulpur oxides (SO_x) gas from wet electrostatic precipitators and sulphur dioxide (SO_2) from flue gas desulphurisation scrubbers.

Furthermore, CCM is employed in selective catalytic reduction systems to reduce sulphur trioxide (SO_3) generated by boilers and SCR units, as well as to lessen opacity emissions and acid plumes related to SO_3, for corrosion control and opacity treatment. MgO further finds application in nuclear waste treatment, with CCM used in the disposal of low-radiation waste.

Other current and potential future examples of MgO applications in the energy industry are listed below. Research on some of these projects has reached the experimental production stage:

• Carbon-negative and environmentally friendly cements and "eco-concrete" floor panels;

• Mg-ion batteries, instead of lithium;

• DBM as a proppant in fracking;

• Heating up (with the use of photovoltaics) the briny discharge FM desalination to convert $MgCl_2$, as MgO is a good absorber of CO_2;

• Photovoltaic/thermal systems with MgO-water nanofluids flowing over silicon solar cells.

Energy policies

It can be argued that the most important policies affecting mineral products like magnesia are the climate change measures, ETS and carbon leakage (referring to the relocation by businesses of carbon-emitting operations to other countries with laxer restraints on CO_2 emissions).

The most recent major news on this area comes from the EU and the US. EU ETS structural reform, announced in July 2015, is a legislative proposal to deliver a new deal for energy consumers. The new plan seeks to launch a redesign of the European electricity market, update energy efficiency labelling and revise the EU ETS for the

period after 2020, in line with the 2030 climate and energy policy framework and the Energy Union strategy to achieve the targeted 40% reduction in emissions from 2005 levels.

Energy intensive industries will continue to receive free carbon emissions allowances, as compensation for the EU's stricter climate rules, under the planned reforms, but fewer will be granted and for a smaller number of qualifying industries. The proposal is also speeding up the annual rate at which it reduces allowances, compared to the current scheme's trading period.

The plans include safeguards for the international competitiveness of EU energy intensive industries. About 50 sectors, including all the major industrials, and magnesia in particular, will continue to receive free allowances from 2021, the next ETS trading period, because of the risk of carbon leakage.

The EU will offer its most CO_2 emitting industries another 10 years of free emission credits worth up to €160bn ($177.6bn**) to help prevent them relocating to regions with less strict environmental rules, under planned carbon-market reforms.

Other EU energy policies of relevance include the European Commission (EC) antitrust charges against Gazprom, the EU's recognition of a "lost decade" for low-carbon investment, the EC and European Investment Bank launching new financial instruments towards investment in energy efficiency and adaptations to climate change

In early August, US President Barack Obama unveiled sweeping curbs on carbon emissions from US power plants as part of the government's Clean Power Plan, with a final regulation calling for a 32% cut in emissions by 2030 from 2005 levels. In making these aggressive cuts, Obama hopes to make the US a leader in global efforts to tackle emissions. However, Obama is set to leave office next year and it remains to be seen who will run the US political administration from 2016.

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http://www.indmin.com/Article/3483732/Energy-mining-and-magnesiaa-look-at-the-industrys-power-needs-and-uses.html