Magnesium metal, its perspectives

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Horčík - jeho perspectívy

Až donedávna bola spotreba a produkcia horčíka-kovu, pomerne nízka a pohybovala sa okolo 350 000 t ročne. Aj ceny boli relatívne, stále: 1,10 - 1,20 USD lb.

V priemysle sa horčík používa hlavne pri výrobe áut a lietadiel (Jumbo), vďaka niektorým z jeho fyzikálnych vlastností, najmä väčšej pevnosti a nízkej špecifickej váhe. (Jeho zliatiny sú o 30% ľahšie ako hliníkové, a o 75% ťažšie ako oceľ.)

Za posledné 4 roky však výroba horčíka vzrástla cca o 30% a v r. 1999 dosiahla 452 000 ton, hlavne v dôsledku zvýšenej spotreby vo výrobe áut, kde sa používa najmä ako zliatina s hliníkom. Všeobecne sa predpokladá, že spotreba v tomto odvetví bude ďalej rásť a v r. 2005 dosiahne 750 000 t. To by predstavovalo nedostatok produkcie cca 300 000 t, berúc do úvahy súčasnú kapacitu výroby a možnosť dať do chodu nové závody. Z hľadiska prognóz nie je vylúčené ani spotreba 1,5 Mt/rok.

Vzhľadom na tieto perspektívy sa v poslednej dobe objavila celá séria plánov/projektov na nové výrobné kapacity horčíka (viď. tabuľku v texte). Potrebné investície sa pohybujú okolo 600-900 miliónov dolárov. Pretože však tieto projekty majú obyčajne veľký význam pre rozvoj celých regiónov, miestne autority/vlády, sú do nich často zainteresované (infraštruktúra, urýchlenie úradných záležitostí, atď.).

Prezentovaný článok popisuje trocha detailnejšie dva z týchto projektov: Magnola v Quebeku, ktorý bude vyrábať horčík zo serpentinitu, z háld po ťažbe azbestu a SAMAG v Južnej Austrálii, kde surovinou bude na výrobu magnezit.

Key words: *magnesium metal, magnesia, magnesite, Australia, Quebec*

Introduction, magnesium compounds (magnesia)

Magnesium is one of the Earth's most abundant elements. It occurs in some 60 minerals. However, only magnesite, dolomite brucite and olivine (chrysotile asbestos) are used commercially to produce the metal and its compounds, that are also extracted from seawater and lake brines. It is mostly used in the form of magnesia (MgO). Of the 8 Mt of magnesia produced each year, around 84% is derived from magnesite (MgCO3) by calcination (cf Clifford, 2000). The annual world production of magnesite for the last 10 years has been about 19 Mt. Leading producing countries have been China, countries of former Soviet Union (Russia, Kazakhstan, etc.), North Korea, Austria and Slovakia. Of 2,11 Mt magnesia was produced in 1991 from seawater and brines, most came from USA and Japan (Coope, 1992).

Because of high melting point, most magnesia (around 80%) is used for the high-temperature insulation, especially as refractory bricks in the furnace lining. The remainder is consumed in agriculture (fertiliser, animal feed), industry (paper processing, chemicals), construction (cement), environmental and other applications.

Magnesium metal: use, supply- demand relationships, outlook

Magnesium metal is used for several physical properties, especially a very low relative density, strenght, and corrosion resistance. (Magnesium alloys are 75% lighter then steel and 30% lighter then aluminium alloys). Its castability is also important. The metal and its alloys are easy to structure, they can be joined and welded. It is used mainly as an alloy with aluminium, in transportation equipments (particularly in vehicle and jumbo aircraft manufacture), in the industrial machinery (some low-weight equipments). Other uses include chemicals (as a component of some organic chemicals and petrochemicals), desulphurisation, and reducing agents in the production of nonferrous metals. The main outlet for magnesium is alloying wih aluminium and die-casting; their share in 1998 was respectively 43% and 31% of the produced metal.

Magnesium metal is costly to produce. The mostly used technology for its production is the electrolytic process, whe the metal is produced from magnesium chloride. (Production of a pure anhydrous $MgCl_2$ is the key step). If the feed is magnesite, the latter is ground before leaching in hydrochloric acid. Then the pregnant leach liquor, containing the magnesium brine, is purified and dehydrated to a solid salt which is electrolysed to produce molten magnesium. Production costs have tended to be lower from seawater than from brines or magnesite.

Until relatively recently, the use of magnesium metal have been quite limited. In 1973, world produced 261 000 short tons of the metal (Chin, 1975), in 1990, 355 000 t, with the US production representing 37.5% and the CIS/USSR 25.4% (Ridgway, 1992). Since 1995, the production has grown steadily, reaching 452 000 t last year (see table below, mostly after Clifford, 2000).

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World magnesium producers

Country	Location	Capacity	Source	Process	Est cost US$/lb
Canada	Becancour, Queb. Haley, Ontario	42 000 7 000	Magnesite Dolomite	Electrolytic Pidgeon	0,65
USA	Addy, Washingt. Rowley,Utah	40 000 38 000	Dolomite Brines	Magnetherm Electrolytic	1,15 1,00
Brasil	Bacaiuvca, MG	12 000	Brines	Bolzano	
Norway	Porsgrum	55 000	Seawater	Electrolytic	
Israel	Sdom, Dead sea	33 000	Seawater	Electrolytic	1,52
France	Marignac	16 000	Dolomite	Magnetherm	1,15
Serbia	Bela Stena	5 000	Dolomite		
Russia	Solikamsk Berezniky	18 000 20 000	Carnalite Carnalite	Electrolytic Electrolytic	0,75-1,00
Ukraine	Kalush Zaporozhye	25 000 5 000	Carnalite Carnalite	Electrolytic	
Kazakhstan	Ust Kamenogorsk	9 000	Carnalite		
China	Fushun Minhe Wenxi, Shanxi	10 000 10 000 10 000	Dolomite Dolomite Dolomite		+1,00 +1,00 +1,00
Japan	Ube Takaoka	9 000 6 000			
Others		55 000			
World total		**425 000**			

N.B. Dow Chemical plant with the seawater feed, located at Freeport (Texas), which was the world's largest producer in the 1980-90 period (about 90 000 t/y), is not mentioned by Clifford (op. cit.).

The price for magnesium metal in the late 1980s - early 1990, was in US$ 1.10 to 1.20/lb range (Ridgway, 1992). Presently, the spot price is around US$ 1.10/lb (Clifford, op. cit.).

Presently, the world production/supply and demand are roughly in balance. However, it is widely expected that the use of magnesium metal in the vehicle manufacture (a lighter vehicle means a lower fuel consumption, hence a lower exhaust emission) will accelerate. (A target consumption of 40 kg of magnesium per vehicle is being promoted by major car manufacturers, compared with 3 kg at present). The use of magnesium in automotive applications is predicted to overtake the aluminium alloying by 2001. A spectacular grow of 15-20% per annum has already been recorded in last years in die-casting sector. And if this grow rate is sustained, the magnesium consumption for die-casting alone would reach 450 000 t by 2005. Australian equity team at stockbroker Salomon Smith Barney (SSB) believes that the total consumption of magnesium metal could reach 700 000 t by 2005 - a shortfall of some 300 000 t based on the existing world's production capacity. And it could reach nearly 1.0 Mt by 2010, even 1.5 Mt.

Potential new projects

In the mining industry, there has been a resistance in recent years to invest outside the "safe" projects such as gold and base metals. The industrial minerals projects were treated with a caution, especialy magnesium ones involving an investment in the $600-900 million range. The bright prospects perceived for magnesium have given rise to a spate of potential new projects. SSB has identified nine such projects with a combined potential capacity of over 500 000 t/y. Most of them are located in Australia (see the table hereafter, cf Clifford, 2000).

Country	Operation	Capacity	Source	Cap. cost million	Start up
Australia	Stanwell SAMAG Woodsreef Arthur River Main Creek	90 000 52 500 80 000 95 000 80 000	Magnesite Magnesite Serpentine Magnesite Magnesite	US$500 US$375 US$680 US$700	2003 2003 2003
Canada	Magnola	63 000	Serpentine	C$733	2000
Netherlands	Delfzijl	50 000	Carnalite		
Congo	Kouilou	50 000	Carnalite	US$650	2004
Iceland	Sudurnes	50 000	Seawater	US$95	2003
Russia	Solikamsk	22 000	Brucite		
Jordan	Al Safi	25 000	Carnalite		

Quality resources are plentiful for all of these projects, sufficient for a mine life of at least 30 years or even for more than 100 years. Moreover, since the magnesium projects are of significant importance to the economy of the countries or regions in which they are situated, the local governments become involved; they help/commit themselves in the infrastructure, power costs etc.

The most advanced and most hopeful projects are Magnola, located in Quebec and SAMAG in South Australia.

Magnola project (Quebec)

Noranda's Magnola development will be the world largest producer of magnesium, with a capacity of 63 000 t/y of metal. It will also be the world's only facility to recover magnesium metal from serpentine. It will use tailings, accumulated for over a century mining of asbestos near Danville, 130 km of Montreal. There is some 250 Mt of serpentine tailings averaging 24% Mg, a reserve sufficient to supply the Magnola facility for around 300 years. The Danville site, which allows for a potential future expansion, benefits from the access to nearby water and electricity infrastructure. The plant will incorporate an innovative hydrometallurgical recovery process, including leaching of serpentine by hydrochloric acid and electrolysis of magnesium from the magnesium chloride. It is under construction and is supposed to start the production in the 3rd quarter of this year (2000).

SAMAG (South Australia)

The South Australia Magnesium Project (SAMAG) near Leigh Creek, about 450 km north of Adelaide, has been accorded major project development status by the South Australian government. It will exploit magnesite deposits occurring in the North Flinders Ranges (Min. Mag., 2000). The deposits are contained within Skillogate dolomite belonging to the Burra group of Adelaidean, Late Proterozoic age (see Thomson et al., 1975 and Johns, 1975). The magnesite outcrops discontinuously over some 130 km in northwestern strike, commencing at Leigh Creek (fig. 1). It occurs in beds totalling 30-40 m, interleaved with beds of dolomite. Pima Mining in a joint venture with Resource Finance Corp. has defined a resource of 516 Mt of magnesite averaging 42% MgO. They propose to develop a magnesium metal plant at Port Augusta with an initial capacity of 52 500 t/y of Mg metal alloy using the Dow Chemical technology (electrolytic process for the production of magnesium from Mg chloride). The Mt Hutton deposit, located north of Leigh Creek, will be mined initially at a rate of 240 000 t/y. The project benefits from being close to the existing rail and port facility. The completed feasibility study indicate that the operation would cost US$ 375 million and the production cost would be of about US$ 0.60/lb. The production can start by mid 2003, following a 2.5 year construction period.

Conclusions

Until relatively recently, the use of magnesium as a metal and its production have been quite limited. (It is mostly used in the form of magnesia - MgO). At present, the world production/supply and demand of this metal are roughly in balance. However, it is widely expected that its use will rise sharply, especially in the vehicle manufacture and overtake the use of aluminium alloying by 2001. A spectacular grow of 15-20% per annum has already been recorded in last years in the die-casting sector. The production of the metal has grown steadily, reaching 452 000 t last year. It is predicted that the total consumption of magnesium metal could attain 700 000 t by 2005 - a shortfall of some 300 000 t based on the existing world's production capacity. And it could reach nearly 1.0 Mt by 2010. This bright outlook for magnesium have given rise to a series of potential new projects with combined potential capacity of over 500 000 t/y. Most of them are located in Australia. Quality resources are in plenty for all these projects, sufficient for a mine life of at least 30 years. The projects are involving an investment in the $600-900 million range. However, since they are of significant importance to the economy of the countries or regions in which they are situated, the local governments tend to become involved, helping/committing themselves in the infrastructure, power costs etc.

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