Magnesium Compounds

By Benjamin Petkof[1]

The United States retained its place as a major world producer of magnesium compounds in 1978 and 1979. Domestic output was based chiefly on the production of magnesia from natural brines. The total quantities of magnesium compounds shipped and used in 1978 and 1979 increased over those of 1977. Total exports of magnesite and magnesia increased in 1978 and 1979 over those of 1977, and total imports of magnesite increased in 1978 and 1979 over those of 1977.

Austria, Greece, Mainland China, North Korea, and the U.S.S.R. were major world sources of magnesite.

Legislation and Government Programs.—New tariff rates resulted for some classes of magnesium compounds from the 1979 Tokyo Round of tariff negotiations giving most nations "most-favored-nation" status. The tariffs for material from these nations will decline annually, in stages, beginning January 1, 1980, and ending January 1, 1987.

Table 1.—Salient magnesium compound statistics

(Thousand short tons and thousand dollars)

	1975	1976	1977	1978	1979
United States:					
Caustic-calcined and specified magnesias:[1]					
Shipments by producers:					
Quantity	120	134	129	156	164
Value	$17,207	$28,277	$29,574	$43,008	$50,047
Exports: Value[2]	$4,538	$5,422	$6,336	$7,741	$16,433
Imports for consumption: Value[2]	$502	$808	$566	$793	$1,169
Refractory magnesia:					
Sold and used by producers:					
Quantity	709	768	690	796	847
Value	$103,839	$106,522	$94,799	$125,082	$125,289
Exports: Value	$14,146	$13,466	$16,477	$10,617	$8,182
Imports: Value	$20,588	$13,976	$12,332	$14,421	$13,546
Dead-burned dolomite:					
Sold and used by producers:					
Quantity	914	1,007	968	1,016	793
Value	$31,193	$37,079	$37,992	$45,881	$41,676
World: Crude magnesite production: Quantity	r10,614	r9,933	r10,706	10,704	11,086

r Revised.
[1]Excludes caustic-calcined magnesia used in production of refractory magnesia.
[2]Caustic-calcined magnesia only.

DOMESTIC PRODUCTION

Natural brine solutions, from seawater, lakes, and wells, continued to be the primary source of domestically produced magnesium compounds. Natural magnesite and olivine were produced at a few operations in the United States. Natural magnesite was also converted to magnesium compounds. Olivine was comminuted to various grades for foundry use.

The Velsicol Chemical Corp. discontinued magnesium compound operations as of September 1978.

Most of the firms that produced magnesium hydroxide also produced other magne-

sium compounds. Current domestic magnesium compounds producers by raw material source, location, and capacity follow:

Raw material source and producing company	Location	Capacity (short tons of MgO equivalent)
Magnesite: Basic, Inc	Gabbs, Nev	150,000
Lake brines:		
Great Salt Lake Minerals & Chemicals Corp	Ogden, Utah	100,000
Kaiser Aluminum & Chemical Corp	Wendover, Utah	50,000
Well brines:		
The Dow Chemical Co	Ludington, Mich	300,000
The Dow Chemical Co	Midland, Mich	75,000
Martin Marietta Chemicals	Manistee, Mich	300,000
Velsicol Chemical Corp.[1]	St. Louis, Mich	25,000
Morton Chemical Co	Manistee, Mich	5,000
Seawater:		
Barcroft Co	Lewes, Del	5,000
Basic Magnesia, Inc	Port St. Joe, Fla	100,000
Corning Glass Works, Ceramic Products Division	Pascagoula, Miss	40,000
The Dow Chemical Co	Freeport, Tex	75,000
Harbison-Walker Refractories Co	Cape May, N.J	100,000
Kaiser Aluminum & Chemical Corp	Moss Landing, Calif	150,000
Merck & Co., Inc	South San Francisco, Calif	15,000
Western Magnesium Corp	Chula Vista, Calif	5,000
Total		[2]1,470,000

[1]MgO production discontinued in September 1978.
[2]Production capacity of Velsicol Chemical Corp. not included in total.

CONSUMPTION AND USES

Domestic demand for magnesium compounds was strong during 1978 and 1979 and above that of 1977. The manufacture of refractory products continued to be the major end use for magnesium compounds. Caustic-calcined and specified magnesias also remained in strong demand by the chemical processing and pharmaceutical industries. Some major uses for caustic-calcined and specified magnesias were in the manufacture of animal feeds, fertilizers, construction materials, chemicals, electrical heating rods, fluxes, petroleum additives, rayon, and uranium.

Table 2.—Magnesium compounds shipped and used in the United States

	1978		1979	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Caustic-calcined[1] and specified (USP and technical) magnesias	156,192	$43,008	163,565	$50,047
Refractory magnesia	795,596	125,082	846,612	125,289
Magnesium hydroxide (100% $Mg(OH)_2$)[1]	509,824	40,520	511,370	47,475
Magnesium sulfate (anhydrous and hydrous)	52,096	11,885	48,325	10,271
Precipitated magnesium carbonate[1]	3,935	1,131	4,020	1,224

[1]Excludes material produced as an intermediate step in the manufacture of other magnesium compounds.

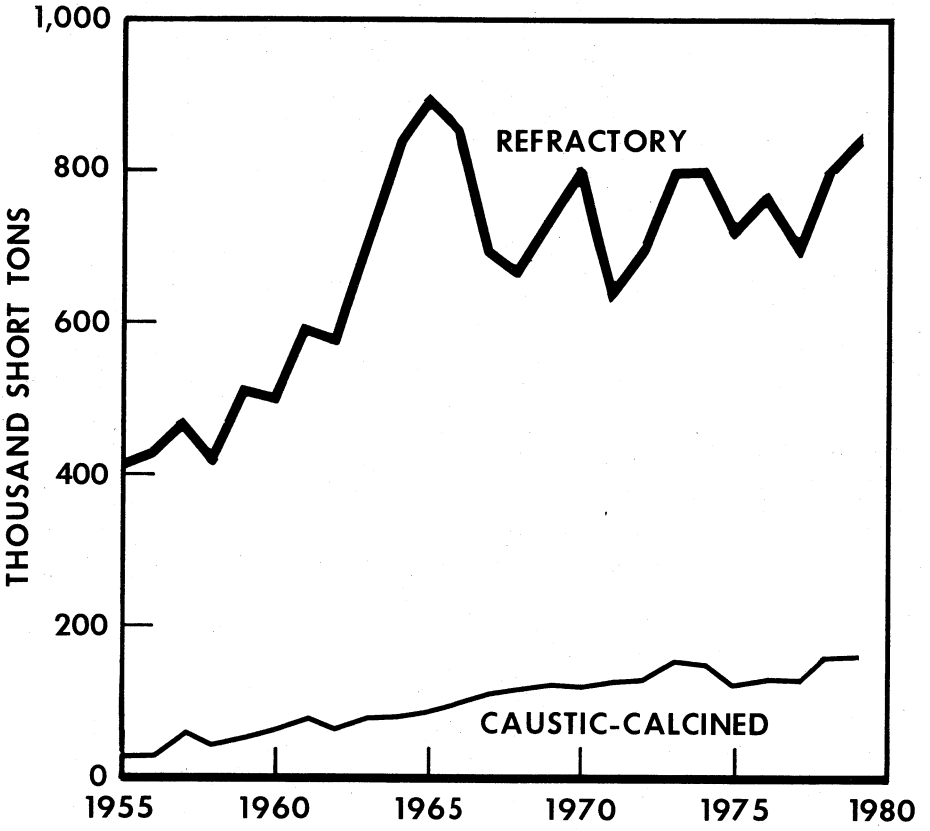

Figure 1.—Consumption and shipments of magnesia in the United States.

Table 3.—Domestic shipments of caustic-calcined and specified magnesias, by use

(Short tons)

Use	1977	1978	1979
Agriculture, nutrition, and pharmaceuticals:			
Animal feed	26,518	35,776	W
Fertilizer	10,379	16,506	W
Medicinals and pharmaceuticals	689	1,923	701
Sugar and candy	3,886	W	W
Winemaking	--	W	--
Total	41,472	54,205	W
Construction materials:			
Insulation and wallboard	(1)	(1)	W
Oxychloride and oxysulfate cement	10,889	3,753	W
Total	10,889	3,753	W
Chemical processing, manufacturing, and metallurgical:			
Chemical	7,935	12,070	W
Electrical heating rods	11,650	W	W
Flux	W	W	W
Petroleum additive	11,912	20,652	W
Pulp and paper	15,933	W	W
Rayon	9,785	W	W
Rubber	11,677	12,568	14,209
Stack gas scrubbing	--	W	W
Uranium processing	W	W	W
Water treatment	3,089	3,404	W
Total	71,981	48,694	95,534
Unspecified uses	4,504	49,540	148,684
Grand total	128,846	156,192	163,594

W Withheld to avoid disclosing company proprietary data; included with "Unspecified uses."
[1]Included with "Oxychloride and oxysulfate cement."

PRICES

Price quotations, as reported by the Chemical Marketing Reporter, for some magnesium compounds were unchanged during 1978 and 1979. These were: Magnesia, natural, technical, heavy, 85% and 90% (bulk, carlot and truckload, f.o.b. Nevada), $120 and $140 per short ton, respectively; and magnesium chloride, hydrous, 99%, flake (bags, carlot, works), $140 per ton. Quotations for other magnesium compounds increased during the 2-year period. Magnesia, technical, neoprene-grade, light (bags, carlot and truckload, works) was quoted at $346 per ton during 1978. Magnesium carbonate, technical (bags, carlot and truckload, works, freight-equalized) was quoted at $0.22 to $0.23 per pound during 1978. However, the price quoted increased to $0.52 to $0.54 per pound by yearend 1979. Magnesium hydroxide, NF, powder (drums, carlot and truckload, works, freight-equalized) was quoted as follows: At the beginning of 1978, $0.35 to $0.36 per pound; at the end of 1978, $0.49 to $0.53 per pound; and at the end of 1979, $0.54 to $0.58 per pound. Magnesium sulfate, technical (bags, mixed carlot, 10,000-pound minimum, works), was quoted at $0.091 per pound at the beginning of 1978. At the end of both 1978 and 1979 the price was quoted at $0.121 per pound. The price quotation for magnesium sulfate in bulk was $0.006 less per pound.

FOREIGN TRADE

Significant quantities of magnesium materials such as deadburned magnesite and magnesia and crude caustic-calcined lump or ground magnesite were exported. Large quantities of these magnesium commodities were supplied to Canada, Mexico, the United Kingdom, and Venezuela.

Total imports of crude and processed magnesite were under 100,000 tons and valued under $20 million in both years. The United States also imported additional magnesium compounds valued at $3.06 million in 1977, $4.6 million in 1978, and $5.62 million in 1979.

Table 4.—U.S. exports of magnesite and magnesia, by country

Destination	Magnesite and magnesia, dead-burned				Magnesite, n.e.c., including crude caustic-calcined, lump or ground			
	1978		1979		1978		1979	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Argentina	6	$8	26	$18	52	$44	4,887	$1,314
Australia	--	--	225	152	833	600	683	585
Belgium-Luxembourg	--	--	--	--	81	19	1,187	281
Brazil	83	78	105	79	42	31	33	30
Canada	50,708	7,704	26,053	5,929	34,057	2,462	51,238	8,869
Chile	--	--	--	--	51	25	113	48
Colombia	15	16	1,466	170	38	37	64	60
Dominican Republic	776	148	649	112	3	3	3	4
Ecuador	--	--	--	--	11	11	96	22
France	2,058	488	37	20	305	190	1,078	431
Germany, Federal Republic of	6,216	1,499	3	3	419	256	593	402
Guatemala	--	--	--	--	73	15	40	26
Guyana	--	--	360	30	--	--	--	--
Italy	41	35	21	18	248	197	587	362
Jamaica	54	8	--	--	2	3	--	--
Japan	196	142	36	33	203	210	157	187
Korea, Republic of	--	--	42	39	61	56	78	77
Mexico	160	40	1,114	273	3,456	517	711	166
Netherlands	214	54	286	85	333	531	327	591
New Zealand	--	--	20	24	67	64	149	148
Peru	--	--	8	2	120	28	8	13
Poland	--	--	--	--	757	200	--	--
Singapore	--	--	410	106	3	4	11	5
South Africa, Republic of	114	100	104	102	240	103	87	60
Spain	--	--	22	9	117	42	94	38
Sweden	77	72	43	51	241	237	194	210
Taiwan	57	49	73	71	142	54	203	85
United Kingdom	139	134	100	101	1,355	764	675	532
U.S.S.R.	--	--	--	--	--	--	1,102	336
Venezuela	--	--	1,716	724	2,845	900	3,824	1,414
Other	90	42	116	30	198	138	153	137
Total	61,004	10,617	33,035	8,183	46,353	7,741	68,375	16,433

[1]Less than 1/2 unit.

Table 5.—U.S. imports for consumption of crude and processed magnesite, by country

Country	1978		1979	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Lump or ground caustic-calcined magnesia:[1]				
Australia	1,593	$260	1,063	$221
Germany, Federal Republic of	2	1	25	6
Greece	1,102	160	3,732	628
India	4,325	333	428	39
Netherlands	202	39	114	26
Turkey	--	--	1,123	249
Total	7,224	793	6,485	1,169
Dead-burned and grain magnesia and periclase:				
Not containing lime or not over 4% lime:				
Austria	72	29	--	--
Brazil	--	--	6,283	867
Canada	45	6	--	--
France	--	--	(2)	3
Germany, Federal Republic of	8	3	(2)	(2)
Greece	14,669	2,692	9,095	2,209
Ireland	43,747	8,441	24,183	4,809
Israel	1,093	274	2,330	617
Japan	15,920	2,976	23,171	5,041
Total	75,554	14,421	65,062	13,546
Containing over 4% lime:				
Canada	999	51	1,424	163
Germany, Federal Republic of	152	36	341	90
Greece	4,449	432	--	--
Ireland	6,250	1,188	24,572	4,727
Mexico	57	3	1,527	54
United Kingdom	--	--	1	(2)
Total	11,907	1,710	27,865	5,034
Total dead-burned and grain magnesia and periclase	87,461	16,131	92,927	18,580

[1]In addition, crude magnesite was imported as follows: 1978—India 6 short tons ($300), Mexico 46 short tons ($2,374); 1979—Canada 96 short tons ($3,771), India 11 short tons ($800), and Japan 2 short tons ($801).
[2]Less than 1/2 unit.

Table 6.—U.S. imports for consumption of magnesium compounds

Year	Oxide or calcined magnesia		Magnesium carbonate[1] (precipitated)		Magnesium chloride (anhydrous)		Magnesium chloride (other)		Magnesium sulfate (epsom salts and kieserite)		Magnesium salts and compounds n.s.p.f.[2]	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
1977	420	$536	67	$117	53	$26	90	$14	36,100	$1,388	5,115	$976
1978	705	795	80	149	48	12	215	55	28,984	1,650	7,892	1,803
1979	3,216	1,772	95	187	26	15	164	73	25,950	1,530	6,988	2,042

[1]In addition, magnesium carbonate not precipitated, was imported as follows: 1977— 33 short tons ($29,064); 1978— 65 short tons ($39,824); 1979—32 short tons ($24,942).
[2]Not specifically provided for; includes magnesium silicofloride or fluosilicate and calcined magnesium.

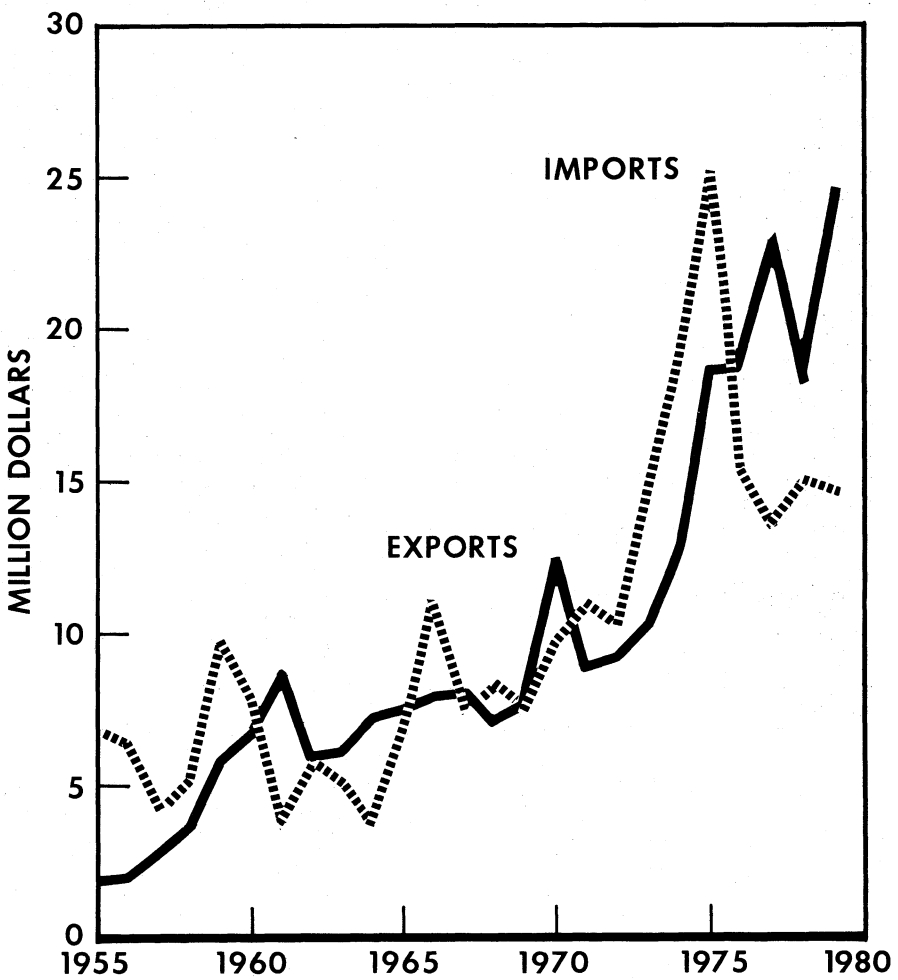

Figure 2.—Value of U.S. exports and imports of magnesia.

WORLD REVIEW

Australia.—Magnesite was mined in New South Wales by Fifield Magnesite and Refractory Pty. The company was acquired in 1977 by Harbison-ACI, a joint subsidiary of Harbison-Walker Refractories and Australian Consolidated Industries. Major investments were made in new mining and processing equipment for the Fifield plant to produce about 15,000 tons per year of dead-burned magnesite, primarily for consumption in Harbison-ACI's refractories plant at Unanderra. The Young Mining Co. Pty. also produced magnesite and was being expanded to increase production of caustic-calcined magnesia and light and heavy magnesium carbonate.

Canada.—A pilot plant, in Quebec City, established by the Ministry of Natural Resources of Quebec, recovered magnesium compounds from asbestos tailings. The asbestos tailings were treated with hydrochloric acid to convert magnesium compounds

Table 7.—Magnesite: World production, by country[1]

(Short tons)

Country	1976	1977	1978[p]	1979[e]
North America:				
Canada[e]	26,000	41,000	39,000	58,000
Mexico	25,558	73,193	83,814	84,000
United States	W	W	W	W
South America:				
Brazil[2]	215,917	226,766	239,500	239,000
Colombia	[r]1,909	1,951	1,543	1,500
Europe:				
Austria	1,021,334	1,105,662	1,082,821	1,100,000
Czechoslovakia	[r]720,911	728,627	724,218	730,000
Greece	1,415,730	1,146,903	903,421	850,000
Poland	[r]28,990	27,000	[e]27,000	28,000
Spain	[r]383,694	464,338	[e]450,000	500,000
U.S.S.R.[e]	1,980,000	2,040,000	2,090,000	2,150,000
Yugoslavia	431,003	380,297	367,069	327,000
Africa:				
Kenya	3	3,941	[e]4,000	4,100
Rhodesia, Southern[e]	22,000	22,000	46,300	46,300
South Africa, Republic of	69,289	54,255	41,234	44,000
Asia:				
China, Mainland[e]	1,100,000	[r]1,700,000	2,000,000	2,200,000
India	[r]363,429	443,136	462,575	470,000
Iran[3]	5,500	5,500	5,500	--
Korea, North[e]	1,650,000	1,650,000	1,650,000	1,650,000
Pakistan	[r]3,578	1,724	2,945	3,000
Turkey	[r]451,149	568,971	459,885	580,000
Oceania:				
Australia	[r]16,211	20,426	[e]22,000	20,000
New Zealand	887	614	925	950
Total	[r]9,933,092	10,706,304	10,703,750	11,085,850

[e]Estimate. [p]Preliminary. [r]Revised. W Withheld to avoid disclosing company proprietary data.

[1]Figures represent crude salable magnesite. In addition to the countries listed, Bulgaria and Canada produce magnesite, but output is not reported quantitatively and available general information is inadequate for formulation of reliable estimates of output levels.

[2]Series reflects output of marketable concentrates. Production of crude ore was as follows: 1976—414,612; 1977—481,154; 1978—[e]510,000; 1979—[e]510,000.

[3]Year beginning March 21 of that stated.

to magnesium chloride. This was further processed to magnesium oxide with regeneration of hydrochloric acid. The process is operated under wet conditions, eliminating the danger of asbestos dust.

India.—A 20-million-metric-ton magnesite deposit was found in Bagolis in the Chanoli district of the Gashwal Himalayas by personnel from the Wadia Institute of Himalayan Studies.

Nepal.—The Department of Mines and Geology and M/s Orissa Industries Ltd. of Rourkela, Orissa, India, have signed an agreement to develop and operate the Kharidhunga magnesite deposit to produce about 55,000 tons of deadburned magnesia at Lamosangu and 22,000 tons per year of basic refractory brick at Birgunj. A long-term loan for the project was to be arranged by the company and guaranteed by the Government of Nepal. The Kharidhunga deposit was estimated to contain almost 200 million tons, of magnesite of which about 73 million tons were considered refractory grade. The geographic area and depth of the deposit were also established.

Netherlands.—A magnesium oxide plant using brine as a magnesium compound source is planned at Veendam by mid-1981, with a capacity of about 100,000 tons per year. Billiton International Metals B. V. (subsidiary of Shell Oil) and the Dutch Government's Northern Development Co. have underwritten the plant for $100 million.

Turkey.—There were four major magnesite producers in the country: Kutahya Manyezit Isletmeleri AS (Kumas), Manyezit AS, Sumerbank, and Continental Madencilik Sanayi ve' Ticaret AS (Comag). Kumas, Manyezit, and Sumerbank produced deadburned magnesite. Comag produced caustic-calcined magnesite. The deadburned magnesite producers had a production capacity of about 375,000 tons per year; and the caustic-calcined producer, about 33,000 tons per year. None of these companies operated at full capacity, but they did mine and process their own raw material.

TECHNOLOGY

The effects of water vapor on the magnesia sintering process were studied by measuring the isothermal shrinkage at temperatures from 900° to 1,200°C as a function of water vapor pressure from 0.002 to 189 mm Hg. It was observed that magnesia sintering was greatly improved with higher water vapor pressure.[2]

Construction of a modified slag test furnace to simulate basic oxygen furnace corrosion was reported. The installation used a coke bed to control furnace atmosphere, establish a thermal gradient, and provide for ease of slag removal. The furnace was used to determine the effect of various slag compositions on the corrosion of tar-impregnated magnesia refractories.[3]

The effects of reducing conditions on the high-temperature strength of pitch-impregnated magnesia refractories were discussed. It was found that the chemical composition of the brick, especially the ratio of CaO to SiO_2 and the quantity of CaO, were important factors in the retention of high-temperature strength when measured under reducing conditions.[4]

A technique for qualitative evaluation of the thermal shock resistance of magnesia refractory brick was developed. The chance for crack formation behind a hot brick face was calculated using experimentally determined physical properties and the thermal gradient behind the hot face of the brick. Needed physical properties, such as the critical deformation under load and the critical deformation in tension, were determined for burned magnesia refractories.[5]

An improved method of preparing magnesium oxychloride or magnesium oxysulfate cements was described.[6]

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[1]Physical scientist, Section of Nonferrous metals.

[2]Hamano, K., K. Asano, Y. Akiyama, and Z. E. Nakagawa. Effects of Water Vapor Pressure on Sintering of Magnesia. Report of the Res. Lab. of Eng. Mater., Tokyo Inst. of Technol., 1979, pp. 59-68.

[3]Tompkins, T. L., R. A. Howe, and T. D. McGee. Furnace for Testing Refractory Corrosion By Basic Oxygen Furnace Slags. Am. Ceram. Soc. Bull., v. 58, No. 7, July 1979, pp. 710-714.

[4]Shultz, R. L., and B. Brezny. High Temperature Strength of MgO Refractories Under Reducing Conditions. Am. Ceram. Soc. Bull., v 58, No. 7, July 1979, pp. 683-686.

[5]Brezny, B. Crack Formation in BOF Refractories During Gunning. Am. Ceram. Soc. Bull., v. 58, No. 7, July 1979, pp. 679-682.

[6]Irwin, R. G. (assigned to PPG Industries). Preparing Magnesium Oxychloride and/or Oxysulfate Cements. U.S. Pat. 4,158,570, June 19, 1979.