Boron

By K. P. Wang [1]

Production and domestic consumption of boron minerals continued the rising trend begun in 1961 and reached a new high in 1972. However, recorded exports in terms of B_2O_3 content showed little overall change from 1971 and were considerably lower than the average level in 1969–70. For some time, all U.S. output had been in the form of sodium borates and boric acid. Recently, production of calcium borate (colemanite) on a commercial scale was resumed in California, which provides the entire domestic production of boron minerals.

Legislation and Government Programs.—During 1972 there were no Government programs and no legislation proposed or enacted pertaining to boron. The Government had no stocks, and no procurement programs were in effect.

The depletion allowance remained at 14% for both domestically and foreign-produced borates in accordance with the Tax Reform Act of 1969.

Table 1.—Salient boron minerals and compounds statistics in the United States

(Thousand short tons and thousand dollars)

	1968	1969	1970	1971	1972
Sold or used by producers:					
Quantity:					
Gross weight	963	1,020	1,041	1,047	1,121
Boron oxide	519	551	562	568	607
Value	$76,535	$81,261	$86,827	$89,856	$95,882
Imports for consumption:[1]					
Quantity	19	24	27	7	20
Value	$558	$718	$831	$233	$626

[1] Colemanite only.

DOMESTIC PRODUCTION

Domestic production and sales of boron increased slightly in 1972 compared with those of 1971. Most of the output came from Kern County, Calif., and to a lesser extent from San Bernardino County, Calif.

The large open pit mine of U.S. Borax & Chemical Corp., a subsidiary of the British-owned Rio Tinto Zinc Corp. Ltd., at Boron, Kern County, remained the world's foremost source of boron. U.S. Borax produced upgraded crude sodium borates, refined borates, including anhydrous borax, and boric acid, including anhydrous boric acid, at the mine site. High-purity and specialty products were produced mainly at Wilmington, Calif., and secondarily at Burlington, Iowa. Wilmington was also the company's port of export. These plants headed by the one at Boron had a combined annual capacity of more than 500,000 short tons of equivalent B_2O_3 in 1972. A 3-year, $10 million program to drastically cut down dust emissions at Boron was successfully concluded in 1972.

Kerr-McGee Chemical Corp., formerly American Potash & Chemical Co., and Stauffer Chemical Co. produced boron compounds and other products from brines of Searles Lake in San Bernardino County, Calif., at their almost-adjoining plants in Trona. Kerr-McGee's annual capacity is about 100,000 short tons of B_2O_3 and Stauffer Chemical's capacity 25,000 to 30,000 tons of B_2O_3. In the spring of 1972, Kerr-

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McGee announced plans to build a $100 million soda ash plant along with additional borate refining facilities.

In 1972, Tenneco Oil Co. produced far less colemanite than it had originally planned from its deposit in the Furnace Creek district of Inyo County, Calif., and its nearby processing plant in Nevada. Tenneco had designed the facilities to produce 150,000 short tons of raw colemanite, or roughly 70,000 short tons of calcined colemanite, per year, but actually turned out only a fraction of this, because of difficulties in calcining. The 48% B_2O_3 grade calcined colemanite was shipped primarily to Owens-Corning Fiberglas Corp.'s plants in Anderson, S.C., and Burkette, Tenn.

Although Occidental Petroleum Corp. through its subsidiary Hooker Chemical Corp. was scheduled to become the third borate-producing company on the shores of Searles Lake before yearend 1972, a proposed plant never took shape because of excessive quantities of brines needed.

CONSUMPTION AND USES

U.S. consumption of boron materials is difficult to estimate because of the wide range of products and the large tonnages of exports in the form of both crude and finished borates. Although U.S. Borax is an international company with farflung worldwide interests, it does not disclose details on shipments to foreign countries. Kerr-McGee also exports considerable quantities of borates. Water-borne freight charges from Wilmington, Calif., to Europe are less than those to the east coast United States, because high-cost U.S. bottoms must be used in domestic runs and special low rates are possible on European runs. U.S. Borax's 20,000- to 30,000-deadweight-ton ships carrying borates to Europe often come back with Volkswagens that pay for a large part of the freight charge.

Generally speaking, about one-half of the U.S. output of boron minerals and compounds was consumed at home, and the other one-half was exported. Official U.S. trade statistics do not list crude borates as a separate category and imply that none is exported. Actually, shipments of unfinished products to foreign countries were larger than those of fully refined products.

An estimated 40% to 45% of the boron compounds consumed were used in manufacturing various kinds of glasses within the United States. Boron materials account for 5% to 10% of many special glasses by weight and 50% to 75% by value. About 15% of all boron consumed went into insulating fiber glass, 10% into textile fiber glass, and 15% to 20% into all other glasses. The manufacture of enamels, frits, and glazes for protective and decorative coatings on sinks, stoves, refrigerators, and many other household and industrial appliances accounted for another 10% of the boron consumption.

Approximately 15% of the boron compounds consumed in the United States, (about one-third in the form of sodium perborate detergents), went into soaps and cleansers during 1972. Herein lies one major difference in U.S. and European consumption patterns. In Europe, sodium perborate detergents, used primarily in high-temperature washing, account for more than one-quarter of the boron consumed whereas in the United States, consumption for cleansers is higher. Borax and boric acid are used in the cleansing field because of their bactericidal characteristics, easy solubility in water, and excellent water-softening properties. They also go into toothpaste, mouthwash, and eyewash.

Borax added to fertilizers to supply boron as an essential plant nutrient accounted for about 5% of the U.S. boron demand. Another 2% to 3% went into the making of herbicides. Substituting colemanite for fluorite in steelmaking did not progress beyond the pilot plant stage.

About one-fourth of the boron consumed in the United States went into many miscellaneous uses. Minor amounts of boron compounds were used as fluxing materials in welding, soldering, and metal refining. Some elemental boron was used as a deoxidizer in nonferrous metallurgy, as a grain refiner in aluminum, as a thermal neutron absorber in atomic reactors, in delayed action fuses, as an ignitor in radio tubes, and as a coating material in solar batteries. Use of boron compounds in abrasives gained ground, particularly cubic boron nitride produced by synthetic diamond producers. Use of boric acid as a catalyst in the air oxidation of hydrocarbons accounted for more than 3% of the boron consumption. Boron materials went into many other areas, including direct consumption in chemicals, conditioning agents or precursors to chemicals, plasticizers, adhesive additives for latex paints, fire retardents, antifreeze, textile and paper products, biocides in jet fuels, photography, and composite materials.

PRICES

Prices of virtually all borate products at yearend 1972 were the same as the prices posted for yearend 1971. Elemental boron prices were quoted at yearend 1972 by the American Metal Market as follows, per pound, in ton lots: 90% to 92% $13; 97% to 99% $18; and over 99%, $70. Prices of various boron compounds are shown in table 2.

Table 2.—Prices of boron compounds at yearend, 1972

	Price per short ton [1]
Borax, technical:	
Anhydrous, 99%:	
Bags	$113.00
Bulk	103.25
Granular, decahydrate, 99.5%:	
Bags	64.75
Bulk	56.25
Granular, pentahydrate, 99.5%:	
Bags	83.75
Bulk	75.25
Boric acid, technical:[2]	
Anhydrous, 99.9%, bags [3]	197.00
Crystals, 99.9%, bags	253.00
Granular, 99.9%, bags	138.00
Sodium borate powder, U.S.P., bags	117.25

[1] Carlots, f.o.b. plant works.
[2] Technical boric acid, $33 per ton higher in drums.
[3] Anhydrous and granular $10 to $12 per ton lower in bulk.

Source: Chemical Marketing Reporter and industry sources.

FOREIGN TRADE

U.S. exports of boric acid were 27,655 short tons (valued at $4.2 million) in 1972, compared with 36,409 tons in 1971. Exports of refined sodium borate showed little change—162,123 tons (valued at $18.3 million) in 1972 and 166,087 tons in 1971. The overall level of exports of all the refined boron compounds was therefore about the same during the last 2 years and considerably below the average level during 1969–70. As noted, these figures hardly tell the whole story since exports of crude borates were actually higher than exports of refined borates.

Detailed breakdown of the recorded exports in 1972, namely boric acid and refined sodium borate, are shown in table 3. Within this table, data for all countries outside Western Europe are accurate. The problem for Western Europe is that the Netherlands distorts the total because this country is primarily a transshipment point for boron compounds to other nearby countries. A more meaningful estimate embracing crude borates as well would show that West Germany, the United Kingdom, France, and Japan were the ranking final export destinations, in that order, and the Netherlands was actually eighth in 1972.

In 1972, the United States imported 20,227 short tons of calcium borate (colemanite) valued at $626,000, all from Turkey. This tonnage was of nearly the same magnitude as the average imports during 1968–70 and approximately three times the 1971 imports.

Table 3.—U.S. exports of boric acid and sodium borates, in 1972

Destination	Boric acid (H_3BO_3 content)		Sodium borates (refined)	
	Short tons	Value (thousands)	Short tons	Value (thousands)
Australia	2,446	$379	4,341	$424
Belgium-Luxembourg	--	--	279	22
Brazil	1,109	201	2,221	268
Canada	3,796	494	11,251	1,152
Chile	174	32	471	61
Colombia	626	105	715	75
Costa Rica	33	6	281	30
El Salvador	3	1	295	87
Finland	--	--	729	96
France	--	--	1,956	217
Germany, West	1,668	230	737	79
Guatemala	10	2	243	78
Hong Kong	206	31	3,634	441
Indonesia	22	3	1,066	91
Israel	--	--	623	62
Italy	49	11	59	3
Japan	9,516	1,367	34,422	3,767
Korea, Republic of	447	72	2,410	205
Malaysia	43	8	287	28
Mexico	2,109	315	8,494	882
Netherlands	1,455	325	71,378	8,408
New Guinea	470	77	139	17
New Zealand	426	67	2,486	410
Nicaragua	11	2	189	61
Pakistan	167	26	--	--
Peru	162	29	375	38
Philippines	558	84	870	102
Singapore	85	16	206	23
South Africa, Republic of	86	15	1,271	190
Spain	--	--	298	36
Sweden	105	15	292	18
Switzerland	--	--	196	16
Taiwan	510	75	3,034	298
Thailand	241	46	1,322	139
United Kingdom	353	39	880	57
Venezuela	273	51	586	63
Vietnam, South	283	42	2,207	164
Yugoslavia	--	--	617	70
Other	213	41	1,263	145
Total	27,655	4,207	162,123	18,323

WORLD REVIEW

Argentina.—Argentina's output of sodium borates has increased from about 23,000 short tons in 1968 to more than 50,000 tons in 1972, but overall potential is far from extensive. Ores mined in the Andes are trucked from Tincalaya to Quijano in the lowlands for processing. The principal producer, Boroquimica Limitada, is another subsidiary of Rio Tinto Zinc Corp. During 1970–71, recorded exports of processed borates from Argentina were about 12,000 tons per year, mainly to Brazil.

China, Peoples Republic of.—Large resources of borates are claimed by the Chinese, particularly for the Iksaydam dried lake area of Tsinghai Province. The textile fiber glass industry in China, which consumes considerable borates, has been expanded sharply in recent years. For some time now, China has shipped a few thousand tons of surplus borates annually to Japan.

Turkey.—Turkey's 1972 output of boron minerals registered another increase over the 629,000 short tons of 39% B_2O_3 grade crude product reported for 1971. Virtually all of this was colemanite, as the extensive deposits of sodium borates have not yet been developed. The output was shipped mainly in the crude form to refineries in Europe. Approximately one-half of Turkey's 1970–72 colemanite production was accounted for by the Government-owned Etibank, which announced the completion of a 600,000-ton concentrator in the Kirka area in mid-1972.

The nationalization issue was not yet resolved by yearend so that the three existing private producers of borates headed by

Rio Tinto Zinc Corp.'s subsidiary Türk Boraks Madençilik Co. were still operating independently. A new coalition government under Feret Melen, in power since the spring of 1972, has introduced a bill in parliament concerning nationalization which was still pending at yearend. With a 50–50 chance of passage, the bill stipulates that boron would be one of four major mineral industries to be nationalized and private owners would be compensated according to "book value."

TECHNOLOGY

Use of colemanite as a substitute for fluorspar in the basic oxygen furnace steel process did not make any headway beyond the testing stage.

In the field of cement manufacture, it was claimed that the addition of 1.5% to 2.5% by weight of boron trioxide in the form of boric acid, calcium tetraborate, or crude colemanite to the raw mix results in a more easily grindable clinker and ultimately a stronger cement.

Boron was being investigated by the U.S. Air Force as part of a fluidized-solids propellant mixture to be used in aerospace rockets.[2] The propellant would consist mainly of fluidizing gas with solids representing only about 1% of the weight.

Use of boron and titanium in grain refining of aluminum and its alloys was discussed.[3]

Less expensive ways for producing boron nitride for abrasives were being investigated.

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[2] Chemical Engineering. May 15, 1972, p. 54.
[3] Metallurgical Transactions. V. 3, No. 8, August 1972, pp. 2290–2292.