Silicon

By E. Shekarchi [1]

Major domestic producers of ferrosilicon and metallurgical-grade silicon engaged during 1972 in expansion toward specialization, and/or plant modernization to comply with 1975 antipollution standards set by local governments and the Federal Government.

Domestic production of ferrosilicon and silicon metal in 1972 increased sharply to meet the rising demands of a wide variety of products. However, increased production of ferrosilicon and silicon metal throughout the world led to severe price erosion both domestically and internationally. High-purity and ultra-high-purity silicon metal, though small in volume, continued to be an important element in the electronics industry; shipments were up 18%. The new demand for silicones as sealants for encapsulation of electric parts greatly increased during the year.

DOMESTIC PRODUCTION

On a gross weight basis, net production of ferrosilicon and silicon metal increased 18% in 1972 while shipments were 23% higher than in 1971. Silicon metal for metallurgical uses was produced at 11 plants of seven companies as shown in table 2.

Northwest Alloy, Inc., a newly formed subsidiary of Aluminum Co. of America (Alcoa), planned construction of a magnesium and silicon plant at Addy, Wash. Initial plant capacity will be 24,000 tons per year, and the final annual capacity will reach 40,000 tons. The plant will be the first of its kind in the United States to employ the megatherm (electrothermal) process with dolomite as raw material. This process, in operation at Marignac, France, since 1964, involves the reduction of calcined dolomite by ferrosilicon at a temperature in excess of 1,500° C. The magnesium and silicon metal extracted will be used by Alcoa and will make the company nearly self-sufficient in silicon metal. The Addy plant was scheduled to begin operation in 1975. It is to be the most modern and efficient environmentally controlled facility of its kind. Total cost has been estimated at $50 million.

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Table 1.—Production, shipments, and stocks of silvery pig iron, ferrosilicon, and silicon metal in 1972 [1]

(Short tons, gross weight)

Alloy	Silicon content (%)	Producers' stocks as of Dec. 31, 1971 [r]	Production	Shipments	Producers' stocks as of Dec. 31, 1972
Silvery pig iron	5-24	W	W	W	W
Ferrosilicon (includes briquets)	25-55	66,134	491,967	421,200	58,200
Do.	56-70	14,812	59,672	63,145	10,025
Do.	71-80	27,683	109,961	109,176	24,706
Do.	81-95	2,144	9,089	9,889	1,312
Silicon metal (excludes semiconductor grades)	96-99	13,028	116,376	107,151	7,456
Miscellaneous silicon alloys (exclusive of silicomanganese)	--	10,136	58,282	52,515	10,568
Other silicon alloys and products	--	2,622	8,788	8,526	2,832

[r] Revised. W Withheld to avoid disclosing individual company confidential data.
[1] Excludes ferrosilicon used to make other silicon alloys.

Table 2.—Producers of silicon alloys and/or silicon metal in the United States in 1972

Producers	Plant location	Product
Airco, Inc., Airco Alloys and Carbide Division	Calvert City, Ky	FeSi.
Do	Charleston, S.C	Do.
Do	Mobile, Ala	Do.
Do	Niagara Falls, N.Y	FeSi, Si.
Alabama Metallurgical Corp	Selma, Ala	FeSi.
Chromium Mining & Smelting Corp	Woodstock, Tenn	Do.
Foote Mineral Co	Graham, W. Va	FeSi, Si.
Do	Keokuk, Iowa	FeSi, Silvery iron.
Do	Vancoram, Ohio	FeSi.
Do	Wenatchee, Wash	FeSi, Si.
Hanna Furnace Corp	Buffalo, N.Y	Silvery iron.
Hanna Nickel Smelting Co	Riddle, Oreg	FeSi.
Interlake Steel Corp	Beverly, Ohio	FeSi, Si.
National Metallurgical Corp	Springfield, Oreg	Si.
Ohio Ferro-Alloys Corp	Brillant, Ohio	FeSi, Si.
Do	Philo, Ohio	Do.
Do	Powhatan Point, Ohio	Do.
Do	Tacoma, Wash	Do.
Reynolds Metals Co	Sheffield, Ala	Si.
Tennessee Alloys Corp	Bridgeport, Ala	FeSi.
Union Carbide Corp., Ferroalloys Division	Alloy, W. Va	FeSi, Si.
Do	Ashtabula, Ohio	FeSi.
Do	Marietta, Ohio	Do.
Do	Portland, Oreg	Do.
Do	Sheffield, Ala	Do.
Woodward Corp	Woodward, Ala	Do.
Do	Rockwood, Tenn	Do.

Allegheny Ludlum Steel Corp., a major producer of grain-oriented silicon electrical steels, announced a $15 million expansion and improvement program exclusively for the silicon facilities at its Bagdad processing plant in Bagdad, Pa.

Standard Resources Inc. of Nevada expected to be producing market-ready silica flour at a rate of 150 tons per day early in 1973. The material will be marketed as minus 200-mesh or plus 200-mesh silica flour ready for bagging, or for bulk shipment.

CONSUMPTION AND USES

New uses for semiconductors and transistors included transistorized circuitry in electronic stoves, tiny semiconductors in diagnostic computer systems, and large numbers of integrated circuits. U.S. factory shipments of semiconductors in 1972 were

Table 3.—Consumption, by major end use, and stocks of silicon alloys and metal in the United States in 1972

(Short tons)

	Silicon content (%)						Miscellaneous silicon alloys [2]
	Silvery pig iron 5–24	Ferrosilicon [1] 25–55	Ferrosilicon [1] 56–70	Ferrosilicon [1] 71–80	Ferrosilicon [1] 81–95	Silicon metal 96–99	
Steel:							
Carbon	3,136	103,544	10,516	24,787	1,238	1,005	17,938
Stainless and heat-resisting	W	17,975	261	9,239	169	70	505
Full alloy	594	35,834	1,531	12,457	1,329	1,106	1,517
High-strength low-alloy	2,222	8,050	W	1,506	W	W	W
Electric	--	1,113	W	W	W	W	--
Tool	--	2,090	W	602	W	W	W
Cast irons	197,273	223,906	11,802	29,673	7,213	23	73,979
Superalloys	--	304	W	10	W	W	W
Alloys (excludes alloy steels and superalloys)	367	2,567	W	278	8,777	51,414	7,954
Miscellaneous and unspecified	4,571	6,539	578	20,902	691	30,133	2,846
Total	208,163	401,922	24,688	99,454	19,417	83,751	104,739
Consumers stocks, Dec. 31, 1972	62,067	30,501	2,023	6,856	1,923	5,692	24,519

W Withheld to avoid disclosing individual company confidential data; included in "Miscellaneous and unspecified."

[1] Includes briquets.

[2] Includes magnesium-ferrosilicon and other silicon alloys.

18% higher than in 1971. Large producers of semiconductors, Texas Instruments, Inc., Motorola Inc., and Fairchild Camera & Instrument Corp., were expanding their production facilities to meet anticipated domestic and foreign demands in 1973.

The range of application of the new silicones, Room Temperature Volcanizers (RTV), increased significantly in 1972. These new products can be poured or spread as a paste which cures to an elastomeric solid at room temperature. The key to this behavior is a chemical reaction which takes place under the catalytic influence of dibutyltin dilaurate, a tin compound. The elastomeric solids were used as sealants in building and engineering, in the production of molds for casting plastics and low-melting-point metals, for coating paper, and for encapsulation of electrical parts.

The consumption patterns of ferrosilicon and silicon metal in the steel and aluminum industries were similar to those of previous years. However, it was predicted by automakers that more silicon alloys would be used in the production of engine castings for economy-size cars in the coming years.

PRICES

The f.o.b. price of 50% ferrosilicon was decreased in March 1972 from 16 to 15 cents per pound contained silicon, bulk, carload lots. The price remained unchanged for the remainder of the year.

Metallurgical-grade silicon, 98% minimum silicon, 0.35% maximum iron, was quoted throughout the year at 25.4 cents per pound. Amorphous silica in 50-pound paper bags, 200 mesh, 90 to 95% silicon, was quoted at $26 per ton, and 98 to 99% silicon was priced at $27 per ton at year-end.

Despite improved steel demand, ferrosilicon prices generally were stable during the year. There appeared to be a tendency in the steel industry to hold raw material inventories down, and buyers were hesitant to make long-term commitments.

FOREIGN TRADE

During 1972 net trade in ferrosilicon, though active, continued to be unfavorable to the United States. Exports decreased 71% in volume and about 61% in value; major recipients were Canada, 3,335 tons; West Germany, 1,617 tons; and the United Kingdom, 1,275 tons. Nineteen countries received shipments ranging in quantity from 1 to 6 tons.

Imports of ferrosilicon and silicon metal for consumption increased 75% in volume and 83% in value over those of 1971. Major increases were in the silicon metal categories. For example, silicon metal imports of not more than 99.7%silicon increased eighteen fold by volume in 1972 compared with 1971 imports. Table 5 has been expanded to include the higher silicon content categories, as reported by the Bureau of the Census.

Table 4.—U.S. exports of ferrosilicon

Year	Quantity (short tons)	Value (thousands)
1970	44,694	$11,887
1971	25,506	5,603
1972	7,367	2,196

Table 5.—U.S. imports for consumption of ferrosilicon and silicon metal, by grade and country

Grade and country	1970			1971			1972		
	Quantity (short tons)		Value (thousands)	Quantity (short tons)		Value (thousands)	Quantity (short tons)		Value (thousands)
	Gross weight	Silicon content		Gross weight	Silicon content		Gross weight	Silicon content	
Ferrosilicon:									
Over 8% but not over 60% silicon:									
Canada	9,450	1,738	$652	6,039	987	$419	6,579	1,043	$419
Denmark	--	--	--	--	--	--	113	51	37
France	1,395	670	473	1,388	624	492	2,553	1,245	936
Germany, West	402	200	119	276	127	75	552	305	226
Italy	80	38	21	--	--	--	--	--	--
Japan	2,035	958	595	3,587	1,687	1,111	2,466	1,174	736
Norway	59	26	18	685	304	213	2,205	980	684
Spain	--	--	--	--	--	--	57	26	16
Total	13,421	3,630	1,878	11,975	3,729	2,310	14,525	4,824	3,054
Over 60% but not over 80% silicon:									
Belgium-Luxembourg	--	--	--	--	--	--	55	37	23
Canada	4,722	3,648	908	791	603	215	949	715	240
Denmark	--	--	--	44	26	17	--	--	--
France	2,676	1,634	1,010	2,836	1,744	1,129	4,538	2,806	1,791
Germany:									
East	28	21	10	--	--	--	--	--	--
West	405	248	128	444	270	162	56	35	21
Japan	--	--	--	50	38	10	--	--	--
Netherlands	--	--	--	--	--	--	2,894	2,205	433
Norway	620	464	92	2,569	1,919	736	9,159	6,935	1,549
South Africa, Republic of	433	330	69	318	246	63	157	120	34
Sweden	--	--	--	3,114	2,307	541	4,901	3,632	1,256
Taiwan	--	--	--	28	20	7	--	--	--
Turkey	--	--	--	--	--	--	2,211	1,697	367
Yugoslavia	--	--	--	2,224	1,718	r 539	--	--	--
Total	8,884	6,345	2,217	12,418	8,891	r 3,419	24,920	18,182	5,714
Over 80% but not over 90% silicon:									
Canada	--	--	--	60	51	18	--	--	--
South Africa, Republic of	99	85	22	14	12	3	--	--	--
Total	99	85	22	74	63	21	--	--	--
Over 90% silicon content:									
France	--	--	--	--	--	--	40	38	12
Norway	--	--	--	--	--	--	115	110	35
Total	--	--	--	--	--	--	155	148	47
Grand total	22,404	10,060	4,117	24,467	12,683	r 5,750	39,600	23,154	8,815
Silicon metal:									
Not over 99.7% silicon:									
Canada	400	363	108	174	173	74	790	780	385
France	--	--	--	--	--	--	121	120	46
Germany, West	--	--	--	--	--	--	(1)	(1)	(1)
Italy	26	25	9	--	--	--	1,681	1,657	584
Japan	(1)	(1)	11	--	--	--	--	--	--
Norway	--	--	--	22	21	8	594	583	216
United Kingdom	1	(1)	1	2	1	2	276	272	97
Yugoslavia	--	--	--	--	--	--	61	55	18
Total	427	388	129	198	195	84	3,523	3,467	1,346

See footnotes at end of table.

Table 5.—U.S. imports for consumption of ferrosilicon and silicon metal, by grade and country—Continued

Grade and country	1970			1971			1972		
	Quantity (short tons)		Value (thousands)	Quantity (short tons)		Value (thousands)	Quantity (short tons)		Value (thousands)
	Gross weight	Silicon content		Gross weight	Silicon content		Gross weight	Silicon content	
Silicon metal—Continued:									
Over 99.7% silicon:									
Belgium-Luxembourg	(1)	(1)	$71	(1)	(1)	$4	(1)	(1)	$38
Canada	--	--	--	--	--	--	1	1	2
Denmark	(1)	(1)	83	(1)	(1)	44	(1)	(1)	73
France	(1)	(1)	(1)	2	2	92	1	1	35
Germany, West	30	30	2,422	12	12	1,173	53	53	3,318
Italy	(1)	(1)	(1)	--	--	--	--	--	--
Japan	15	15	899	17	17	607	5	5	450
Switzerland	1	1	16	--	--	--	--	--	--
United Kingdom	1	1	127	(1)	(1)	(1)	(1)	(1)	7
Total	47	47	3,618	31	31	1,920	60	60	3,923
Grand total	474	435	3,747	229	226	2,004	3,583	3,527	5,269

r Revised.
1 Less than ½ unit.

WORLD REVIEW

India.—The two major ferrosilicon producers in India were the public sector, Mysore Iron and Steel, Ltd., at Bhadravati and the private sector, Indian Metals and Ferroalloys Ltd., at Bhubaneshwar, Orissa. Output of ferrosilicon and silicon metal during 1972 was approximately 19,000 tons, a slight increase over 1971 production.

The Government Planning Commission estimated that India will consume all of its 1973 ferrosilicon production and that the demand will increase to 31,500 tons by 1975 and to 46,000 by 1980.

Italy.—Construction of a new plant in Sicily which will produce about 148,800 tons per year of silicon metal, ferrosilicon, and ferrochrome continued in 1972. Most of the raw material, except chromite, will come from the plant vicinity.

Japan.—Kanabe Kokoki, which built a completely sealed nonrotating, 45,000-kilovolt-ampere ferrosilicon plant in 1968, completed the construction of two fully sealed rotating electric furnace plants early in 1972. One of these plants, which belongs to Yahagi Iron Company of Nagoya, Japan, reportedly produced 36,000 tons of 50% ferrosilicon in a fully enclosed, pollution-free 60,000-kilovolt-ampere electric furnace without any poking. The other plant, which belongs to Joetsu Ferroalloy Company, has the same specifications and was utilized in the production of 75% ferrosilicon.

Of the estimated 300,000 tons of ferrosilicon produced by Japan in 1972, more than half was of 75% ferrosilicon grade, reflecting a trend toward specialization.

Norway.—The construction of two new electric furnaces for production of silicon metal was completed in 1972. One of the furnaces, belonging to Bremanger Smelteverk, a division of Elkem-Spigerverket, increased the production capacity at its Svelgen plant to 10,000 tons of silicon metal per year. The other furnace, belonging to A/S Meraker Smelteverk, a subsidiary of Union Carbide Corp., has a production capacity of 14,000 tons of silicon metal per year.

Exports of silicon metal from Norway in 1972 totaled 42,000 tons, a 62% increase compared with 1971 exports.

South Africa, Republic of.—A new submerged arc electric furnace, reportedly the largest in South Africa, was commissioned in May 1972 at the Ferrometals Ltd. plant in Witbank. Ferrometals Ltd. is a subsidiary of African Metals Corp., Ltd. (AMCOR), which supplies most of the South African domestic market with metallurgical-grade silicon, ferrosilicon, and other alloys. The furnace has a trans-

former capacity of 48 megavolt amperes and was built at a cost of about $4.2 million.

From 1966 to the end of 1971 South African exports of ferrosilicon were reduced drastically in order to meet the needs of the expanding domestic market. However, with the start of new facilities, producers predict an increase of ferrosilicon exports in excess of $7 million per year.