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Ferroalloys

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Ferroalloys are alloys of iron employed to add chemical elements into molten metal, usually during steelmaking. The alloying elements delivered by ferroalloys impart distinctive qualities to steel and cast iron or serve important functions during production. The leading ferroalloy-producing countries in 2012 were, in decreasing order of production, China (59%), South Africa (8%), India (6%), Russia (4%), and Kazakhstan (4%) (table 7). These five countries accounted for 81% of world ferroalloy production. World production of bulk ferroalloys—chromium, manganese, and silicon—was estimated to have been 37.5 million metric tons (Mt) in 2012, a slight increase compared with the revised figure of 37.1 Mt for 2011 (table 7).

Twelve companies in the United States produced 7 ferroalloys at 12 plants (table 1). Production statistics were concealed for most domestically produced ferroalloys after 2010 to avoid disclosing company proprietary data (table 7). U.S. reported consumption of the bulk ferroalloys in 2012 was approximately 993,000 metric tons (t) of manganese and silicon ferroalloys (table 3) and about 256,000 t of contained chromium in ferrochromium (table 4). Comparing reported consumption in 2012 with that of 2011, ferrochromium increased slightly, ferromanganese (including silicomanganese) decreased slightly, and ferrosilicon decreased by 12%. The United States was a net importer of ferroalloys and ferroalloy metals in 2012. On a gross-weight basis, U.S. total ferroalloy and ferroalloy metal imports increased slightly and exports decreased by 16% compared with that of 2011, which resulted in a 2.7% increase in net imports (table 6).

Ferrochromium

The leading world chromite-ore-producing countries in 2012 were South Africa (11 Mt), Kazahkstan (4.0 Mt), and India (3.9 Mt). More than 95% of chromite ore production was smelted in electric arc furnaces to produce ferrochromium for the metallurgical industry. The leading world ferrochromium-producing countries were South Africa (3 Mt), China (2.8 Mt), and Kazakhstan (1.3 Mt). India produced more than 0.8 Mt of ferrochromium. Of the 8.98 Mt of ferrochromium produced, most was consumed in the manufacture of stainless steel. The leading stainless-steel-producing areas of the world—Asia (primarily China, India, Japan, the Republic of Korea, and Taiwan), Europe (primarily Belgium, Finland, France, Germany, Italy, Spain, Sweden, and the United Kingdom), and the Americas (primarily Brazil and the United States)—accounted for most of world stainless steel production. World stainless steel production was estimated to be about 34 Mt in 2012, based on the average of multiple reports. China accounted for 45% of global stainless steel production.

In response to anticipated increases in demand, new ferrochromium-producing plants were under construction or planned in Kazakhstan and South Africa. Several industry trends were evolving—ferrochromium was being increasingly produced using ecological, energy- and recovery-efficient, prereduction, closed-furnace processes; chromium was being increasingly recovered from ferrochromium slag; and the ferrochromium and stainless steel production industries were consolidating ownership, and strategic alliances between these two industries were being developed.

Ferromanganese

Two manganese ferroalloys, ferromanganese and silicomanganese, are key ingredients for steelmaking. In the United States, two companies produced manganese ferroalloys—Eramet Marietta Inc. (owned by France's Eramet Group) and Felman Production Inc. (owned by Miami-based Georgian American Alloys, Inc.) (table 1). In addition to domestic production in 2012, the United States imported 749,000 t of ferromanganese and silicomanganese (gross weight). Of that amount, 45% was imported from South Africa (336,000 t), 15% from Georgia (114,000 t), 9.2% from Norway (68,900 t), and 7.8% from Australia (58,700 t) (Corathers, 2013a, tables 3, 4). China was the leading world producer of manganese ferroalloys, with output about 270% greater than that of the next three major producers—India, South Africa, and Ukraine—combined (table 7).

Ferromolybdenum

Chile, China, and the United States accounted for about 77% of world production of molybdenite ore in 2012. Three other molybdenite-ore-producing countries—Canada, Mexico, and Peru—supplied an additional 14% of world production. Molybdenite concentrates are roasted to form molybdic oxide, which can then be converted into ferromolybdenum, molybdenum chemicals, or molybdenum metal. About 43% of the total reported molybdenum materials consumed in the United States (18,400 t) was in the form of molybdic oxides, and about 27% was consumed as ferromolybdenum. Although the United States was the second leading molybdenum-producing country in the world, it imported more than one-half of its ferromolybdenum requirements in 2012 (Polyak, 2014). The steel industry accounted for most of the ferromolybdenum consumed in the United States in 2012, principally in the production of stainless and full alloy steels (table 4).

Ferronickel

In 2012, more than 85% of ferronickel consumed in the United States was used in stainless, heat-resistant, and certain alloy steels. No ferronickel was produced in the United States from lateritic ores in 2012. The International Metals Reclamation Co. produced a remelt alloy from recycled materials, which was used as a substitute for ferrochromium and ferronickel in the production of austenitic stainless steel. In 2012, excluding China, the major ferronickel-producing countries were Japan (372,000 t gross weight), New Caledonia (142,000 t), Brazil (135,000 t) and Colombia (128,000 t). China produced large tonnages of conventional ferronickel grades, ranging from 15% to as much as 80% nickel content based on customer end use, plus nickel pig iron (NPI), a nickel-iron alloy containing less than 15% nickel, for an estimated output exceeding 1.4 Mt gross weight.

In Brazil, Anglo American Brasil Limitada's Barro Alto plant produced 21,600 t of nickel content of ferronickel in 2012, more than triple the 6,200 t output of 2011, and was scheduled to reach full production—41,000 metric tons per year (t/yr) of nickel content of ferronickel—in early 2013 (Anglo American plc, 2013, p. 80–89).

Vale S.A suspended operations at its Onça Puma ferronickel smelting complex in June 2012 after both furnaces developed problems and were damaged during ramp up. The company decided to rebuild one of the damaged furnaces at an estimated cost of $188 million and planned to resume ramp up of the rebuilt furnace in the fourth quarter of 2013. With only one furnace operating, the complex would have a nominal capacity of 25,000 t/yr of nickel content of ferronickel (Vale S.A., 2013, p. 16, 21, 40, 42, 64, F–29).

In November 2012, the Government of Venezuela refused to renew the mining concessions and operating permits held by Minera Loma de Niquel C.A., and took control of the laterite mining and ferronickel operation. The Government had already canceled 13 of Loma de Niquel's concessions, forcing the parent company, Anglo American plc, to halt mining in September. Petróleos de Venezuela, S.A., the parastatal oil company, was given responsibility for the operation (Anglo American plc, 2013, p. 81–82, 88; León, 2012).

According to the China Nonferrous Metals Industry Association, China produced 308,000 t of nickel contained in NPI in 2012, up from 254,300 t in 2011 (Beijing Antaike Information Development Co., Ltd., 2013). At yearend 2012, at least 10 greenfield NPI plants were in varying stages of construction. One of these, the 600,000-t/yr NPI project of the Fujian Haihe Industry Co., started two 30,000-kilovolt-ampere (KVA) furnaces in May. Four 60,000-KVA furnaces were to be constructed in Phase 2 of the project (Beijing Antaike Information Development Co., Ltd., 2012).

Ferrosilicon

Silicon ferroalloy consumption is driven by cast iron and steel production, where silicon alloys are used as deoxidizers. Silicon metal was also used as an alloying agent with iron. Starting in 2011, domestic data for silicon metal containing less than 99.9% silicon—silicon metal used as feedstocks for chemical, electronic, and metallurgical applications—were aggregated with those of ferrosilicon to avoid disclosing company proprietary data for both material categories. In 2012, total domestic ferrosilicon and silicon metal production was 357,000 t on a gross-weight basis, which was slightly less than the revised amount (370,000 t) in 2011 (table 7). In addition to domestic production in 2012, the United States imported 387,000 t of ferrosilicon and silicon metal (gross weight). Of that amount, 70% was imported from Russia (112,000 t), Canada (62,500 t), Brazil (46,200 t), and China (49,400 t) (Corathers, 2013b, table 6). China produced more ferrosilicon and silicon metal than the rest of the world combined and about four times more than that of the next three major producing countries—Russia, Norway, and the United States—combined. China's ferrosilicon and silicon metal production consisted of 69% and 67% of the world total, respectively, excluding net production in the United States (table 7).

Ferrotitanium

Titanium is used in steelmaking for deoxidation, grain-size control, and carbon and nitrogen control and stabilization. During steelmaking, titanium is usually introduced as ferrotitanium, because it has a lower melting temperature and higher density than titanium scrap. Steels with relatively high titanium content include interstitial-free, stainless, and high-strength low-alloy steels. Ferrotitanium is typically produced by induction melting of titanium scrap with iron or steel; however, it also is produced directly from titanium mineral concentrates. The standard grades of ferrotitanium are 30% and 70% titanium. U.S. producers of ferrotitanium were Global Titanium Inc. (Detroit, MI), with 10,000 t/yr of ferrotitanium production capacity, and RTI International Metals, Inc. (Canton, OH), with 7,260 t/yr of ferrotitanium and specialty alloy production capacity. The leading ferrotitanium-producing countries were China, India, Russia, and the United States.

In the United States, reported domestic consumption of titanium products in steel and other alloys was 12,900 t (gross weight), a 3% increase compared with that of 2011. Increased global steel production in 2012 increased the demand for ferrotitanium. In 2012, the average U.S. spot-market price range for 70%-grade ferrotitanium reported by Platts Metals Week decreased to $3.20 to $3.25 per pound from $3.45 to $3.55 per pound in 2011.

Ferrotungsten

Tungsten is an important alloying element in high-speed and other tool steels and is used to a lesser extent in some stainless and structural steels. Tungsten can be added to steel melts as (1) ferrotungsten, which is a master alloy containing between 75% and 80% tungsten; (2) tungsten melting base, which is a master alloy containing as much as 38% tungsten; (3) tungsten metal scrap; or (4) scheelite ore concentrates (Lassner and Schubert, 1999, p. 307–312; Roskill Information Services Ltd., 2007, p. 167–168, 174, 178–179).

World ferrotungsten production was dominated by China, where production was estimated to be 6,000 to 7,500 t, gross weight, during 2010–11. During the first half of 2012, China's

production of ferrotungsten was 34% lower than that of the first half of 2011. China's full-year 2012 ferrotungsten exports decreased by 53% to 459 t from 984 t in 2011. Although low in quantity (19 t, gross weight), China's imports of ferrotungsten increased in 2012 (Fang, 2012, p. 12, 18, 44; Liu, 2013, p. 36).

Minpro AB (Strassa, Sweden) introduced a new type of ferrotungsten to the market. The ferrotungsten was produced from secondary (scrap) materials and was porous, which allowed it to dissolve more quickly in steel melts in spite of having a higher tungsten content than ferrotungsten produced by smelting ore concentrates. Minpro's plant in Strassa had a production capacity of about 1,000 t/yr of ferrotungsten, which was estimated to be sufficient to supply about one-third of European consumption (Advantage Environment, 2013).

Vietnam Youngsun Tungsten Industry Co., Ltd.'s plant in Halong City, Quang Ninh Province, reportedly shipped 2,700 t of ferrotungsten, mainly to Europe, but also to Japan, the Republic of Korea, and the United States. Vietnam Youngsun used domestic ore to produce the ferrotungsten (Hack, 2013; Metal Bulletin, 2013).

At yearend, Hazelwood Resources was securing feedstock from overseas suppliers for its majority-owned, 4,000-t/yr Asia Tungsten Products ferrotungsten plant in the Vinh Bao district near the port of Haiphong in Vietnam. Hazelwood planned to produce the first salable ferrotungsten in the early 2013 (Hazelwood Resources Ltd., 2012).

U.S. reported consumption of ferrotungsten increased from that of 2011. The Platts Metals Week average annual ferrotungsten price was slightly lower than that of 2011; during the year, weekly prices ranged between $42 and $59.50 per kilogram of contained tungsten.

Ferrovanadium

In 2012, China, Russia, and South Africa accounted for 96% of world vanadium mine production. In these countries, vanadium was primarily recovered from titanium-bearing magnetite ore processed to produce pig iron. The process produced a slag containing 20% to 24% vanadium pentoxide, which was further processed to ferrovanadium containing 40% to 50% vanadium (Polyak, 2013).

In 2012, vanadium recovered from various industrial waste materials, such as vanadium-bearing fly ash, petroleum residues, pig iron slag, and spent catalysts was the leading source of U.S. vanadium production. A small amount of vanadium was obtained as a coproduct from the mining of uraniferous sandstones on the Colorado Plateau (Polyak, 2013).

In 2012, most of U.S. reported vanadium consumption was for steelmaking, principally in carbon, full alloy, and high-strength low-alloy steels. Ferrovanadium supplied 79% of the 3,980 t of vanadium consumed in the United States (Polyak, 2013). Steel manufacturing consumed almost all of the ferrovanadium in 2012 (table 4).

Outlook

The near-term trend for domestic ferroalloy consumption was expected to follow closely that of U.S. steel production. Details of the outlook for the steel industry are discussed in the Outlook section of the Iron and Steel chapter of the 2012 USGS Minerals Yearbook, volume I, Metals and minerals. Crude steel production in the United States increased slightly to 88.7 Mt in 2012 from 86.4 Mt in 2011 (Fenton, 2014, table 1). According to the World Steel Association (2013a), world raw steel production in 2012 increased slightly to 1.55 billion metric tons (Gt) from 1.53 Gt in 2011. Raw steel production in China, the world's leading producer of raw steel, increased by 3.1% to about 717 Mt.

Changes in steel production reflect changes in apparent use of steel. World apparent consumption of finished steel products increased slightly to 1.41 Gt in 2012. This was the smallest increase since 2009, when apparent consumption decreased by 6.5%, and was caused mainly by decreased apparent consumption in the European Union. Even in China, the leading world consumer of steel products, apparent steel consumption growth slowed, increasing slightly to 646 Mt in 2012. The combined steel consumption in the BRIC countries—Brazil, Russia, India, and China—also only increased slightly to 785 Mt; these countries accounted for about 55% of the world total. World steel apparent consumption was projected to increase 1.45 in 2013 and 1.5 in 2014. Apparent steel use in North America was expected to increase by 4.5% to 135 Mt in 2013 from that in 2012, and to 139 Mt in 2014, as a result of continued economic recovery (World Steel Association, 2013b).

Chromium, manganese, silicon, and other ferroalloy metals are discussed in more detail, including domestic data coverage, foreign trade by country, outlook, and U.S. Government stockpile information, in the respective mineral commodity chapters in the U.S. Geological Survey Minerals Yearbook, volume I, Metals and minerals.

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TABLE 1
DOMESTIC PRODUCERS OF FERROALLOYS IN 2012

Company	Plant location	Products[1]						
		FeMo	FeMn	FeNb	FeSi	FeTi	FeV	SiMn
Bear Metallurgical Co.	Butler, PA	X					X	
CC Metals & Alloys, LLC[2]	Calvert City, KY				X			
Core Metals Group[3]	Bridgeport, AL				X			
Eramet Marietta Inc.	Marietta, OH		X					X
Felman Production Inc.[2]	Letart, WV							X
Global Titanium Inc.	Detroit, MI					X		
Globe Metallurgical Inc.[3]	Beverly, OH				X			
Metallurg Vanadium Corp.	Cambridge, OH						X	
Reading Alloys Inc.	Robesonia, PA			X				
RTI International Metals, Inc.	Canton, OH					X		
Stratcor, Inc.	Butler, PA						X	
Thompson Creek Metals Co. Inc.	Langeloth, PA	X						

[1]FeMo, ferromolybdenum; FeMn, ferromanganese; FeNb, ferroniobium; FeSi, ferrosilicon; FeTi, ferrotitanium; FeV, ferrovanadium; SiMn, silicomanganese.
[2]Subsidiary of Georgian American Alloys, Inc.
[3]Owned by Globe Specialty Metals.

TABLE 2
GOVERNMENT INVENTORY OF FERROALLOYS, DECEMBER 31, 2012[1, 2]

(Metric tons of alloys)

Alloy	Inventory
Ferrochromium:	
High-carbon	94,300
Low-carbon	49,400
Ferromanganese, high-carbon	348,000

[1]Data are rounded to no more than three significant digits.
[2]Data are uncommitted inventory.

Source: Defense Logistics Agency, DLA Strategic Materials.

TABLE 3
REPORTED U.S. CONSUMPTION OF FERROALLOYS AS ALLOYING ELEMENTS BY END USE IN 2012[1, 2]

(Metric tons of alloys)

End use	FeB	FeMn	SiMn	FeP	FeSi	FeTi
Steel:						
Carbon and high-strength low-alloy	468	311,000	107,000	4,040	77,200	7,330
Stainless and heat-resisting	207	9,660	15,700	(3)	48,500	3,360
Other alloy	(3)	50,500	23,200	(3)	19,300	413
Tool	(3)	(3)	(3)	(3)	(3)	(4)
Unspecified	198	983	963	840	33,700	(4)
Total steel	873	373,000	147,000	4,880	179,000	11,100
Cast irons	(5)	8,870	381	441	91,800	16
Superalloys	36	(6)	--	(5)	972	568
Alloys (excluding alloy steels and superalloys)	(5)	702	2,920	(5)	29,600	1,060
Miscellaneous and unspecified	605	(6)	(6)	462	160,000	135
Grand total	1,510	382,000	150,000 [7]	5,790	461,000	12,900
Total 2011	1,390 [r]	394,000 [r]	154,000 [r, 7]	5,750	526,000 [r]	12,500 [r]
Percentage of 2011	109	97	97	101	88	103
Consumer stocks, December 31	158	17,700 [8]	4,230 [8]	651	14,200	1,770

[r]Revised. -- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]FeB, ferroboron, including other boron materials; FeMn, ferromanganese, including manganese metal; SiMn, silicomanganese; FeP, ferrophosphorus, including other phosphorus materials; FeSi, ferrosilicon, including silicon metal, silvery pig iron, silicon carbide, and inoculant alloys; FeTi, ferrotitanium, including titanium scrap and other titanium materials.

[3]All or part included with “Steel, unspecified.”

[4]All or part included with “Steel, other alloy.”

[5]All or part included with “Miscellaneous and unspecified.”

[6]All or part included with “Alloys (excluding alloy steels and superalloys).”

[7]Internal evaluation indicates that silicomanganese consumption is considerably understated.

[8]Consumer and producer stocks.

TABLE 4

REPORTED U.S. CONSUMPTION OF FERROALLOYS AS ALLOYING ELEMENTS BY END USE IN 2012[1, 2]

(Metric tons of contained alloying elements)

End use	FeCr	FeMo	FeNb	FeNi	FeV	FeW
Steel:						
Carbon	4,020	283	1,570	--	737	(3)
High-strength low-alloy	1,760	123	(3)	(3)	(4)	--
Stainless and heat-resisting	213,000	684	811	(3)	62	(3)
Other alloy	15,300	3,440	318	(3)	2,320	(3)
Tool	(4)	(5)	17	(3)	(4)	(3)
Unspecified	8,700	--	3,320	12,700 p	--	165
Total	243,000	4,530	6,030	12,700 p	3,120	165
Cast irons	(6)	345	--	--	(5)	--
Superalloys	9,450	(5)	1,620	(5)	5	(3)
Alloys (excluding alloy steels and superalloys)	3,220	(5)	20	(5)	(5)	(3)
Miscellaneous and unspecified	(6)	139	--	2,080 p	14	--
Grand total	256,000	5,010	7,670	14,800 p	3,140	165
Total 2011	253,000 r	5,470 r	9,330 r	13,900 r	4,140 r	115
Percentage of 2011	101	92	82	106	76	143
Consumer stocks, December 31	7,620	331	388	996 p	209	W

pPreliminary. rRevised. W Withheld to avoid disclosing company proprietary data. -- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]FeCr, ferrochromium, including other chromium ferroalloys and chromium metal; FeMo, ferromolybdenum, including calcium molybdate; FeNb, ferroniobium, including nickel niobium; FeNi, ferronickel; FeV, ferrovanadium, including other vanadium-carbon-iron ferroalloys; and FeW, ferrotungsten.

[3]All or part included with "Steel, unspecified."

[4]All or part included with "Steel, other alloy."

[5]All or part included with "Miscellaneous and unspecified."

[6]All or part included with "Grand total."

TABLE 5
SELECTED FERROALLOY PRICES IN 2012

	High	Low	Average
Chromium:			
Ferrochromium:			
0.05% carbon[1]	236.29	232.46	234.37
0.10% carbon[1]	219.34	215.42	217.38
0.15% carbon[1]	210.91	208.39	209.65
Over 4% carbon:			
49–51% chromium[1]	110.17	105.65	107.91
60–65% chromium[1]	112.03	108.00	110.02
Manganese:			
Medium-carbon ferromanganese[1]	92.53	89.61	91.07
Standard high-carbon ferromanganese[2]	1,232.06	1,210.32	1,221.19
Silicomanganese[3]	63.35	60.87	62.11
Molybdenum:			
Ferromolybdenum[4]	14.85	14.58	14.72
Molybdenum oxide[4]	12.85	12.63	12.74
Silicon:			
50% ferrosilicon[1]	101.65	99.23	100.44
75% ferrosilicon[1]	92.70	90.26	91.48
Silicon metal[1]	129.08	123.19	126.13
Vanadium, ferrovanadium[4]	15.73	14.04	14.88

[1]Cents per pound of contained element.
[2]Dollars per gross ton.
[3]Cents per pound.
[4]Dollars per pound of contained element.

Sources: Platts Metals Week and Ryan's Notes.

TABLE 6
U.S. IMPORTS FOR CONSUMPTION AND EXPORTS OF FERROALLOYS AND FERROALLOY METALS IN 2012[1]

Alloy	Imports			Exports		
	Gross weight (metric tons)	Contained weight (metric tons)	Value (thousands)	Gross weight (metric tons)	Contained weight (metric tons)	Value (thousands)
Ferroalloys:						
Chromium ferroalloys:						
Ferrochromium containing:						
More than 4% carbon	449,000	257,000	$526,000	4,460	2,240	$5,790
Not more than 4% carbon	XX	XX	XX	768	347	1,350
More than 3% but not more than 4% carbon	411	222	221	XX	XX	XX
More than 0.5% but not more than 3% carbon	7,580	5,150	18,500	XX	XX	XX
Not more than 0.5% carbon	43,900	30,300	146,000	XX	XX	XX
Ferrochromium-silicon	25,800	9,730	36,500	64	22	105
Total	526,000	302,000	728,000	5,300	2,610	7,250
Manganese ferroalloys:						
Ferromanganese containing:						
More than 4% carbon	300,000	231,000	316,000	XX	XX	XX
More than 2% but not more than 4% carbon	177	146	414	XX	XX	XX
More than 1% but not more than 2% carbon	66,500	53,500	98,200	XX	XX	XX
Not more than 1% carbon	34,700	29,200	67,300	XX	XX	XX
Ferromanganese, all grades	XX	XX	XX	5,350	XX	6,540
Silicomanganese	348,000	231,000	419,000	5,850	XX	8,220
Total	749,000	545,000	901,000	11,200	XX	14,800
Silicon ferroalloys:						
Ferrosilicon containing:						
More than 55% silicon	XX	XX	XX	15,200	9,750	22,800
55% to 80% silicon and more than 3% calcium	3,440	2,520	5,930	XX	XX	XX
Magnesium ferrosilicon	17,500	7,890	35,800	XX	XX	XX
Ferrosilicon, other[2, 3]	229,000	163,000	331,000	5,370	2,470	11,600
Total	250,000	173,000	373,000	20,600	12,200	34,000
Other ferroalloys:						
Ferrocerium and other pyrophoric alloys	1,390	XX	11,800	XX	XX	XX
Ferromolybdenum	6,450	4,320	138,000	1,440	996	33,100
Ferronickel	39,000	13,000	228,000	314	182	5,190
Ferroniobium	11,400	XX	324,000	512	XX	5,630
Ferrophosphorus	7,070	XX	4,340	161	XX	358
Ferrotitanium and ferrosilicon-titanium	2,410	XX	12,000	3,610	XX	17,300
Ferrotungsten and ferrosilicon-tungsten	410	316	14,200	3	2	32
Ferrovanadium	5,230	4,190	108,000	454	337	11,000
Ferrozirconium	6	XX	72	2,560	XX	6,420
Ferroalloys, other	8,160	XX	32,200	3,240	XX	7,900
Total	81,500	21,800	873,000	12,300	1,520	86,900
Total ferroalloys	1,610,000	1,040,000	2,880,000	49,400	16,300	143,000
Metals:						
Chromium (total, all grades)	15,300	XX	203,000	462	XX	13,000
Manganese:						
Metal, including alloys and waste and scrap	XX	XX	XX	2,580	XX	7,510
Unwrought	43,300	XX	125,000	XX	XX	XX
Other manganese, wrought	55	XX	457	XX	XX	XX
Silicon:						
Less than 99% silicon	25,400	24,900	67,500	10,900	10,200	37,300
Less than 99.99% but not less 99% silicon	109,000	109,000	328,000	9,700	9,300	27,000
More than 99.99% silicon	2,580	XX	157,000	55,600	XX	1,840,000
Total metals	196,000	133,000	881,000	79,200	19,500	1,920,000
Grand total	1,800,000	1,180,000	3,760,000	129,000	35,900	2,070,000

XX Not applicable.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Includes less than 55% silicon and 55% to 80% silicon, other.

[3]Includes imports of ferrosilicon containing 80% to 90% silicon and more than 90% silicon.

Source: U.S. Census Bureau.

TABLE 7
FERROALLOYS: WORLD PRODUCTION, BY COUNTRY, FURNACE TYPE, AND ALLOY TYPE[1]

(Metric tons, gross weight)

Country, furnace type, and alloy type[2]	2008	2009	2010	2011	2012[e]
Albania, electric furnace, ferrochromium	11,916	7,556	23,233 [r]	28,694 [r]	29,000
Argentina, electric furnace:[e]					
Ferrosilicon	10,400	11,300	11,000	11,000	11,000
Silicomanganese	9,172 [3]	6,644 [3]	10,900	11,000 [r]	11,000
Total	19,600	17,900	21,900	22,000 [r]	22,000
Armenia, electric furnace, ferromolybdenum	5,325	5,144	5,126	5,525 [r]	5,600
Australia, electric furnace:[e]					
Ferromanganese	147,000	87,000	136,000	146,000	102,000
Silicomanganese	125,000	74,000	131,000	130,000	96,000
Silicon metal	35,000	30,000	30,000	30,000	30,000
Total	307,000	191,000	297,000	306,000	228,000
Austria, electric furnace:					
Ferronickel, including ferronickel molybdenum[e]	1,250 [r]	1,750	1,500	1,750 [r]	2,000
Other	305,750 [r]	586,250 [r]	635,500 [r]	648,250 [r]	598,000
Total[e]	307,000 [r]	588,000 [r]	637,000 [r]	650,000 [r]	600,000
Bahrain, electric furnace:[4]					
Ferromanganese	--	5,700	5,600	35,300	35,100
Silicomanganese	--	6,500	3,700	3,000	3,000
Total	--	12,200	9,300	38,300	38,100
Bhutan, electric furnace, ferrosilicon, exports	30,824	90,798	97,528	94,000	94,000
Bosnia and Herzegovina, electric furnace, net exports:[e]					
Ferrosilicon	640	470	870	1,800	--
Silicon metal	12,400	11,000	17,300	17,500	15,900
Total	13,000	11,500	18,200	19,300	15,900
Brazil, electric furnace:					
Ferrochromium[5]	194,324	131,048	277,114	145,122 [r]	150,000 [p]
Ferrochromium silicon	11,507	11,510	11,600	11,700 [e]	11,700
Ferromanganese[e]	155,000 [r]	42,300 [r]	92,000 [r]	88,000 [r]	96,000 [p]
Ferronickel	36,544	37,708	33,860	67,000 [r]	135,400 [p, 3]
Ferroniobium (ferrocolumbium)	53,839	34,746	52,588	52,600	52,600
Ferrosilicon[e]	144,832 [3]	145,000	145,000	145,000	145,000
Ferrotitanium	4,002	482	806 [r]	59 [r]	105 [p]
Silicomanganese[e]	233,000 [r]	112,000 [r]	214,000 [r]	227,000 [r]	219,000 [p]
Silicon metal[e]	131,940 [3]	132,000	132,000	132,000 [r]	133,000
Other[e]	19,344 [3]	19,350 [3]	19,400	19,500	19,500
Total[e]	984,000	666,000	978,000 [r]	888,000 [r]	962,000
Bulgaria, electric furnace, ferrosilicon[e]	6,000 [3]	3,000 [3]	--	--	--
Canada, electric furnace:[e]					
Ferroniobium (ferrocolumbium)	7,000 [r]	7,000 [r]	7,000 [r]	8,000 [r]	8,000
Ferrosilicon	35,000	25,820 [3]	36,786 [3]	31,039 [3]	31,979 [3]
Ferrovanadium	1,000	900	900	900	800
Silicon metal	50,000	30,000	30,000	30,000	35,000
Total	93,000 [r]	63,700 [r]	74,700 [r]	69,900 [r]	75,800
Chile, electric furnace, ferromolybdenum	16,918	10,820	12,485	17,177	15,000
China:[e]					
Blast furnace:					
Ferromanganese	600,000	350,000	350,000	350,000	350,000
Other	50,000	30,000	30,000	-- [r]	--
Electric furnace:					
Ferrochromium	1,500,000	1,810,000	2,400,000	2,700,000 [r]	2,800,000
Ferromanganese	2,100,000	2,070,000	2,300,000	2,600,000 [r]	2,800,000
Ferromolybdenum	80,000	90,000	90,000	53,000 [r]	80,000
Ferronickel and high nickel pig iron	590,000	600,000	900,000	1,280,000 [r]	1,400,000
Ferrosilicon	4,900,000	5,100,000	5,300,000	5,400,000	5,500,000
Ferrotitanium	14,000	300	5,600	5,000	5,000

See footnotes at end of table.

TABLE 7—Continued
FERROALLOYS: WORLD PRODUCTION, BY COUNTRY, FURNACE TYPE, AND ALLOY TYPE[1]

(Metric tons, gross weight)

Country, furnace type, and alloy type[2]	2008	2009	2010	2011	2012[e]
China—Continued:[e]					
Electric furnace—Continued:					
Silicomanganese	5,000,000	5,430,000	5,840,000	6,700,000 [r]	6,900,000
Silicon metal	1,100,000 [r]	993,000 [r]	1,140,000 [r]	1,050,000 [r]	1,500,000
Other	3,230,000	6,620,000	7,600,000	8,000,000	7,000,000
Total, blast and electric furnaces	19,200,000 [r]	23,100,000 [r]	26,000,000 [r]	28,100,000 [r]	28,300,000
Colombia, electric furnace, ferronickel	126,638	153,628	145,239	103,371 [r]	127,509 [3]
Czech Republic, electric furnace, other[e]	2,800	--	--	--	--
Dominican Republic, electric furnace, ferronickel	47,408	--	--	34,610	38,938 [3]
Egypt, electric furnace:[e]					
Ferromanganese[4]	28,800 [3]	26,300 [3]	20,000 [3]	30,000	30,000
Ferrosilicon	59,000	78,000	78,000	78,000	78,000
Total	87,800	104,000	98,000	108,000	108,000
Finland, electric furnace, ferrochromium[e]	233,550 [3]	123,310 [3]	125,000	125,000	125,000
France, electric furnace:					
Ferromanganese[4]	46,600	46,000	138,100	130,500	101,000
Ferrosilicon[e]	30,000	18,300	27,000	59,000	71,000
Silicomanganese[4]	60,200	54,100	62,400	63,400	68,500
Silicon metal[e]	118,000	80,000	112,000	128,000	130,000
Other[e]	60,000	60,000	60,000	60,000	60,000
Total[e]	315,000	258,000	400,000	441,000	431,000
Georgia, electric furnace:					
Ferromanganese	11,342 [r]	1,838 [r]	824 [r]	-- [r]	--
Silicomanganese	113,455 [r]	112,016	203,464	242,746 [r]	257,421 [3]
Total	124,797 [r]	113,854 [r]	204,288 [r]	242,746 [r]	257,421 [3]
Germany, electric furnace:					
Ferrochromium[e, 5]	26,960 [3]	13,667 [3]	17,300	17,800	17,500
Silicon metal	29,092	27,620	30,105	30,134	30,000
Other[e]	5,000	6,336 [3]	9,200	9,000	9,000
Total[e]	61,100	47,623 [3]	56,600	56,900	56,500
Greece, electric furnace, ferronickel	87,664	42,423	69,596 [r]	93,905 [r]	96,435 [p, 3]
Iceland, electric furnace, ferrosilicon	107,882 [r]	112,993	114,231	120,076	115,000
India, electric furnace:[e, 6]					
Ferroaluminum	8,170 [3]	7,017 [3]	7,000	7,000	7,100
Ferroboron	83	90 [3]	95	98	95
Ferrochromium[5]	750,000 [3]	873,385 [3]	850,000	830,000	800,000
Ferromanganese[4]	386,200 [3]	399,100 [3]	413,000 [r]	420,000 [r]	463,900
Ferromolybdenum	2,162 [3]	2,822 [3]	3,000	3,200	3,100
Ferronickel magnesium	221 [3]	209 [3]	229 [r, 3]	255 [r, 3]	272
Ferrosilicomagnesium	13,400 [3]	17,342 [3]	17,000	18,000	18,000
Ferrosilicon	92,000	101,337 [3]	101,000	105,000	108,000
Ferrosilicozirconium	87 [3]	120 [3]	150	170	180
Ferrotitanium	1,661 [3]	2,379 [3]	2,200	2,300	2,400
Ferrotungsten	150 [3]	150 [3]	150 [r, 3]	225 [r, 3]	230
Ferrovanadium	1,501 [3]	1,769 [3]	1,800	1,850	1,900
Silicomanganese[4]	848,700 [r, 3]	875,500 [3]	1,170,000 [r, 3]	1,433,600 [r, 3]	1,522,600
Total	2,104,335 [r]	2,281,220 [r, 3]	2,570,000 [r]	2,820,000 [r]	2,930,000
Indonesia, electric furnace:[e]					
Ferromanganese	12,000	12,000	12,000	12,000	13,000
Ferronickel	87,800 [3]	62,700 [3]	93,300 [3]	98,200	91,500
Silicomanganese	7,000	7,000	8,000	8,000	9,000
Total	107,000	81,700	113,000	118,000	114,000

See footnotes at end of table.

TABLE 7—Continued
FERROALLOYS: WORLD PRODUCTION, BY COUNTRY, FURNACE TYPE, AND ALLOY TYPE[1]

(Metric tons, gross weight)

Country, furnace type, and alloy type[2]	2008	2009	2010	2011	2012[e]
Iran, electric furnace:					
Ferrochromium	NA [r]	NA [r]	NA [r]	NA [r]	NA
Ferrosilicon	NA [r]	NA [r]	NA [r]	NA [r]	NA
Total	NA [r]	NA [r]	NA [r]	NA [r]	NA
Italy, electric furnace:					
Ferromanganese[4]	8,500	5,500	17,000	18,000	18,000
Silicomanganese[4]	25,500	17,000	22,900	24,600	42,000
Other, excluding calcium-silicon[e]	10,000	10,000	10,000	10,000	10,000
Total[e]	44,000	32,500	49,900	52,600	70,000
Japan, electric furnace:					
Ferrochromium[7]	13,888	7,698	16,208	17,217 [r]	18,000
Ferromanganese	431,181	361,375	453,265	456,798	436,171 [3]
Ferromolybdenum	4,554	3,598	4,615	5,167 [r]	5,200
Ferronickel	301,361	284,884	348,420	279,944 [r]	371,913 [3]
Ferrovanadium	3,477	2,560	4,190	3,980 [r]	4,000
Silicomanganese	58,884	49,205	49,865	49,798 [r]	52,287 [3]
Other	14,478	12,957	16,374	20,913 [r]	21,000
Total	827,823	722,277	892,937	833,817 [r]	909,000
Kazakhstan, electric furnace:					
Ferrochromium	1,220,315	1,173,286	1,311,302	1,289,917 [r]	1,305,566 [3]
Ferrochromium silicon	133,828	60,829	159,765	143,296 [r]	164,854 [3]
Ferrosilicon	54,964	33,100	4,813	1,683 [r]	496 [3]
Silicomanganese	179,939	200,374	224,627	232,039 [r]	251,445 [3]
Silicon metal	--	--	1,500	8,000	18,000 [3]
Other	1,473	1,205	1,283	1,754	1,845 [3]
Total	1,590,519 [r]	1,468,794 [r]	1,703,290 [r]	1,676,689 [r]	1,742,206 [3]
Korea, North, electric furnace, other	NA [r]	NA [r]	NA [r]	NA [r]	NA
Korea, Republic of, electric furnace:					
Ferromanganese	251,125	216,400	286,259	355,047	364,800
Ferronickel	6,600	56,911	55,215	50,069	51,300 [3]
Silicomanganese	76,184	151,100 [4]	120,779	195,650	184,700 [4]
Other	4,000 [e]	--	--	--	--
Total	338,000 [e]	424,411	462,253	600,766	601,000
Kosovo, ferronickel	24,300	47,900 [r]	41,300 [r]	35,100 [r]	20,100
Laos, silicon metal, net exports[e]	3,020	7,350	7,770	3,001 [r]	15,281 [3]
Macedonia, electric furnace:					
Ferromanganese	12,623	--	--	--	--
Ferronickel	65,300	52,200	62,700 [r]	75,200 [r]	83,700 [3]
Ferrosilicon	42,674	7,657	30,044	56,167	42,402 [3]
Silicomanganese	54,931	--	36,705	50,756	14,179 [3]
Total	175,528 [r]	59,857 [r]	129,449 [r]	182,123 [r]	140,281 [3]
Mexico, electric furnace:[4]					
Ferromanganese	97,366	42,492	81,019 [r]	73,684 [r]	61,939 [3]
Silicomanganese	114,320	85,065	134,470 [r]	139,044 [r]	161,336 [3]
Total	211,686	127,557	215,489 [r]	212,728 [r]	223,275 [3]
New Caledonia, electric furnace, ferronickel	123,600 [r]	126,100 [r]	131,300 [r]	132,100 [r]	142,000
Norway, electric furnace:					
Ferromanganese[4]	308,400	196,700	297,300	337,900	325,900 [3]
Ferrosilicon	185,344 [r]	233,974 [r]	225,000 [r]	170,102 [r]	220,000
Silicomanganese[4]	262,400	231,300	248,700	266,000	271,400 [3]
Silicon metal[e]	155,000 [r]	150,000 [r]	175,000 [r]	175,000 [r]	150,000
Total[e]	911,000 [r]	812,000 [r]	946,000 [r]	949,000 [r]	970,000
Peru, electric furnace, ferrosilicon[e]	600	600	600	600	600

See footnotes at end of table.

TABLE 7—Continued
FERROALLOYS: WORLD PRODUCTION, BY COUNTRY, FURNACE TYPE, AND ALLOY TYPE[1]

(Metric tons, gross weight)

Country, furnace type, and alloy type[2]	2008	2009	2010	2011	2012[e]
Poland:					
Blast furnace, ferromanganese	8,500	1,700	800 [r]	800 [r, e]	800
Electric furnace:					
Ferrosilicon	56,031	9,685	53,206	72,668 [r]	73,000
Silicomanganese	25,100	--	100 [r]	100 [r, e]	100
Total, blast and electric furnaces	89,631	11,385	54,106 [r]	73,600 [r, e]	73,900
Romania, electric furnace:					
Ferrochromium	6,000	15,000	14,000	--	--
Silicomanganese[e]	10,000	--	20,000 [r]	31,000 [r]	16,500
Total[e]	16,000	15,000	34,000 [r]	31,000 [r]	16,500
Russia:[e]					
Blast furnace:					
Ferromanganese	110,000	88,000 [3]	171,600 [3]	146,000 [r]	165,000
Ferrophosphorus	3,500	3,000	3,600	3,600	3,600
Spiegeleisen	7,000	6,500	5,500	6,000 [r]	6,000
Electric furnace:					
Ferrochromium	490,000	378,000 [3]	414,288 [r, 3]	501,700 [r, 3]	500,000
Ferrochromium silicon	4,000	3,500	4,200 [r]	4,200 [r]	4,200
Ferronickel:					
High-nickel[3, 8]	17,971	18,312 [r]	19,763	19,881	11,529
Other[e]	13,440	14,040	14,600	14,700 [r]	8,520
Ferroniobium (ferrocolumbium)	80	79	80	80	80
Ferrosilicon	850,000	745,000	916,000	1,030,000 [r]	1,050,000
Ferrotitanium	NA	NA	4,000	4,000	4,000
Ferrovanadium	12,000	8,029 [3]	13,057 [3]	13,500	13,500
Silicomanganese	40,000	98,700 [3]	147,900 [3]	150,000	160,000
Silicon metal	54,000	23,900	48,700	52,000 [r]	52,000
Other	22,000	20,000	18,000	18,000 [r]	18,000
Total, blast and electric furnaces	1,620,000	1,410,000	1,780,000	1,960,000 [r]	2,000,000
Saudi Arabia, electric furnace:					
Ferromanganese[4]	38,500	37,500	26,000	26,000	26,000
Silicomanganese[4]	57,700	60,000	61,300	96,000	80,000
Other[e]	90,000	80,000	90,000	90,000	90,000
Total[e]	186,000	178,000	177,000	212,000	196,000
Slovakia, electric furnace:					
Ferromanganese	61,194	21,000	35,449	18,180	12,862 [3]
Ferrosilicon	10,844	8,622	37,034	38,771	24,658 [3]
Silicomanganese	59,940	32,000	34,960	25,023	50,089 [3]
Total	131,978	61,622	107,443	81,974	87,609 [3]
South Africa, electric furnace:					
Ferrochromium	3,268,659	2,346,132	3,607,132	3,425,911 [r]	3,000,000
Ferromanganese	503,000	273,000 [r]	473,000 [r]	714,000 [r]	730,000 [3]
Ferronickel, high-nickel	5,733	1,067	1,040	975 [r, e]	940
Ferrosilicon	134,500 [r]	110,400 [r]	127,500 [r]	124,300 [r]	120,000
Ferrovanadium[e]	19,000	14,000	19,000	19,000 [r]	17,000
Silicomanganese[4]	237,100	135,100	274,400	313,600	148,800 [3]
Silicon metal	51,800 [r]	38,600 [r]	46,400 [r]	58,800 [r]	55,000
Total[e]	4,220,000 [r]	2,920,000 [r]	4,550,000 [r]	4,660,000 [r]	4,070,000
Spain, electric furnace:[e]					
Ferromanganese	148,000 [r, 3]	23,400 [r, 3]	102,200 [r, 3]	92,100 [r, 3]	80,200
Ferrosilicon	74,000	44,000	64,400	57,000	42,000
Silicomanganese	111,400 [r, 3]	64,100 [r, 3]	134,200 [r, 3]	142,300 [r, 3]	148,100
Silicon metal	33,000	23,000	32,500	43,000	62,000
Other	5,000	5,000	5,000	5,000	5,000
Total	371,000 [r]	160,000 [r]	338,000 [r]	339,000 [r]	337,000

See footnotes at end of table.

TABLE 7—Continued
FERROALLOYS: WORLD PRODUCTION, BY COUNTRY, FURNACE TYPE, AND ALLOY TYPE[1]

(Metric tons, gross weight)

Country, furnace type, and alloy type[2]	2008	2009	2010	2011	2012[e]
Sweden, electric furnace:[e]					
Ferrochromium	117,053 [3]	31,345 [3]	36,000	36,000	36,000
Ferrosilicon	-- [r]	-- [r]	-- [r]	-- [r]	--
Total	117,053 [r, 3]	31,345 [r, 3]	36,000 [r]	36,000 [r]	36,000
Turkey, electric furnace:[e]					
Ferrochromium	79,840 [3]	41,028 [3]	60,000	60,000	60,000
Ferrosilicon	4,500	4,000	4,000	4,000	4,000
Total	84,300	45,000	64,000	64,000	64,000
Ukraine, electric furnace:					
Ferromanganese	362,400	129,400	280,100	180,500	151,600 [3]
Ferronickel[3]	89,825	61,449	102,940 [r]	88,903 [r]	119,652
Ferrosilicon	152,800	150,300	195,500	150,900	119,400 [3]
Silicomanganese	894,900	741,900	940,400	843,500	724,600 [3]
Other[e]	23,000	23,900	28,500	25,100 [r]	25,000
Total[e]	1,520,000	1,110,000	1,550,000	1,290,000 [r]	1,140,000
United States, electric furnace:[9]					
Ferrochromium[5]	W	W	--	--	--
Ferrosilicon	248,000	194,000	246,000 [r]	W	W
Other	W	W	W	W	W
Total	W	W	W	W	W
Uzbekistan, silicon metal	--	--	--	--	1,700
Venezuela, electric furnace:[e]					
Ferromanganese[4]	20,000	15,800	5,300	12,000 [3]	9,000 [3]
Ferronickel	42,300	40,113	45,200	51,800	31,300
Ferrosilicon	88,000	52,100	76,800	70,000	81,000
Silicomanganese[4]	52,000	45,800	16,500	24,000 [3]	14,200 [3]
Total	202,000	154,000	144,000	158,000	136,000
Zimbabwe, electric furnace:					
Ferrochromium	145,430	72,223	146,000 [e]	140,000 [e]	137,534 [p, 3]
Ferrochromium silicon	1,612	603	--	--	--
Total	147,042	72,826	146,000 [e]	140,000 [e]	137,534 [p, 3]
Grand total	37,600,000 [r]	38,300,000 [r]	45,800,000 [r]	48,300,000 [r]	47,900,000
Of which:					
Blast furnace:					
Ferromanganese	719,000	440,000	522,000 [r]	497,000 [r]	516,000
Spiegeleisen	7,000	6,500	5,500	6,000 [r]	6,000
Other	53,500	33,000	33,600	3,600 [r]	3,600
Electric furnace:					
Ferrochromium[7]	8,060,000 [r]	7,020,000 [r]	9,300,000 [r]	9,320,000 [r]	8,980,000
Ferrochromium silicon	151,000	76,400	176,000 [r]	159,000 [r]	181,000
Ferromanganese	5,130,000 [r]	4,010,000 [r]	5,170,000 [r]	5,750,000 [r]	5,860,000
Ferromolybdenum	109,000	112,000	115,000	84,100 [r]	109,000
Ferronickel[8]	1,670,000 [r]	1,600,000 [r]	2,070,000 [r]	2,430,000 [r]	2,730,000
Ferroniobium (ferrocolumbium)	60,900 [r]	41,800 [r]	59,700 [r]	60,700 [r]	60,700
Ferrosilicon	7,320,000 [r]	7,280,000 [r]	7,890,000 [r]	7,820,000 [r]	7,930,000
Ferrovanadium[e]	37,000	27,300	38,900	39,200 [r]	37,200
Silicomanganese	8,660,000 [r]	8,590,000 [r]	10,100,000 [r]	11,400,000 [r]	11,400,000
Silicon metal	1,770,000 [r]	1,550,000 [r]	1,800,000 [r]	1,760,000 [r]	2,230,000
Other[10]	3,830,000 [r]	7,470,000 [r]	8,530,000 [r]	8,940,000 [r]	7,890,000

[e]Estimated. [p]Preliminary. [r]Revised. NA Not available. W Withheld to avoid disclosing company proprietary data. -- Zero.

[1]World totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown. Includes data available through March 4, 2015.

[2]To the extent possible, ferroalloy production of each country shown has been separated according to the furnace from which production is obtained; production derived from metallothermic operation is included with electric furnace production. Ferroalloys may be produced in other countries, but production information is inadequate for the formulation of estimates of output levels.

[3]Reported figure.

TABLE 7—Continued

FERROALLOYS: WORLD PRODUCTION, BY COUNTRY, FURNACE TYPE, AND ALLOY TYPE[1]

[4]Reported by the International Manganese Institute.

[5]Includes high- and low-carbon ferrochromium.

[6]Reported on a fiscal year basis, which is from April 1 to March 31.

[7]Includes high- and low-carbon ferrochromium and ferrochromium silicon.

[8]May contain low-iron ferronickel containing greater than 85% nickel.

[9]U.S. production includes ferrochromium (before 2010), ferromanganese (including silicomanganese), ferromolybdenum, ferroniobium, ferrosilicon, ferrotitanium, ferrovanadium, and silicon metal; data for ferrochromium, ferromanganese (including silicomanganese), and silicon metal are excluded from "Grand total."

[10]May include ferroboron, ferrocolumbium, ferrophosphorus, ferrotitanium, nickel columbium, and silvery pig iron.