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FERROALLOYS

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FERROALLOYS

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Ferroalloys are alloys with iron employed to add chemical elements into molten metal, usually during steelmaking. Ferroalloys impart distinctive qualities to steel and cast iron or serve important functions during production and are, therefore, closely associated with the iron and steel industry, the leading consumer of ferroalloys. The leading ferroalloy-producing countries in 2008 were, in decreasing order of production, China, South Africa, Russia, Kazakhstan, and Ukraine (table 7). These countries accounted for 77% of world ferroalloy production. World production of bulk ferroalloys—chromium, manganese, and silicon—was estimated to have been 29.1 million metric tons (Mt) in 2008, a 3% decrease compared with the revised figure for 2007 (table 7).

Twelve companies in the United States produced 8 ferroalloys at 12 plants (table 1). With the exception of ferrosilicon, production statistics for most ferroalloys were concealed to avoid disclosing company proprietary data (table 7). U.S. reported consumption of bulk ferroalloys in 2008 was approximately 1.0 Mt of manganese and silicon ferroalloys (table 3) and about 0.3 Mt of contained chromium in ferrochromium (table 4). Comparing reported consumption with that of 2007, ferrochromium increased slightly, ferromanganese (including silicomanganese) increased by 14%, and ferrosilicon increased by 8%. The United States was a net importer of ferroalloys and ferroalloy metals in 2008. On a gross weight basis and compared with that in 2007, U.S. total ferroalloy and ferroalloy metal imports increased by 8% and exports increased slightly, which resulted in a net import increase of 8% (table 6).

Boron, chromium, cobalt, copper, molybdenum, nickel, niobium (columbium), phosphorus, silicon, titanium, tungsten, vanadium, zirconium, and the rare-earth elements are some of the other alloying elements used for the characteristics they provide to steels and cast irons (Brown and Murphy, 1985, p. 265).

Ferrochromium

The leading world chromite ore-producing countries in 2008 were India (almost 4 Mt), Kazakhstan (more than 3 Mt), and South Africa (almost 10 Mt). More than 94% of chromite ore production was smelted in electric-arc furnaces to produce ferrochromium for the metallurgical industry (International Chromium Development Association, 2009, p. 1). The world chromium industry in 2008 operated with production capacity near demand at the beginning of the year and exceeding demand by yearend. The leading world ferrochromium-producing countries were China (more than 1 Mt), Kazakhstan (more than 1 Mt), and South Africa (more than 3 Mt). India and Russia each produced in excess of 0.5 Mt of ferrochromium. Most of the 7.84 Mt of ferrochromium produced worldwide was consumed in the manufacture of stainless steel. The leading stainless-steel producing areas of the world—Asia (primarily China, India, Japan, Republic of Korea, and Taiwan), Europe (primarily Western Europe and Scandinavia, including 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 exceeded 26 Mt in 2008. The leading stainless steel producing countries in 2008 were China (more than 7 Mt), Japan (more than 3 Mt), and the United States (less than 2 Mt) (International Chromium Development Association, 2009, p. 41).

Factors affecting world ferrochromium supply in 2008 included decreasing consumption, excess stocks, and availability of financing, owing to the world financial problems during the fourth quarter. As a result, world ferrochromium production was 7% less than that of 2007, with production suspended at many plants.

Ferromanganese

Two manganese ferroalloys, ferromanganese and silicomanganese, are key ingredients for steelmaking. Manganese ferroalloys were produced domestically by two companies—Eramet Marietta Inc., owned by France's Eramet Group, and Felman Production Inc., owned by Ukraine's Privat Group (table 1). Despite domestic production in 2008, the United States had to import 813,000 metric tons (t) of ferromanganese and silicomanganese (gross weight). Of that amount, 82% was imported from, in decreasing order, South Africa (350,000 t), Norway (142,000 t), China (111,000 t), and Georgia (67,800 t). China was the leading world producer of manganese ferroalloys, with output about 250% greater than that of the next three major producers—Brazil, South Africa, and Ukraine—combined (table 7).

Ferromolybdenum

Chile, China, and the United States accounted for about 78% of world production of molybdenite ore in 2008. Three other molybdenite ore-producing countries—Canada, Mexico, and Peru—supplied an additional 15% of world production. Molybdenite concentrates are roasted to form molybdic oxide, which can be converted into ferromolybdenum, molybdenum chemicals, or molybdenum metal. About 45% of the total reported molybdenum consumed in the United States (20,900 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 70% of its ferromolybdenum requirements in 2008. The steel industry accounted for about 83% of ferromolybdenum consumed in the United States in 2008, principally in the production of stainless and full alloy steels (table 4).

Ferronickel

In 2008, the major ferronickel-producing countries were, in descending order of gross weight output, Japan (301,000 t), New Caledonia (144,000 t), and Colombia (105,000 t). Together, these three countries accounted for about 51% of world production if China is excluded. Ukraine, Indonesia, Greece, and Macedonia, in descending order of gross weight output, all produced between 68,000 t and 90,000 t of ferronickel, accounting for an additional 31%, excluding China. China is a special case and was excluded from these calculations because its industry produced large tonnages of nickel pig iron in addition to a spectrum of conventional ferronickel grades, for an estimated combined output of 590,000 t gross weight. The nickel content of individual Chinese products varied from about 1.6% to as much as 80%, depending upon customer end use.

In August, Xstrata plc suspended production indefinitely at its Falcondo ferronickel operation in the Dominican Republic owing to high fuel oil prices and low nickel prices. At yearend, the plant was put on long-term care-and-maintenance status until a less expensive, alternative energy source could be employed. The production loss from the Dominican Republic was more than offset by new production from the Republic of Korea. In October, POSCO (Pohang) and its joint-venture partner Société Minière du Sud Pacifique (SMSP) commissioned a large ferronickel smelter at Gwangyang near POSCO's stainless steel operations. The SMSP Group agreed to deliver 1.8 Mt of ore annually to Gwangyang from its mines in New Caledonia. The Gwangyang facility was expected to produce 79,000 metric tons per year (t/yr) of ferronickel on a gross weight basis once full capacity is achieved in 2010. The Korean ferronickel averaged about 20% nickel.

Brazil had three ferronickel smelting complexes in varying stages of construction at the end of 2008—Barro Alto, Goias State (Anglo American plc), Niquelandia, Goias State (Grupo Votorantim), and Onca Puma, Para State. In the South Pacific, Xstrata plc and the SMSP Group were planning to commission their Koniambo smelter on the island of New Caledonia in mid-2012. The joint venture was awarded $866 million worth of construction contracts in 2008, including one for a powerplant (Xstrata plc, 2009, p. 43, 67, 175).

In the United States, the steel industry accounted for virtually all the ferronickel consumed in 2008, with more than 98% used in stainless and heat-resistant steels. No ferronickel was produced in the United States in 2008 from either domestic or imported ores, but International Metals Reclamation Company Inc., Ellwood City, PA, produced a remelt alloy from recycled materials, which typically averaged 13% chromium and 12% nickel. Stainless steel producers substituted the remelt alloy for ferrochromium and ferronickel. Almost all U.S. ferronickel exports were either re-exports or material upgraded for specialty purposes.

Ferrosilicon

Silicon ferroalloy consumption is driven by cast iron and steel production, where silicon alloys are used as deoxidizers. Some silicon metal was also used as an alloying agent with iron. On the basis of silicon content, U.S. net production of silicon ferroalloys (ferrosilicon and miscellaneous silicon alloys) was 148,000 t, 4% more than the revised amount of 143,000 t in 2007. On a gross weight basis, U.S. net production of ferrosilicon in 2008 (228,000 t) also increased by 4% compared with that of 2007 (table 7). China produced more ferrosilicon than the rest of the world combined and more than four times that of the next two major producing countries—Norway and Russia—combined.

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 of its lower melting temperature and higher density compared with those of titanium scrap. Steels with relatively high titanium content include interstitial-free, stainless, and high-strength low-alloy steels. Ferrotitanium is usually 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. Ferrosilicon-titanium also is produced to allow the simultaneous addition of silicon and titanium. The leading ferrotitanium producing countries included Brazil, China, India, Japan, Russia, Ukraine, United Kingdom, and the United States.

In 2008, reported domestic consumption of titanium products in steel and other alloys was 12,000 t, a 9% decrease compared with that of 2007. Decreased global steel production reduced demand for ferrotitanium, and producers idled production capacity accordingly. In Brazil, Scandinavian Steel AB idled its Sao Paulo ferrotitanium plant. The plant had produced 35% ferrotitanium from ilmenite (Metal-Pages Ltd., 2009). The Kluchevsky Ferroalloys Plant in Russia was reported to have drastically cut production of ferrotitanium. In October, production of ferrotitanium was 67 t, an 87% decrease compared with that of the previous October. The Kluchevsky plant produced both 30%- and 70%-grade ferrotitanium from ilmenite and scrap (Metal-Pages Ltd., 2008).

Decreased demand from specialty steel producers coupled with an excess supply of titanium sponge and scrap in 2008 caused ferrotitanium prices to decline. The yearend price for ferrotitanium with 70%-contained titanium declined by about 22% compared with the yearend price of 2007.

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 up to 36% 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. In 2008, China exported 4,835 t, gross weight, of ferrotungsten. China's Office of Customs Tariff Commission increased export taxes on ferrotungsten to 20% from 10% and those on ferrosilicotungsten to 20% from 15% (Beijing Antaike Information Development Co., Ltd., 2008; 2009). U.S. reported consumption of ferrotungsten decreased slightly compared with that of 2007. Ferrotungsten prices remained high, with the Platts Metals Week price ranging between $31 and $44 per kilogram of contained tungsten during the year.

Ferrovanadium

In 2008, China, Russia, and South Africa accounted for 98% of world vanadium mine production. In these three countries, vanadium was primarily recovered from titanium-bearing magnetite ore processed to produce pig iron. The process produces a slag containing 20% to 24% vanadium pentoxide, which can be further processed to ferrovanadium containing 40% to 50% vanadium.

In 2008, there was no primary (from mining) vanadium production in the United States; however, there was secondary (recycling) production. Vanadium oxides were recovered from fly ash, petroleum residues, and poisoned refinery catalysts. U.S. production from these sources continued to increase. Vanadium oxides were used to produce catalysts, chemicals, and 75% to 80% vanadium-content ferrovanadium.

The domestic steel industry accounted for 94% of U.S. reported vanadium consumption in 2008, principally in carbon, full alloy and high-strength, low-alloy steels. Of the 5,090 t of vanadium consumed in the United States, 84% came from ferrovanadium, an 8% increase compared with that of 2007. Steel manufacturing consumed 99% of the ferrovanadium in 2008 (table 4).

Outlook

The number of ferroalloy companies and plants in the United States has decreased markedly. Didaleusky and others (2010) reported that prior to 1990, 33 ferroalloy companies operated 42 plants in the United States. By 2007, 12 ferroalloy companies operated 12 plants. The decline in the number of U.S. ferroalloy producers was primarily a result of increased global competition.

The near-term trend for domestic ferroalloy consumption was expected to follow closely that of U.S. steel production. Crude steel production in the United States decreased 6.3% to 91.9 Mt in 2008 from that in 2007 (American Iron and Steel Institute, 2009, p. 75). Changes in steel production reflect changes in apparent use of steel. The World Steel Association (2010) projected that U.S. apparent steel use in 2009 would decrease by 42% to 57.4 Mt, owing to U.S. economic problems. However, domestic apparent steel use was expected to increase by 26.5% and 7.5% in 2010 and 2011, respectively, with the recovery of the U.S. economy and rebuilding of stocks.

Chromium, manganese, silicon, and other ferroalloy metals are discussed in more detail, including domestic data coverage, 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 2008

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

[1]FeCr, ferrochromium; FeMo, ferromolybdenum; FeMn, ferromanganese; FeNb, ferroniobium; FeSi, ferrosilicon; FeTi, ferrotitanium; FeV, ferrovanadium; SiMn, silicomanganese.
[2]Formerly Oxbow Carbon and Minerals LLC.

TABLE 2
GOVERNMENT INVENTORY OF FERROALLOYS, DECEMBER 31, 2008[1, 2]

(Metric tons, alloys)

Alloy	Inventory
Ferrochromium:	
High-carbon	94,100
Low-carbon	45,700
Ferromanganese, high carbon	436,000

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

Source: Defense National Stockpile Center.

TABLE 3

REPORTED U.S. CONSUMPTION OF FERROALLOYS AS ALLOYING ELEMENTS BY END USE IN 2008[1, 2]

(Metric tons, alloys)

End use	FeB	Manganese		FeP	FeSi	FeTi
		FeMn	SiMn			
Steel:						
Carbon and high-strength low-alloy	481	238,000 [3]	71,700	3,160	34,700 [3, 4]	5,750
Stainless and heat-resisting	(3)	10,700	16,000	(3)	46,400 [3]	3,270
Other alloy	(3)	35,400	20,500	(3)	15,900 [3]	810
Tool	(3)	(3)	(3)	--	(3)	(5)
Unspecified	274	5,010	934	831	78,200 [6]	--
Total steel	755	290,000	109,000	3,990	175,000	9,840
Cast irons	(6)	6,990	535	1,220	134,000 [6]	16
Superalloys	66	(7)	(8)	(4)	(4), (6)	1,060
Alloys (excluding alloy steels and superalloys)	(6)	29,800	3,040	(4)	54,300 [4, 6]	1,030
Miscellaneous and unspecified	318	(8)	(8)	--	179,000 [4]	40
Grand total	1,140	326,000	113,000 [9]	5,210	542,000	12,000
Total 2007	1,270 [r]	292,000 [r]	92,400 [9]	10,100 [r]	504,000 [r]	13,200
Percentage of 2007	90	112	122	52	108	91
Consumer stocks, December 31	233	25,900 [10]	19,600 [10]	747	14,200	1,330

[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 "Cast irons."

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

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

[7]Included with "Alloys (excluding alloy steels and superalloys)."

[8]All or part withheld to avoid disclosing company proprietary data.

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

[10]Consumer and producer stocks.

TABLE 4

REPORTED U.S. CONSUMPTION OF FERROALLOYS AS ALLOYING ELEMENTS BY END USE IN 2008[1, 2]

(Metric tons, contained elements)

End use	FeCr	FeMo	FeNb	FeNi	FeV	FeW
Steel:						
Carbon and high-strength low-alloy	5,730	150 [3]	2,310	--	2,140	(4)
Stainless and heat-resisting	199,000	799	674	10,200	116	(4)
Other alloy	14,400 [5]	3,640	(6)	W	1,830	(4)
Tool	W	W	(6)	--	64	(4)
Unspecified	W	--	1,590	--	--	--
Total	220,000	4,590	4,570	10,200	4,150	253
Cast irons	W	377	--	W	W	--
Superalloys	7,790	W	1,420	W	38	(4)
Alloys (excluding alloy steels and superalloys)	W	85 [3]	16	W	W	(4)
Miscellaneous and unspecified	29,500 [7]	508	--	1,150	2	--
Grand total	257,000	5,560	6,000	11,300	4,190	253
Total 2007	254,000	5,240	6,510	11,000	3,780	255 [r]
Percentage of 2007	101	106	92	103	111	99
Consumer stocks, December 31	7,220	332	338	741	234	16

[r]Revised. W Withheld to avoid disclosing company proprietary data; included with "Miscellaneous and unspecified."
-- 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 "Miscellaneous and unspecified."

[4]Included with "Steel, total."

[5]Includes full alloy steel.

[6]Included with "Steel, unspecified."

[7]Includes cast irons, alloys (excluding alloy steels and superalloys), electrical steel, tool steel, and unspecified uses.

TABLE 5
FERROALLOY PRICES IN 2008

	High	Low	Average[1]
Chromium:			
Ferrochromium:			
0.05% carbon[2]	455.99	447.54	451.77
0.10% carbon[2]	429.17	416.51	422.84
0.15% carbon[2]	411.84	401.67	406.76
Over 4% carbon:			
50–55% chromium[2]	183.76	174.32	179.04
60–65% chromium[2]	190.05	178.57	184.31
Manganese:			
Medium-carbon ferromanganese[2]	248.00	140.00	213.13
Standard-grade ferromanganese[3]	3,375.00	1,375.00	2,736.40
Silicomanganese[4]	120.00	45.00	100.87
Molybdenum:			
Ferromolybdenum[5]	36.50	11.00	31.58
Molybdenum oxide[5]	33.75	8.25	28.42
Silicon:			
50% ferrosilicon[2]	155.00	78.00	115.86
75% ferrosilicon[2]	155.00	71.00	108.71
Silicon metal[2]	185.00	135.00	162.29
Vanadium, ferrovanadium[5]	45.00	13.00	31.39

[1]Annual time-weighted average.
[2]Cents per pound of contained element.
[3]Dollars per long ton.
[4]Cents per pound.
[5]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 2008[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	469,000	217,000	$398,000	10,800	4,280	$14,500
Not more than 4% carbon	XX	XX	XX	13,400	5,990	27,500
More than 0.5% but not more than 3% carbon	2,250	1,450	7,090	XX	XX	XX
Not more than 0.5% carbon	37,000	25,300	190,000	XX	XX	XX
Ferrochromium-silicon	24,200	16,700	42,700	216	18	1,140
Total	533,000	260,000	638,000	24,500	10,300	43,100
Manganese ferroalloys:						
Ferromanganese containing:						
More than 4% carbon	292,000	224,000	687,000	XX	XX	XX
More than 2% but not more than 4% carbon	3,960	3,340	11,200	XX	XX	XX
More than 1% but not more than 2% carbon	102,000	81,400	276,000	XX	XX	XX
Not more than 1% carbon	51,000	42,300	160,000	XX	XX	XX
Ferromanganese, all grades	XX	XX	XX	23,400	XX	20,600
Silicomanganese	365,000	245,000	682,000	7,140	XX	9,020
Total	813,000	596,000	1,820,000	30,500	XX	29,600
Silicon ferroalloys:						
Ferrosilicon containing:						
More than 55% silicon	XX	XX	XX	12,400	7,490	19,500
More than 55% but not more than 80% silicon and more than 3% calcium	18,600	13,100	25,300	XX	XX	XX
Magnesium ferrosilicon	12,000	5,310	18,700	XX	XX	XX
Ferrosilicon, other[2, 3]	250,000	172,000	351,000	5,270	2,620	10,000
Total	281,000	190,000	395,000	17,700	10,100	29,500
Other ferroalloys:						
Ferrocerium and other pyrophoric alloys and other	1,280	XX	10,700	XX	XX	XX
Ferromolybdenum	3,470	2,320	166,000	1,840	1,290	62,400
Ferronickel	31,800	11,000	272,000	7	1	113
Ferroniobium	11,000	XX	245,000	1,130	XX	12,500
Ferrophosphorus	10,200	XX	7,530	2,350	XX	4,590
Ferrotitanium and ferrosilicon-titanium	2,830	XX	14,900	1,620	XX	9,090
Ferrotungsten and ferrosilicon-tungsten	402	309	10,500	20	10	127
Ferrovanadium	3,530	2,800	158,000	452	281	12,600
Ferrozirconium	129	XX	594	316	XX	574
Ferroalloys, other	12,900	XX	36,700	9,360	XX	16,300
Total	77,500	16,400	922,000	17,100	1,580	118,000
Total ferroalloys	1,700,000	1,060,000	3,770,000	89,800	22,000	220,000
Metals:						
Chromium (total, all grades)	13,100	XX	145,000	998	XX	20,400
Manganese:						
Metal, including alloys and waste and scrap	XX	XX	XX	4,580	XX	11,600
Unwrought	30,300	XX	111,000	XX	XX	XX
Other manganese, wrought	1,080	XX	4,900	XX	XX	XX
Silicon:						
Less than 99% silicon	25,700	24,700	60,300	8,280	8,030	25,200
Less than 99.99% but not less 99% silicon	144,000	141,000	359,000	1,740	1,720	4,060
Not less than 99.99% silicon	2,750	XX	258,000	25,400	XX	2,230,000
Total metals	217,000	165,000	939,000	41,000	9,750	2,290,000
Grand total	1,920,000	1,230,000	4,710,000	131,000	31,700	2,510,000

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, 2]

(Metric tons, gross weight)

Country, furnace type, and alloy type[3, 4, 5]	2004	2005	2006	2007	2008[e]
Albania, electric furnace, ferrochromium	34,650	34,400	17,040	-- [r]	11,916 [6]
Argentina, electric furnace:[e]					
Ferrosilicon	10,000	10,000	10,000	10,000	10,000
Silicomanganese	24,000	24,000	24,000	24,000	24,000
Total	34,000	34,000	34,000	34,000	34,000
Armenia, electric furnace, ferromolybdenum	--	2,260	4,865	5,977	4,910
Australia, electric furnace:[e]					
Ferromanganese	115,000	120,000	125,000	125,000	125,000
Silicomanganese	135,000	140,000	140,000	140,000	140,000
Silicon metal	30,000	35,000	35,000	35,000	35,000
Total	280,000	295,000	300,000	300,000	300,000
Austria, electric furnace:[e]					
Ferronickel, including ferronickelmolybdenum	4,000	3,100 [r]	2,800 [r]	2,800 [r]	3,100
Other	4,000	4,000	4,000	4,000	4,000
Total	8,000	7,100 [r]	6,800 [r]	6,800 [r]	7,100
Bhutan, electric furnace, ferrosilicon[e]	21,147 [6]	20,000	20,000	21,000	36,600
Bosnia and Herzegovina, electric furnace:[e]					
Ferrosilicon	500	500	500	500	500
Silicon metal	50	50	50	50	50
Total	550	550	550	550	550
Brazil, electric furnace:					
Ferrochromium[7]	216,277	197,653	166,577	195,890 [r]	196,000 [p]
Ferrochromiumsilicon	11,560	11,600	11,600 [e]	11,600 [e]	11,600
Ferromanganese	204,216 [r]	182,400	280,770 [r]	336,630 [r]	340,000
Ferronickel	20,338	26,340	29,300 [r]	29,223	29,000 [p]
Ferroniobium (ferrocolumbium)	38,135 [r]	58,817 [r]	62,979 [r]	79,458 [r]	79,545 [p, 6]
Ferrosilicon	156,824	177,245	177,000	128,000 [e]	120,000
Silicomanganese	303,784	297,600	292,230	350,370	350,000
Silicon metal	180,937	219,813	187,950	186,000	185,000
Other	61,231	60,160	44,934	44,500 [e]	45,000
Total	1,193,302 [r]	1,231,628 [r]	1,253,340 [r]	1,361,671 [r]	1,360,000
Bulgaria, electric furnace, ferrosilicon[e]	10,000	10,000	10,000	10,000	10,000
Canada, electric furnace:[e]					
Ferroniobium (ferrocolumbium)	5,392 [r, 6]	5,621 [r, 6]	6,298 [r, 6]	6,571 [r, 6]	6,644 [6]
Ferrosilicon	35,000 [r]	35,000 [r]	35,000 [r]	35,000 [r]	35,000
Ferrovanadium	1,000	1,000	1,000	1,000	1,000
Silicon metal	30,000	30,000	30,000	30,000	50,000
Total	71,400 [r]	71,600 [r]	72,300 [r]	72,600 [r]	92,600
Chile, electric furnace, ferromolybdenum	5,762 [r]	9,248 [r]	14,001 [r]	14,828 [r]	16,918 [6]
China:[e]					
Blast furnace:					
Ferromanganese	590,000	500,000	600,000	600,000 [r]	600,000
Other	100,000	60,000	60,000	50,000 [r]	50,000
Electric furnace:					
Ferrochromium	640,000	850,000	1,000,000	1,300,000 [r]	1,400,000
Ferromanganese	1,120,000	1,150,000	1,400,000	1,930,000 [r]	2,100,000
Ferromolybdenum	70,000	80,000	90,000	60,000 [r]	40,000
Ferronickel and high nickel pig iron[e, 8]	--	48,000	390,000	845,000	590,000
Ferrosilicon	3,000,000	3,300,000	4,020,000	4,710,000 [r]	4,900,000
Silicomanganese	2,600,000	3,000,000	3,600,000	4,340,000 [r]	4,500,000
Other	800,000	1,760,000	3,530,000	4,510,000 [r]	4,710,000
Total, blast and electric furnaces	8,920,000	10,700,000	14,700,000 [r]	18,300,000 [r]	18,900,000

See footnotes at end of table.

TABLE 7–Continued

FERROALLOYS: WORLD PRODUCTION, BY COUNTRY, FURNACE TYPE, AND ALLOY TYPE[1, 2]

(Metric tons, gross weight)

Country, furnace type, and alloy type[3, 4, 5]	2004	2005	2006	2007	2008[e]
Colombia, electric furnace, ferronickel[e]	113,647 [r, 6]	122,000 [r]	119,000 [r]	121,000 [r]	105,000
Czech Republic, electric furnace, other[e]	3,500	2,700	2,800	2,800	2,800
Dominican Republic, electric furnace, ferronickel	75,763	73,962 [r]	76,659	75,069 [r]	47,700
Egypt, electric furnace:[e]					
Ferromanganese	30,000	30,000	30,000	30,000	30,000
Ferrosilicon	55,000	55,000	50,000	50,000	50,000
Total	85,000	85,000	80,000	80,000	80,000
Finland, electric furnace, ferrochromium	264,492	234,881	243,350	241,760	233,550 [6]
France, electric furnace:[e]					
Ferromanganese	106,000	109,000	146,000	103,000	103,000
Ferrosilicon	87,000	67,000	67,000	71,000	22,000
Silicomanganese	64,100	52,300	63,300	65,000	55,000
Silicon metal	85,000	100,000	100,000	120,000	100,000
Other	65,000	65,000	60,000	60,000	60,000
Total	407,000	393,000	436,000	419,000	340,000
Georgia, electric furnace:					
Ferromanganese	12,800	13,945	5,130	5,000 [e]	5,000
Silicomanganese	91,900	109,414	116,945	120,000 [e]	120,000
Total	104,700	123,359	122,075	125,000 [e]	125,000
Germany, electric furnace:					
Ferrochromium	24,857	22,672	26,710	22,030	26,960 [6]
Silicon metal	28,773	29,349	35,500 [r]	35,245 [r]	30,000
Other[e, 9]	26,500 [r]	25,400 [r]	24,100 [r]	5,000 [r]	5,000
Total	80,130 [r]	77,421 [r]	86,310 [r]	62,275 [r]	62,000
Greece, electric furnace, ferronickel[e]	96,000	95,000	88,000	90,000	86,000
Hungary, electric furnace:[e, 10]					
Ferrosilicon	7,000	7,000	7,000	7,000	7,000
Silicon metal	500	500	500	500	500
Total	7,500	7,500	7,500	7,500	7,500
Iceland, electric furnace, ferrosilicon[e]	118,000	120,000	113,798 [6]	114,000	112,000
India, electric furnace:[e]					
Ferrochromium[11]	527,100 [6]	611,373 [6]	634,200 [6]	820,000	750,000
Ferrochromiumsilicon	10,000	10,000	10,000	10,000	10,000
Ferromanganese	204,800 [6]	192,900 [6]	180,000	180,000	170,000
Ferroniobium (ferrocolumbium)	61 [r]	65	65	65	65
Ferrosilicon	55,000	56,000	58,000	60,000	62,000
Silicomanganese	96,893 [6]	69,224 [6]	80,000 [r]	80,000 [r]	90,000
Other	8,940	8,935	8,935	8,935	9,000
Total	903,000	948,000	971,000 [r]	1,160,000 [r]	1,090,000
Indonesia, electric furnace:					
Ferromanganese[e]	12,000	12,000	12,000	12,000	12,000
Ferronickel	39,538	36,690	72,300	92,600 [r]	87,800
Silicomanganese[e]	7,000	4,000	5,000	6,000	7,000
Total	58,538	52,690	89,300	110,600 [r]	107,000
Iran, electric furnace:[e]					
Ferrochromium	7,750 [6]	8,000	7,000	8,000	8,000
Ferromanganese	36,700	NA	NA	NA	NA
Ferrosilicon	50,150 [6]	50,000	45,000	45,000	45,000
Total	94,600	58,000	52,000	53,000	53,000

See footnotes at end of table.

TABLE 7–Continued

FERROALLOYS: WORLD PRODUCTION, BY COUNTRY, FURNACE TYPE, AND ALLOY TYPE[1, 2]

(Metric tons, gross weight)

Country, furnace type, and alloy type[3, 4, 5]	2004	2005	2006	2007	2008[e]
Italy, electric furnace:[e]					
Ferromanganese	38,000	32,000	13,000	15,000	15,000
Silicomanganese	100,000	100,000	96,600	95,000	95,000
Other[12]	10,000	10,000	10,000	10,000	10,000
Total	148,000	142,000	120,000	120,000	120,000
Japan, electric furnace:					
Ferrochromium[13]	13,472	12,367	13,056	12,016 [r]	12,500
Ferromanganese	437,389	448,616	406,162	420,151	430,000
Ferronickel	374,213	391,074	335,884	351,503 [r]	301,361 [6]
Silicomanganese	73,041	94,725	59,424	52,901	56,000
Other[14]	12,822	16,436	19,394	21,760 [r]	22,000
Total	910,937	963,218	833,920	858,331 [r]	822,000
Kazakhstan, electric furnace:					
Ferrochromium	1,080,993	1,156,168	1,200,000 [e]	1,307,536 [r]	1,220,315 [6]
Ferrochromiumsilicon	104,800	97,870	100,000 [e]	145,695 [r]	133,828 [6]
Ferromanganese[e]	2,000	2,100	2,100	2,100	2,100
Ferrosilicon	103,580	104,185	105,000 [e]	59,886 [r]	54,964 [6]
Silicomanganese	155,324	170,214	220,000 [e]	188,445 [r]	179,939 [6]
Other[e]	9,000	9,000	9,000	9,000	9,000
Total	1,455,697	1,539,537	1,640,000 [e]	1,712,662 [r]	1,600,146 [6]
Korea, North, electric furnace, other[e]	10,000	10,000	10,000	10,000	10,000
Korea, Republic of, electric furnace:					
Ferromanganese	165,525	124,434	169,202	209,321	251,125 [6]
Ferronickel	--	--	--	--	6,600 [p]
Silicomanganese	82,917	74,193	94,119	105,607	76,184 [6]
Other	4,811	3,670	3,653	4,224	4,000
Total	253,253	202,297	266,974	319,152	337,909 [6]
Kosovo, ferronickel	--	--	--	3,480 [15]	30,900 [6, 15]
Macedonia, electric furnace:					
Ferromanganese	--	--	--	--	12,623 [6]
Ferronickel[e]	24,100	36,800 [r]	49,500 [r]	68,200	68,200
Ferrosilicon	56,000 [e]	71,249	59,023	34,215 [r]	42,674 [6]
Silicomanganese	--	--	--	70,472 [r]	54,931 [6]
Total	80,100 [e]	108,049 [r]	108,523 [r]	172,887 [r]	178,428 [6]
Mexico, electric furnace:[16]					
Ferromanganese	72,471	89,642	62,485	74,578 [r]	97,366 [6]
Silicomanganese	103,206	104,780	97,457	109,286 [r]	114,320 [6]
Total	175,677	194,422	159,942	183,864 [r]	211,686 [6]
New Caledonia, electric furnace, ferronickel	151,296	155,800	162,400	151,100 [r]	144,300 [6]
Norway, electric furnace:[e]					
Ferromanganese	245,000	250,000	245,000	245,000	215,000
Ferrosilicon	300,000	165,000	93,000	215,000	210,000
Silicomanganese	230,000	230,000	230,000	225,000	200,000
Silicon metal	105,000	105,000	100,000	100,000	100,000
Other[9]	15,000	15,000	15,000	15,000	15,000
Total	895,000	765,000	683,000	800,000	740,000
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, 2]

(Metric tons, gross weight)

Country, furnace type, and alloy type[3, 4, 5]	2004	2005	2006	2007	2008[e]
Poland:					
Blast furnace, ferromanganese	46,900	7,800	4,100	4,000	4,000
Electric furnace:					
Ferrosilicon	83,600	65,100	13,000	58,538 [r]	56,031 [6]
Silicomanganese	29,600	10,242	3,310	3,000	3,000
Total, blast and electric furnaces	160,100	83,142	20,410	65,538 [r]	63,031 [6]
Romania, electric furnace:					
Ferromanganese	191	18,625	3,329	--	--
Silicomanganese	194,745	100,957	53,085	26,868	10,000
Total	194,936	119,582	56,414	26,868	10,000
Russia:[e]					
Blast furnace:					
Ferromanganese	110,000	110,000	130,000	120,000	110,000
Ferrophosphorus	3,500	3,500	3,500	3,500	3,500
Spiegeleisen	7,000	7,000	7,000	7,000	7,000
Electric furnace:					
Ferrochromium	454,000	578,000 [6]	600,000	570,000	530,000
Ferrochromiumsilicon	4,000	4,000	4,000	4,000	4,000
Ferronickel:[17]					
High-nickel[18]	14,900 [r, 6]	14,800 [r, 6]	16,085 [r, 6]	19,031 [r, 6]	17,971 [6]
Other	-- [r, 6]	7,250 [r, 6]	13,000 [r, 6]	17,000 [r, 6]	21,532 [6]
Ferroniobium (ferrocolumbium)	--	--	--	121 [r]	121
Ferrosilicon	721,000	742,000 [6]	882,300 [6]	896,100 [6]	850,000
Ferrovanadium	13,700	12,880 [6]	11,000	12,000	12,000
Silicomanganese	141,000	48,000	40,000	40,000	40,000
Silicon metal	75,000	58,000	54,500	54,000	54,000
Other	22,000	22,000	22,000	22,000	22,000
Total, blast and electric furnaces	1,570,000 [r]	1,610,000	1,780,000	1,760,000	1,670,000
Saudi Arabia, electric furnace, other[e]	-- [r]	-- [r]	85,000 [r]	85,000 [r]	90,000
Slovakia, electric furnace:					
Ferrochromium	1,784	867	19	-- [r]	--
Ferromanganese	66,959	43,458	59,391	74,065 [r]	61,194 [6]
Ferrosilicon	34,600	16,512	16,155 [r]	8,583 [r]	20,679 [6]
Silicomanganese	64,842	47,843	59,128	71,587 [r]	59,940 [6]
Other[e]	5,000	5,000	5,000	5,000	--
Total	173,185	113,680	139,693 [r]	159,235 [r]	141,813 [6]
Slovenia, electric furnace, ferrosilicon	22,482 [r]	15,529 [r]	12,550 [r]	6,000 [r, e]	--
South Africa, electric furnace:					
Ferrochromium	2,965,000	2,812,000	3,030,000	3,561,491	3,100,000
Ferromanganese	611,914	570,574	656,235	698,654 [r]	610,000
Ferrosilicon	140,600	127,000	148,900	189,900 [r]	170,000
Ferrovanadium[e]	20,000	19,000	18,000	19,000 [r]	17,000
Silicomanganese[e]	334,000 [r]	231,000 [r]	247,000 [r]	302,000 [r]	260,000
Silicon metal	50,500	53,500 [r]	53,300 [r]	50,300 [r]	44,000
Other[e, 19]	80,000	80,000	80,000	80,000	70,000
Total	4,202,014 [r]	3,893,074 [r]	4,233,435 [r]	4,901,345 [r]	4,270,000

See footnotes at end of table.

TABLE 7–Continued

FERROALLOYS: WORLD PRODUCTION, BY COUNTRY, FURNACE TYPE, AND ALLOY TYPE[1, 2]

(Metric tons, gross weight)

Country, furnace type, and alloy type[3, 4, 5]	2004	2005	2006	2007	2008[e]
Spain, electric furnace:[e]					
Ferromanganese	10,000	10,000	10,000	10,000	10,000
Ferrosilicon	60,000	70,000	67,000	71,000	22,000
Silicomanganese	100,000	100,000	100,000	100,000	100,000
Silicon metal	30,000	32,000	32,000	32,000	10,000
Other	5,000	5,000	5,000	5,000	5,000
Total	205,000	217,000	214,000	218,000	147,000
Sweden, electric furnace:					
Ferrochromium	128,191	127,451	136,374	124,403	117,053 [6]
Ferrosilicon[e]	18,500	9,800	4,000	5,000	5,000
Total	146,691	137,251	140,374	129,403 [r]	122,000
Turkey, electric furnace:					
Ferrochromium	33,686	26,043	67,975	69,730	79,840 [6]
Ferrosilicon	--	--	5,000 [e]	5,000 [e]	5,000
Total	33,686	26,043	72,975	74,730 [r]	84,800
Ukraine:					
Blast furnace:[e]					
Ferromanganese	79,000	30,000	25,000 [r]	20,000 [r]	14,200 [6]
Spiegeleisen	5,000	5,000	5,000	5,000	5,000
Electric furnace:					
Ferromanganese	375,990	359,000	373,000	368,000	362,400 [6]
Ferronickel[e]	60,000	60,000	90,000	90,000	90,000
Ferrosilicon	248,060	228,000	168,000	167,300	152,800 [6]
Silicomanganese	1,060,000	1,040,000	1,168,000	1,281,000	894,400 [6]
Other[e]	25,000	25,000	25,000	25,000	25,000
Total, blast and electric furnaces	1,853,050	1,747,000	1,854,000 [r]	1,956,300 [r]	1,543,800 [6]
United States, electric furnace:					
Ferrochromium[20]	W	W	W	W	W
Ferromanganese[21]	W	W	W	W	W
Ferroniobium (ferrocolumbium)	NA	NA	NA	NA	NA
Ferrosilicon[22]	171,000	164,000	194,000	220,000 [r]	228,000 [6]
Silicon metal[22]	144,000	143,000	W	W	W
Other[23]	W	W	W	W	W
Total	315,000	307,000	194,000	220,000 [r]	228,000 [6]
Uruguay, electric furnace, ferrosilicon[e]	200	200	200	200	200
Venezuela, electric furnace:[e]					
Ferromanganese	15,000	15,000	15,000	15,000	15,000
Ferronickel	58,000 [6]	56,300	57,000 [6]	52,300 [r]	36,300
Ferrosilicon	92,000	95,000	95,000	94,000	93,500
Silicomanganese	35,000	35,000	35,000	35,000	35,000
Total	200,000	201,000	202,000	196,000 [r]	180,000

See footnotes at end of table.

TABLE 7–Continued

FERROALLOYS: WORLD PRODUCTION, BY COUNTRY, FURNACE TYPE, AND ALLOY TYPE[1, 2]

(Metric tons, gross weight)

Country, furnace type, and alloy type[3, 4, 5]	2004	2005	2006	2007	2008[e]
Zimbabwe, electric furnace:[e]					
Ferrochromium	193,077 [6]	235,000	200,000	150,000	150,000
Ferrochromiumsilicon	1,000	5,000	3,000	2,000	2,000
Total	194,077 [6]	240,000	203,000	152,000	152,000
Grand total	26,300,000 [r]	27,600,000 [r]	32,100,000 [r]	37,100,000 [r]	36,100,000
Of which:					
Blast furnace:					
Ferromanganese	826,000	648,000	759,000 [r]	744,000 [r]	728,000
Spiegeleisen	12,000	12,000	12,000	12,000	12,000
Other[24]	104,000	63,500	63,500	53,500 [r]	53,500
Total, blast furnace	941,000	723,000	835,000 [r]	810,000 [r]	794,000
Electric furnace:					
Ferrochromium[25]	6,590,000	6,910,000	7,340,000	8,380,000 [r]	7,840,000
Ferrochromiumsilicon	131,000	128,000	129,000	173,000 [r]	161,000
Ferromanganese	3,880,000 [r]	3,770,000	4,190,000	4,850,000 [r]	4,970,000
Ferronickel	1,030,000 [r]	1,130,000 [r]	1,500,000 [r]	2,010,000 [r]	1,670,000
Ferroniobium (ferrocolumbium)[26]	43,600 [r]	64,500 [r]	69,300 [r]	86,200 [r]	86,400
Ferrosilicon	5,660,000	5,780,000 [r]	6,480,000	7,290,000 [r]	7,320,000
Silicomanganese	6,030,000 [r]	6,080,000	6,820,000 [r]	7,830,000 [r]	7,460,000
Silicon metal	760,000	806,000 [r]	629,000 [r]	643,000 [r]	609,000
Other[27]	1,280,000 [r]	2,250,000 [r]	4,100,000	5,040,000 [r]	5,210,000
Total, electric furnace	25,400,000	26,900,000 [r]	31,300,000 [r]	36,300,000 [r]	35,300,000

[e]Estimated. [r]Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; not included in "Total." -- 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.

[2]Table includes data available through July 1, 2009.

[3]In addition to the countries listed, ferrotungsten is produced in China, Russia, and Vietnam; Austria and Germany are thought to have produced ferroniobium (ferrocolumbium); and Iran is thought to have produced ferromanganese, ferromolybdenum, and inadequate silicomanganese, but production information is for the formulation of estimates of output levels.

[4]To the extent possible, ferroalloy production of each country has been separated according to the furnace from which production is obtained; production derived from metallothermic operation is included with electric furnace production.

[5]To the extent possible, ferroalloy production of each country has been separated to show the following individual major types of ferrochromiumsilicon, ferromanganese, ferronickel, ferrosilicon, silicomanganese, silicon metal, and spiegeleisen. Ferroalloys other than those listed that have been identified specifically in sources, as well as those ferroalloys not identified specifically, but which definitely exclude those listed previously in this footnote, have been reported as "Other." Where one or more of the individual ferroalloys listed separately in this footnote have been inseparable from other ferroalloys owing to a nation's reporting system, deviations are indicated by individual footnotes.

[6]Reported figure.

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

[8]China currently makes several different types of ferronickel. These products range from a low-nickel pig iron (for example, Zhejiang Huaguang Smelting Group Co., Ltd., 8.5% to 9.0% nickel) to high-nickel ferronickel carbonyl powder (Jilin Jien Nickel Industry Co., Ltd., 70% to 80% nickel). The gross weight figures are based on average estimated content ranging from 20% to 25% nickel.

[9]Includes, if any, ferrochromiumsilicon, ferronickel, and silicomanganese.

[10]Hungary is thought to produce some blast furnace ferromanganese.

[11]Includes charge chrome and ferrochrome.

[12]Excludes calcium-silicon.

[13]Includes high- and low-carbon ferrochromium and ferrochromiumsilicon.

[14]Includes calcium-silicon, ferrocolumbium, ferromolybdenum, ferrovanadium, and other ferroalloys.

[15]On February 17, 2008, the Kosovo Assembly declared independence from Serbia. Serbia's ferronickel data for 2004–07 are not available.

[16]Salable products from Cía Minera Autlán S.A. de C.V.

[17]Excludes nickel-chromium remelt alloy produced from scrap. The remelt alloy typically has a nickel content of 20% to 50%.

[18]Low-iron ferronickel containing greater than 85% nickel.

TABLE 7–Continued

FERROALLOYS: WORLD PRODUCTION, BY COUNTRY, FURNACE TYPE, AND ALLOY TYPE[1, 2]

[19]Includes, if any, ferronickel.

[20]U.S. output of ferrochromium includes chromium metal, high- and low-carbon ferrochromium, ferrochromiumsilicon, and other chromium materials.

[21]U.S. output of ferromanganese includes manganese metal and silicomanganese.

[22]Net production.

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

[24]Includes ferrophosphorus and data contained in "Blast furnace: Other."

[25]Ferrochromium includes ferrochromiumsilicon, if any, for Japan, South Africa, and the United States.

[26]In addition to the countries listed, Austria, China, and Germany are thought to have produced ferroniobium (ferrocolumbium), but production information is inadequate to make reliable estimates of output levels.

[27]Includes ferromolybdenum and ferrovanadium.