



2006 Minerals Yearbook

IRON OXIDE PIGMENTS

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In 2006, total U.S. iron oxide pigment (IOP) production was an estimated 70,000 metric tons (t) valued at \$69 million. Exports of IOPs increased to 3,100 t valued at \$8.1 million. Total IOP imports increased by 3% to 199,000 t with China as the leading supplier.

Production

Natural iron oxide pigments are derived from hematite, which is a red iron oxide mineral; limonites, which vary from yellow to brown, such as ochers, siennas, and umbers; and magnetite, which is black iron oxide. Synthetic iron oxide pigments are produced from basic chemicals. The three major methods for the manufacture of synthetic iron oxides are thermal decomposition of iron salts or iron compounds; precipitation of iron salts, usually accompanied by oxidation; and reduction of organic compounds by iron (Podolsky and Reid, 2006, p. 1458).

U.S. production data for crude (natural) IOPs sold or used in 2006 were developed by the U.S. Geological Survey (USGS) from a voluntary survey of three companies, of which two responded. Data are withheld to avoid disclosing company proprietary data. In a second voluntary survey, data were received from 4 of 12 known processing operations for finished (natural and synthetic) IOPs. By tonnage, the four operations represented less than 30% of the output in tables 1 and 2. Data for nonrespondents were estimated on the basis of prior-year levels of output.

At least three U.S. companies produced regenerated iron oxide, which is obtained when spent pickle liquor from steelmaking is treated (table 3). Regenerator iron oxide data were not included in tables 1 and 2.

Lanxess Corp. ended production of yellow IOPs at its New Martinsville, WV, facility in mid-2006 (Lanxess AG, undated). IOP production began at this site in 1980.

Consumption

Although data were not available, construction materials and paints and coatings have been the leading end uses of IOPs. Construction applications included such concrete products as block, brick, or segmental retaining wall units; mortar; paving stones; precast products of various sizes or dimensions, ready-mixed concrete; and roofing tiles. Shipments of total paint and coatings (comprising architectural coatings, original equipment manufacture product coatings, and special-purpose coatings) decreased slightly in 2006 compared with those of 2005 (U.S. Census Bureau, 2007).

Other end uses of IOPs included colorants for ceramics, glass, paper, plastics, rubber, and textiles; in foundry sands; and industrial chemicals, such as catalysts. Other applications were animal feed, cosmetics, ferrites, fertilizers, and magnetic ink and toner.

A major end use for regenerator iron oxides was ferrites, which are magnetic ceramic oxides. There are two types of ferrites—soft, which do not retain permanent magnetism, and hard, which retain permanent magnetism. Uses of soft ferrites include computers, cores for radio frequency coils, inverter cores, memory cores, microwave communication systems, microwave ferrites for telecommunications, pot cores, rectangular modulus cores, television deflection yokes, and other industrial applications. Hard ferrites are used in flexible magnets, generators, loudspeakers, and motors.

Prices

The average annual producer price index (PPI) for IOPs for 2006 was 202.0 compared with 191.3 in 2005, a 6% increase. The PPI measures the average change in the selling prices charged by domestic producers of IOPs over time. The baseline for the IOP PPI is June 1983 (U.S. Bureau of Labor Statistics, 2007).

Foreign Trade

U.S. exports of pigment-grade IOPs in 2006 totaled 3,100 t compared with 2,220 t in 2005 (table 4).

Total U.S. imports of IOPs of 199,000 t in 2006 were 3% higher than those of 2005 (table 5). By tonnage, the three leading sources of IOP imports were China with 62%; Germany, 21%; and Italy, 5% (table 6). The average value of U.S. imports of synthetic IOPs from China was \$627 per metric ton in 2006 compared with \$599 per ton in 2005. The average value of total U.S. imports of synthetic IOPs from all countries was \$808 per ton in 2006 compared with \$734 per ton in 2005.

World Review

World production of IOPs was 1.2 million metric tons (Mt) in 2003 (latest data) (Will, 2006, p. 4). Major producing areas were China with 40%; Western Europe, 31%; Japan, 15%; and the United States, 9%. Total world consumption of IOPs (natural and synthetic) in 2003 (latest data) was estimated to be 1.3 Mt. Natural IOPs composed 16% of the total and synthetic IOPs, 84%. The largest markets were construction materials, with 50%, and coatings, 28% (Will, 2006).

China.—Production of IOPs in 2005 was about 623,000 t, and sales (including exports) were about 568,000 t. Exports of IOPs were about 329,000 t, and major destinations included North America with about 124,000 t; Europe, 83,000 t; and Southeast Asia, 57,000 t. Chinese imports of IOPs in 2005 were about 197,000 t. Principal areas of origin were Asia with about 109,000 t; North America, 56,000 t; and Europe, 26,000 t (Gao, 2006, p. 10). Total exports of iron oxides in 2006 were about 355,000 t (United

Nations Statistics Division, 2007). According to U.S. Census Bureau data, United States imports of IOPs from China increased to 123,000 t in 2006 from 48,000 t in 2000, an increase of 156%.

Outlook

China has been the leading producer of IOPs; however, the Chinese IOP industry has been facing increasing manufacturing costs owing to rising environmental, fuel, and raw material costs. This has resulted in increased prices for IOPs (Gao, 2006, p. 12). More strict governmental regulations on the environment will require new technology and investment in areas such as waste treatment. Other challenges include developing micronized and easy-dispersing pigments for coatings, as well as granular and other dust-free, free-flowing pigments (Zhang, 2006).

New developments in the IOP industry in recent years have included granular forms of iron oxides and new versions of nano-sized (less than 0.1 micron) materials. Future developments may include using iron oxides in nanocomposites and new chemical applications (Podolsky and Reid, 2006, p. 1462-1463). In nanocomposites, nanoparticles act as a filler in a matrix, usually a polymer. Examples of such polymers are thermoplastics such as polyethylene and vinyl. Nanocomposites offer improvements in properties of thermoplastics, including tensile strength (BCC Research, 2004).

References Cited

- BCC Research, 2004, Polymer nanocomposites—Nanoparticles, nanoclays and nanotubes: Norwalk, CT, BCC Research, 200 p. (Accessed September 28, 2007, via <http://www.the-infoshop.com/>.)
- Gao, F.J., 2006, China iron oxide industry annual report 2005, *in* Proceedings of Iron Oxides for Colorant and Chemical Applications 2006, Shanghai, China, September 12-15, 2006: Portland, ME, Intertech Corp., p. 1-13 [separately paginated].
- Lanxess AG, [undated], Annual report 2006: Leverkusen, Germany, Lanxess AG, 129 p. (Accessed September 28, 2007, via <http://www.lanxess.com/>.)
- Podolsky, George, and Reid, A.H., 2006, Pigments, *in* Kogel, J.E., Trivedi, N.C., Barker, J.M., and Krukowski, S.T., eds., Industrial minerals and rocks (7th ed.): Littleton, CO, Society for Mining, Metallurgy, and Exploration, Inc., p. 1453-1469.

- United Nations Statistics Division, 2007, Iron oxides and hydroxides, *in* UN comtrade database: United Nations Statistics Division. (Accessed August 21, 2007, via <http://www.comtrade.un.org/db/>.)
- U.S. Bureau of Labor Statistics, 2007, Producer price index—Commodities: U.S. Bureau of Labor. (Accessed July 11, 2007, via URL <http://data.bls.gov/PDQ/outside.jsp?survey=wp>.)
- U.S. Census Bureau, 2007, Paint and allied products—2006: U.S. Census Bureau, June. (Accessed July 27, 2007, at URL <http://www.census.gov/industry/1/ma325f06.pdf>.)
- Will, Raymond, 2006, Global markets for iron oxide pigments—Construction market update, *in* Proceedings of Iron Oxides for Colorant and Chemical Applications 2006, Shanghai, China, September 12-15, 2006: Portland, ME, Intertech Corp. p. 1-17 [separately paginated].
- Zhang, Wenjun, 2006, Challenges and opportunities for the Chinese iron oxide industry and Deqing Huayuan Pigment Co. Ltd., *in* Proceedings of Iron Oxides for Colorant and Chemical Applications 2006, Shanghai, China, September 12-15, 2006: Portland, ME, Intertech Corp., p. 1-8 [separately paginated].

GENERAL SOURCES OF INFORMATION

U.S. Geological Survey Publication

Pigments and Fillers. Ch. in United States Mineral Resources, Professional Paper 820, 1973.

Other

- CEH Marketing Research Report—Pigments. SRI Consulting, 2004.
- Intertech-Pira Corp. proceedings of conferences.
- Iron Oxide Pigments—Pt. 1.—Fine-Particle Iron Oxides for Pigment, Electronic, and Chemical Use. U.S. Bureau of Mines Information Circular 8771, 1978.
- Iron Oxide Pigments—Pt. 2.—Natural Iron Oxide Pigments—Location, Production, and Geological Description. U.S. Bureau of Mines Information Circular 8813, 1980.
- Manufacture of Different Grades of Iron Oxide—A New Experience. Iron Oxides '91 Proceedings, Falmouth Associates, Inc., 1991.
- Pigment Handbook (2d ed.). John Wiley & Sons, 1988.

TABLE 1
SALIENT U.S. IRON OXIDE PIGMENTS STATISTICS¹

		2002	2003	2004	2005	2006
Crude pigments sold or used:²						
Quantity	metric tons	W	W	W	W	W
Value	thousands	\$1,070	W	W	W	W
Finished pigments sold:³						
Quantity	metric tons	115,000	90,000 ^e	85,000 ^e	90,000 ^e	70,000 ^e
Value	thousands	\$117,000	\$89,300 ^e	\$77,000 ^e	\$93,400 ^e	\$69,300 ^e
Exports:						
Quantity	metric tons	6,270	4,500	3,120	2,220	3,100
Value	thousands	\$12,100	\$11,000	\$7,380	\$6,170	\$8,090
Imports for consumption:						
Quantity	metric tons	132,000	140,000	170,000	193,000	199,000
Value	thousands	\$96,300	\$96,600	\$116,000	\$140,000	\$159,000

^eEstimated. W Withheld to avoid disclosing company proprietary data.

¹Data are rounded to no more than three significant digits.

²Mined.

³Natural (mined) and synthetic.

TABLE 2
FINISHED IRON OXIDE PIGMENTS SOLD BY PROCESSORS IN THE UNITED STATES, BY KIND¹

Kind	2005		2006	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
Natural:				
Black, magnetite	W	W	W	W
Umbers:				
Burnt	W	W	W	W
Raw	W	W	W	W
Red, iron oxide ²	W	W	W	W
Undistributed and other ^{e, 3}	52,000	\$22,600	47,000 ⁴	\$21,400
Total ^e	52,000	22,600	47,000 ⁴	21,400
Synthetic:				
Black, iron oxide	W	W	W	W
Brown, iron oxide	W	W	W	W
Red, iron oxide	W	W	W	W
Yellow, iron oxide ^e	22,800	36,600	W	W
Mixtures of natural and synthetic, iron oxides	W	W	W	W
Total ^{e, 3}	38,000	70,800	23,000 ⁴	47,800
Grand total ^e	90,000	93,400	70,000 ⁴	69,300

^eEstimated. W Withheld to avoid disclosing company proprietary data; included with "Natural, undistributed and other" and "Synthetic, total."

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

²Includes pyrite cinder.

³Includes brown burnt sienna, ocher, raw sienna, and data indicated by symbol W.

⁴Rounded to two significant digits.

TABLE 3
PRODUCERS OF IRON OXIDE PIGMENTS AND REGENERATOR
IRON OXIDES IN THE UNITED STATES IN 2006

Producers	Plant location
Finished pigments:	
Alabama Pigments Co.	Green Pond, AL.
Dynamic Color Solutions, Inc.	Milwaukee, WI.
Elementis Pigments Inc.	Easton, PA.
Hoover Color Corp.	Hiwassee, VA.
Lanxess Corp.	New Martinsville, WV.
New Riverside Ochre Co., Inc.	Cartersville, GA.
Prince Minerals, Inc.	Quincy, IL; and Bowmanstown, PA.
Rockwood Pigments Inc.	Beltsville, MD; and St. Louis, MO.
Solomon Colors, Inc.	Springfield, IL.
Crude pigments:	
Alabama Pigments Co.	Green Pond, AL.
Hoover Color Corp.	Hiwassee, VA.
New Riverside Ochre Co., Inc.	Cartersville, GA.
Regenerator iron oxides:	
Bailey-PVS Oxides, L.L.C.	Decatur, AL; Fairfield, AL; Delta, OH.
International Steel Services, Inc.	Allenport, PA.
Mittal Steel USA Weirton Inc.	Weirton, WV.

TABLE 4
U.S. EXPORTS OF IRON OXIDES AND HYDROXIDES, BY COUNTRY¹

Country	2005				2006			
	Pigment grade		Other grade		Pigment grade		Other grade	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
Australia	1	\$6	250	\$577	18	\$49	291	\$758
Belgium	442	1,480	115	297	520	1,660	238	779
Bermuda	173	318	--	--	199	366	--	--
Brazil	76	377	93	294	136	750	237	159
Canada	26	39	10,300	11,700	52	58	10,400	12,300
China	299	469	43,800	12,700	354	644	43,700	14,400
Colombia	7	17	237	90	11	67	308	150
France	4	58	438	1,110	131	187	343	1,770
Germany	13	16	509	1,040	27	16	1,070	1,170
Hong Kong	85	194	2,490	1,810	22	68	1,910	969
India	85	179	308	332	164	371	131	182
Indonesia	--	--	113	132	8	24	5	33
Italy	19	44	785	835	(2)	8	1,240	1,170
Japan	37	27	980	1,260	196	786	307	216
Korea, Republic of	27	190	3,360	3,050	113	718	742	779
Malaysia	(2)	8	440	864	--	--	172	491
Mexico	174	295	1,260	951	719	991	1,670	1,110
Netherlands	(2)	3	439	845	--	--	443	894
Nigeria	--	--	129	845	--	--	--	--
Russia	195	345	246	413	63	174	--	--
Singapore	--	--	1,380	382	10	28	903	954
Spain	210	1,020	44	114	17	40	39	117
Suriname	--	--	320	55	--	--	--	--
Switzerland	2	8	--	--	18	38	120	205
Taiwan	19	107	1,460	1,800	38	109	1,170	1,300
Thailand	--	--	890	348	1	7	709	182
United Kingdom	167	601	1,870	4,210	119	504	1,500	3,290
Venezuela	13	40	242	87	1	8	10	18
Other	150 ^r	323 ^r	555 ^r	995 ^r	161	422	619	1,020
Total	2,220	6,170	73,100	47,100	3,100	8,090	68,300	44,400

^rRevised. -- Zero.

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

²Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 5
U.S. IMPORTS FOR CONSUMPTION OF SELECTED IRON OXIDE PIGMENTS, BY TYPE¹

Type	2005		2006		Principal sources, 2006 (metric tons)
	Quantity (metric tons)	Value ² (thousands)	Quantity (metric tons)	Value ² (thousands)	
Natural:					
Earth colors ³	3,780	\$1,700	4,400	\$1,920	Cyprus, 4,340.
Micaceous	1,420	896	1,870	970	Spain, 1,170; France, 379; Austria, 211.
Total	5,200	2,590	6,270	2,890	
Synthetic:					
Black	48,600	35,700	47,500	41,800	China, 21,900; Germany, 16,200; Italy, 5,930; Japan, 1,630; Canada, 616; Mexico, 343; Republic of Korea, 340; Hong Kong, 185; India, 162; Egypt, 136.
Red	74,400	47,400	67,500	47,800	China, 44,300; Germany, 15,400; Italy, 2,140; Canada, 1,250; Japan, 938; Colombia, 914; Belgium, 907; Sweden, 677; Hong Kong, 212; Spain, 202; Brazil, 194; India, 127.
Yellow	61,500	49,400	73,900	61,600	China, 54,400; Germany, 9,240; Brazil, 4,880; Italy, 1,950; Colombia, 1,500; Canada, 494; Japan, 416; Mexico, 324; Hong Kong, 258; United Kingdom, 183; France, 136.
Other ⁴	3,360	5,030	3,600	4,700	China, 2,300; Canada, 532; Germany, 499; Japan, 131.
Total	188,000	138,000	193,000	156,000	
Grand total	193,000	140,000	199,000	159,000	

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

²Customs value.

³Includes those earth colors not elsewhere specified or included.

⁴Includes synthetic brown oxides, transparent oxides, and magnetic and precursor oxides.

Source: U.S. Census Bureau.

TABLE 6
U.S. IMPORTS FOR CONSUMPTION OF IRON OXIDE AND IRON HYDROXIDE PIGMENTS, BY COUNTRY¹

Country	Natural				Synthetic			
	2005		2006		2005		2006	
	Quantity (metric tons)	Value ² (thousands)	Quantity (metric tons)	Value ² (thousands)	Quantity (metric tons)	Value ² (thousands)	Quantity (metric tons)	Value ² (thousands)
Austria	219	\$212	211	\$218	--	--	--	--
Belgium	--	--	--	--	1,730	\$612	907	\$354
Brazil	--	--	--	--	4,070	3,740	5,070	4,970
Canada	--	--	--	--	4,580	5,610	2,890	5,510
China	16	63	32	14	117,000	70,100	123,000	77,100
Colombia	--	--	--	--	1,680	2,040	2,450	2,980
Cyprus	3,480	1,510	4,340	1,830	--	--	--	--
Egypt	--	--	--	--	156	130	136	125
France	253	167	379	205	196	830	239	1,230
Germany	106	136	98	123	42,200	33,100	41,300	41,900
Hong Kong	--	--	--	--	343	239	691	602
India	--	--	--	--	831	469	384	100
Italy	18	11	--	--	9,270	11,200	10,000	12,200
Japan	79	135	40	68	3,310	5,970	3,110	5,930
Korea, Republic of	--	--	--	--	112	216	340	562
Mexico	--	--	--	--	1,550	1,530	755	801
Netherlands	18	11	--	--	103	32	--	--
Singapore	1,060	362	--	--	21	32	--	--
Spain	--	--	1,170	433	145	75	236	190
Sweden	--	--	--	--	327	117	677	259
United Kingdom	--	--	--	--	211	1,690	275	1,020
Other	--	--	--	--	38	23	76	109
Total	5,240 ^r	2,610 ^r	6,270	2,890	188,000	138,000	193,000	156,000

^rRevised. -- Zero.

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

²Customs value.

Source: U.S. Census Bureau.

TABLE 7
NATURAL IRON OXIDE PIGMENTS: ESTIMATED WORLD PRODUCTION, BY COUNTRY^{1,2}

(Metric tons)

Country ³	2002	2003	2004	2005	2006
Austria	5,000	5,000	4,000	4,000	4,000
Brazil	2,000	2,000	2,000	2,000	2,000
Cyprus, umber	8,200 ⁴	11,900 ⁴	12,000	12,000	12,000
France	1,000	1,000	1,000	1,000	1,000
Germany	4,000 ^r	4,000 ^r	4,000 ^r	4,000 ^r	4,000
Guatemala	35,226 ⁴	2,276 ⁴	2,823 ⁴	6,041 ⁴	6,000
Honduras	71,000	71,000	71,000	71,000	71,000
India, ocher	360,000	365,000	360,000	360,000	360,000
Iran	2,300 ⁴	2,300	2,500	2,500	2,600
Italy	500	500	500	500	500
Pakistan, ocher	5,000 ^r	5,000 ^r	5,000 ^r	5,500 ^r	5,500
Paraguay, ocher	300	250	250	250	250
South Africa	252 ⁴	764 ⁴	512 ⁴	510 ^{r,4}	590 ⁴
Spain, ocher	140,000 ^r	174,153 ^{r,4}	138,050 ^{r,4}	140,000 ^r	140,000
Turkey	580	560	640	780	880
United States	W	W	W	W	W

^rRevised. W Withheld to avoid disclosing company proprietary data.

¹Estimated data are rounded to no more than three significant digits.

²Table includes data available through June 4, 2007.

³In addition to the countries listed, a number of others undoubtedly produce iron oxide pigments, but output is not reported and no basis is available for formulating estimates of output levels. Such countries include Azerbaijan, China, Kazakhstan, Russia, and Ukraine. Unreported output is probably substantial.

⁴Reported figure.