



# 2007 Minerals Yearbook

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## IRON OXIDE PIGMENTS [ADVANCE RELEASE]

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# IRON OXIDE PIGMENTS

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In 2007, total U.S. iron oxide pigment (IOP) production was an estimated 50,000 metric tons (t) valued at about \$50 million. Exports of IOPs increased to 5,410 t valued at \$15.9 million. Total IOP imports decreased by 11% to 178,000 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. 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 2007 were developed by the U.S. Geological Survey (USGS) from a voluntary survey of three companies, of which one responded. Data are withheld to avoid disclosing company proprietary data. In a second voluntary survey, data were received from 4 of 8 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.

Production data for finished IOPs are collected from operations that are thought to process material in some way. This includes, for example, crushing and grinding of natural IOPs or the synthesis of synthetic IOPs from basic chemicals. Canvass data are not collected from operations that are thought to simply blend, mix, repackage, and/or resell IOP material.

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.

Rockwood Holdings, Inc. acquired the global color pigments business of Elementis plc for approximately \$140 million. The acquisition, which is known as Elementis Pigments, Inc., is headquartered in East St. Louis, IL, and comprises pigments and specialty paint driers business in China, Europe, and North America (Rockwood Holdings, Inc., 2007).

## 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 allied products (comprising architectural coatings, original equipment manufacture product coatings, special-purpose coatings, and miscellaneous allied paint products) decreased by 3% in 2007 compared with those of 2006 (U.S. Census Bureau, 2008).

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 super fine amorphous iron oxide with large surface area made by one U.S. company is used as a catalyst for chemical processes and in solid rocket propellants. It is also suitable for cosmetics, drugs, and foods (Kosowski, 2008, p. 2).

An iron oxide product is produced by one company from the treatment of iron-polluted coal mine drainage, which can end up in creeks and streams. The extraction and use of the iron oxide from these sources lessens water pollution. Applications for the iron oxide product include contaminated soil remediation and pigments (Hedin, 2008, p. 6).

Decorative concrete, which uses IOPs for color almost exclusively, is said to be one of the fastest growing segments of the construction industry. One example of decorative concrete is stamped concrete, which involves imparting texture and color to fresh concrete to make it resemble brick, slate, stone, and many more shapes and forms found in nature, including wood (Pinto, 2008, p. 4, 6).

Iron oxide is obtained from steelmaking when steel is treated with hydrochloric acid to remove surface oxides. The acid is then regenerated to be recycled, and regenerated iron oxide is obtained. The iron oxide has potential applications such as a colorant in brick, cement, and pavers. The quality of regenerated iron oxide is said to be better than in the past. Blending of this material with other iron oxides can reduce costs (Swan, 2008, p. 6, 7, 9, 13).

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 2007 was 204.6 compared with 202.0 in 2006, a 1% 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, 2008). Lanxess AG raised prices for its IOPs, ranging from 5% to 15%. Reasons given for the measure included the increased costs of energy and transportation (Lanxess AG, 2007).

## Foreign Trade

U.S. exports of pigment-grade IOPs in 2007 totaled 5,410 t compared with 3,100 t in 2006 (table 4). Total U.S. imports of IOPs of 178,000 t in 2007 were 11% less than those of 2006 (table 5). By tonnage, the three leading sources of IOP imports were China with 64%; Germany, 17%; and Italy, 5% (table 6). The average value of U.S. imports of synthetic IOPs from China was \$675 per metric ton in 2007 compared with \$627 per ton in 2006. The average value of total U.S. imports of synthetic IOPs from all countries was \$879 per ton in 2007 compared with \$808 per ton in 2006.

## World Review

Based on nongovernment information, total world production of IOPs (natural and synthetic) in 2006 (latest data) was estimated to be 1.4 million metric tons. Natural IOPs composed 13% of the total and synthetic IOPs, 87%. China was the world's leading producer of IOPs in 2006 with 49% of the total. Europe produced 25%, Japan, 12%, and the United States, 7%. For total world consumption of IOPs, the largest markets were construction materials, with 48%, and coatings, 26%. The estimated global market for IOPs in 2006 was \$1.1 billion. Asia had 37% of the market; Europe, 32%; and North America, 26% (Will, 2008, p. 7, 8, 11).

**China.**—Production of IOPs in 2007 was 728,000 t and sales (including exports) were about 690,000 t. Exports of IOPs were about 407,000 t and major destinations included North America with about 132,000 t; Europe, 113,000 t; and Southeast Asia, 91,000 t (Wang, 2008, p. 3, 5, 9).

Lanxess AG opened a new plant in the Jinshan District of Shanghai that produced raw IOPs for the company's existing blending and milling facility in the Taopu section of Shanghai. The capacity of the new plant is approximately 20,000 tons per year (t/yr) (Lanxess AG, 2008).

## Outlook

The U.S. IOP industry has seen consolidation in recent years. Estimated output of IOPs decreased from 154,000 t in 2000 to 50,000 t in 2007. In the same time period, imports increased from 91,300 t to 178,000 t. China's IOP output has increased from nearly 100,000 t/yr in the 1990s to 690,000 t/yr in 2007. Consumption of iron oxides in China's concrete products has increased at a significant rate since the late 1990s. This is a reflection of the rapid pace of urban infrastructure construction.

Use of low dust granular iron oxide and dust-free liquid iron oxide color is projected to be the future trend in the concrete industry (Zhang, 2008, p. 3, 24, 27).

China's IOP industry continues to improve processing equipment and technology, packaging, and test instruments. Increasing costs for energy, labor, and raw materials are projected to result in increased prices for IOPs. Emphasis is being placed on environmental protection and continued efforts to save energy and reduce waste (Wang, 2008, p. 27, 29, 32).

Potential uses for nanosized (less than 0.1 micron or 100 nanometers) iron oxides include catalysts and ferrofluids. Uses for ferrofluids include computer disk drives and high performance loud speakers; other applications are in biology and medicine, including nuclear magnetic resonance imaging (Vollath, 2008, p. 2, 5).

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TABLE 1  
SALIENT U.S. IRON OXIDE PIGMENTS STATISTICS<sup>1</sup>

		2003	2004	2005	2006	2007
Crude pigments sold or used: <sup>2</sup>						
Quantity	metric tons	W	W	W	W	W
Value	thousands	W	W	W	W	W
Finished pigments sold: <sup>3</sup>						
Quantity <sup>4</sup>	metric tons	90,000	85,000	90,000	70,000	50,000
Value	thousands	\$89,300	\$77,300 <sup>r</sup>	\$93,400	\$69,300	\$49,600
Exports:						
Quantity	metric tons	4,500	3,120	2,220	3,100	5,410
Value	thousands	\$11,000	\$7,380	\$6,170	\$8,090	\$15,900
Imports for consumption:						
Quantity	metric tons	140,000	170,000	193,000	199,000	178,000
Value	thousands	\$96,600	\$116,000	\$140,000	\$159,000	\$154,000

<sup>c</sup>Estimated. <sup>r</sup>Revised. W Withheld to avoid disclosing company proprietary data.

<sup>1</sup>Data are rounded to no more than three significant digits.

<sup>2</sup>Mined.

<sup>3</sup>Natural (mined) and synthetic.

<sup>4</sup>Rounded to two significant digits.

TABLE 2  
FINISHED IRON OXIDE PIGMENTS SOLD BY PROCESSORS IN THE UNITED STATES, BY KIND<sup>1</sup>

Kind	2006		2007	
	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 <sup>2</sup>	W	W	W	W
Undistributed and other <sup>c,3</sup>	47,000 <sup>4</sup>	\$21,400	W	W
Total <sup>c</sup>	47,000 <sup>4</sup>	21,400	W	W
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 <sup>c</sup>	W	W	W	W
Mixtures of natural and synthetic, iron oxides	W	W	W	W
Total <sup>c,3</sup>	23,000 <sup>4</sup>	47,800	W	W
Grand total <sup>c</sup>	70,000 <sup>4</sup>	69,300	50,000 <sup>4</sup>	49,600

<sup>c</sup>Estimated. W Withheld to avoid disclosing company proprietary data; included with "Natural, undistributed and other" and "Synthetic, total."

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

<sup>2</sup>Includes pyrite cinder.

<sup>3</sup>Includes brown burnt sienna, ocher, raw sienna, and data indicated by symbol W.

<sup>4</sup>Rounded to two significant digits.

TABLE 3  
PRODUCERS OF IRON OXIDE PIGMENTS AND REGENERATOR IRON OXIDES IN THE UNITED STATES IN 2007

Producers	Plant location
<b>Finished pigments:</b>	
Alabama Pigments Co.	Green Pond, AL.
Dynamic Color Solutions, Inc.	Milwaukee, WI.
Elementis Pigments Inc.	Easton, PA.
Hoover Color Corp.	Hiwassee, VA.
New Riverside Ochre Co., Inc.	Cartersville, GA.
Prince Minerals, Inc.	Quincy, IL.
Rockwood Pigments Inc.	Beltsville, MD; and St. Louis, MO.
<b>Crude pigments:</b>	
Alabama Pigments Co.	Green Pond, AL.
Hoover Color Corp.	Hiwassee, VA.
New Riverside Ochre Co., Inc.	Cartersville, GA.
<b>Regenerator iron oxides:</b>	
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 COUNTRY<sup>1</sup>

Country	2006				2007			
	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	18	\$49	291	\$758	258	\$603	261	\$448
Belgium	520	1,660	238	779	630	2,090	--	--
Bermuda	199	366	--	--	178	260	--	--
Brazil	136	750	237	159	270	1,530	527	215
Canada	52	58	10,400	12,300	176	198	11,500	14,100
China	354	644	43,700	14,400	347	818	41,300	9,890
Colombia	11	67	308	150	25	116	375	181
France	131	187	343	1,770	5	53	383	1,130
Germany	27	16	1,070	1,170	20	56	275	595
Hong Kong	22	68	1,910	969	305	673	1,370	563
India	164	371	131	182	356	796	49	32
Indonesia	8	24	5	33	--	--	5	7
Italy	(2)	8	1,240	1,170	4	9	938	898
Japan	196	786	307	216	68	145	45	62
Korea, Republic of	113	718	742	779	1,350	5,180	78	415
Malaysia	--	--	172	491	--	--	9	16
Mexico	719	991	1,670	1,110	360	417	2,990	1,170
Netherlands	--	--	443	894	139	361	290	559
Russia	63	174	--	--	--	--	--	--
Singapore	10	28	903	954	11	43	298	163
Spain	17	40	39	117	7	21	360	67
Switzerland	18	38	120	205	--	--	4	8
Taiwan	38	109	1,170	1,300	138	259	74	260
Thailand	1	7	709	182	1	4	856	216
United Kingdom	119	504	1,500	3,290	585	1,750	571	1,510
Venezuela	1	8	10	18	6	34	255	87
Other	159	423	619	1,020	174	442	339	867
Total	3,100	8,090	68,300	44,400	5,410	15,900	63,100	33,500

-- Zero.

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

<sup>2</sup>Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 5  
U.S. IMPORTS FOR CONSUMPTION OF SELECTED IRON OXIDE PIGMENTS, BY TYPE<sup>1</sup>

Type	2006		2007		Principal sources, 2007 (metric tons)
	Quantity (metric tons)	Value <sup>2</sup> (thousands)	Quantity (metric tons)	Value <sup>2</sup> (thousands)	
Natural:					
Earth colors <sup>3</sup>	4,400	\$1,920	2,910	\$1,340	Cyprus, 2,840; Germany, 50.
Micaceous	1,870	970	1,550	967	Spain, 830; France, 360; Germany, 130; Australia, 60.
Total	6,270	2,890	4,460	2,310	
Synthetic:					
Black	47,500	41,800	38,100	33,500	China, 21,310; Germany, 9,310; Italy, 4,990; Japan, 990; Republic of Korea, 495; Canada, 480; Egypt, 330.
Red	67,500	47,800	58,600	47,900	China, 41,080; Germany, 11,530; Italy, 2,410; Japan, 870; Canada, 680; Colombia, 460; Sweden, 335; Belgium, 290; United Kingdom, 210; Spain, 200; Brazil, 140; Hong Kong, 120.
Yellow	73,900	61,600	73,300	66,000	China, 49,930; Germany, 9,960; Brazil, 8,580; Italy, 1,800; Japan, 1,220; Colombia, 880; Canada, 400; France, 170.
Other <sup>4</sup>	3,600	4,700	3,270	4,520	China, 2,110; Canada, 610; Hong Kong, 170; France, 140.
Total	193,000	156,000	173,000	152,000	
Grand total	199,000	159,000	178,000	154,000	

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

<sup>2</sup>Customs value.

<sup>3</sup>Includes those earth colors not elsewhere specified or included.

<sup>4</sup>Includes 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 COUNTRY<sup>1</sup>

Country	Natural				Synthetic			
	2006		2007		2006		2007	
	Quantity (metric tons)	Value <sup>2</sup> (thousands)	Quantity (metric tons)	Value <sup>2</sup> (thousands)	Quantity (metric tons)	Value <sup>2</sup> (thousands)	Quantity (metric tons)	Value <sup>2</sup> (thousands)
Austria	211	\$218	57	\$73	--	--	--	--
Belgium	--	--	--	--	907	\$354	291	\$91
Brazil	--	--	12	32	5,070	4,970	8,720	8,030
Canada	--	--	31	33	2,890	5,510	2,180	3,850
China	32	14	54	31	123,000	77,100	114,000	76,900
Colombia	--	--	--	--	2,450	2,980	1,380	2,010
Cyprus	4,340	1,830	2,840	1,240	--	--	--	--
Egypt	--	--	--	--	136	125	333	315
France	379	205	356	220	239	1,230	369	1,530
Germany	98	123	183	241	41,300	41,900	30,900	37,900
Hong Kong	--	--	--	--	691	602	416	327
India	--	--	58	16	384	100	256	82
Italy	--	--	--	--	10,000	12,200	9,210	11,700
Japan	40	68	(3)	5	3,110	5,930	3,200	6,430
Korea, Republic of	--	--	--	--	340	562	495	738
Mexico	--	--	15	4	755	801	151	177
Netherlands	--	--	--	--	--	--	21	19
Spain	1,170	433	836	391	236	190	214	166
Sweden	--	--	--	--	677	259	335	124
United Kingdom	--	--	--	--	275	1,020	301	1,390
Other	--	--	19	23	76	108	86	107
Total	6,270	2,890	4,460	2,310	193,000	156,000	173,000	152,000

-- Zero.

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

<sup>2</sup>Customs value.

<sup>3</sup>Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 7  
 NATURAL IRON OXIDE PIGMENTS: ESTIMATED WORLD PRODUCTION, BY COUNTRY<sup>1,2</sup>

(Metric tons)

Country <sup>3</sup>	2003	2004	2005	2006	2007
Austria	5,000	4,000	4,000	4,000	4,000
Brazil	2,000	2,000	2,000	2,000	2,000
Cyprus, umber	11,900 <sup>4</sup>	12,000	12,000	12,000	12,000
France	2,500 <sup>r</sup>	2,500 <sup>r</sup>	2,500 <sup>r</sup>	2,791 <sup>r,4</sup>	2,800
Germany	4,000	4,000	4,000	4,000	4,000
Guatemala	2,276 <sup>4</sup>	2,823 <sup>4</sup>	11,268 <sup>r,4</sup>	7,341 <sup>r,4</sup>	7,000
Honduras	17,000 <sup>r</sup>	17,363 <sup>r,4</sup>	17,000 <sup>r</sup>	17,000 <sup>r</sup>	17,000
India, ocher	365,000	360,000	360,000	360,000	360,000
Iran	2,300	2,500	2,500	2,600	2,600
Italy	500	500	500	500	500
Lithuania	--	--	--	4	4
Pakistan, ocher	5,000	5,000	5,500	5,500	6,000
Paraguay, ocher	250	250	250	250	250
South Africa	764 <sup>4</sup>	512 <sup>4</sup>	510 <sup>4</sup>	590 <sup>4</sup>	232 <sup>p</sup>
Spain, ocher	174,153 <sup>4</sup>	138,050 <sup>4</sup>	140,000	140,000	140,000
Turkey	200,000 <sup>r</sup>	230,000 <sup>r</sup>	280,000 <sup>r</sup>	206,000 <sup>r</sup>	260,000
United Kingdom, iron oxides and hydroxides <sup>5</sup>	17,024 <sup>4</sup>	15,000	12,000	8,913 <sup>4</sup>	8,000
United States	W	W	W	W	W

<sup>r</sup>Revised. W Withheld to avoid disclosing company proprietary data. -- Zero.

<sup>1</sup>Estimated data are rounded to no more than three significant digits.

<sup>2</sup>Table includes data available through June 4, 2008.

<sup>3</sup>In 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.

<sup>4</sup>Reported figure.

<sup>5</sup>Includes iron oxide pigments.