

# IRON OXIDE PIGMENTS

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Natural iron oxides are derived from hematite, which is a red iron oxide mineral; limonites, which are yellow-to-brown, such as ochers, siennas, and umbers; and magnetite, which is black iron oxide and is found in a number of deposits worldwide. 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 Keller, 1994, p. 765, 767, 772).

U.S. apparent consumption of iron oxide pigments (IOP), which are natural or synthetic, was about 265,000 metric tons (t) in 1999; consumption is measured as material sold by producers plus imports minus exports. According to a non-Government source, world consumption of natural and synthetic iron oxides was estimated to be 810,000 t. Total estimated U.S. IOP consumption was 33% in construction materials; 23%, coatings; and 44%, other. An estimate of world consumption of iron oxides was 51% in construction; 30%, coatings; and 19%, other uses (Adams, 2000).

## Production

U.S. crude IOP sold or used in 1999 totaled 44,100 t, which was slightly less than that of 1998 (table 1). Finished natural IOP sold by processors were 92,000 t, or 10% more than that of 1998. Finished synthetic IOP were 102,000 t, which was an increase of 6% from that of 1998. Total finished natural and synthetic IOP were 194,000 t, or 8% higher than that of 1998 (table 2).

Of natural IOP sold by processors, red made up 61%, and black, 23%. Of synthetic IOP, the red-and-other category was 36%; black, 26%; and yellow, 25% (table 2).

Production data for crude IOP sold or used were developed by means of a voluntary survey. Of six known companies, data were obtained from five, for an 83% response rate. By tonnage, the five companies represented 61% of the output. In a second voluntary survey, data were received from 12 of 16 known operations that produced finished IOP, for a response rate of 75%. By tonnage, the 12 operations represented 73% of the output.

Data were obtained from three producers of regenerator iron oxide; this material is obtained when spent pickle liquor from steelmaking is treated (table 3). Output from the three companies was about 26,500 t of iron oxide. A major end use for this material was ferrites. Regenerator iron oxide data are not included in tables 1, 2, and 4.

Bailey-PVS Oxides, L.L.C. (BPO), with its corporate

headquarters in Canonsburg, PA, was a joint venture iron oxide company of Bailey Engineers, Inc., also in Canonsburg, PA, and PVS Chemicals, Inc., in Detroit, MI. BPO used the Andritz Ruthner Spray Roasting Technology; spent pickle liquor (ferrous chloride solution) from steel finishing operations is treated to produce clean hydrochloric acid and iron oxide. A major portion of the iron oxide was shipped to the ferrite industry where it was mixed with other powders that contained, for example, strontium and barium to produce ferrite powders used to make magnets. BPO believed its iron oxide was also well suited for the pigment industry, especially in construction (Galís, 2000).

Bayer Corp.'s 18,000-t-capacity expansion at its IOP facility in New Martinsville, WV, which was scheduled for completion in 1999, was to include two manufacturing lines—one for yellow iron oxides and the other for zinc ferrite and iron oxide used as a catalyst (Paint & Coatings Industry, 1999).

## Consumption

Coatings and construction materials, which continued to be the largest IOP end uses in 1999, made up 35% of natural IOP reported shipments, 75% of synthetic IOP shipments, and 56% of all natural and synthetic IOP shipments (table 4).

The paint and coatings market includes, in estimated descending dollar sales, such categories as trade sales (standard shelf goods, a significant portion of which are architectural), automobile OEM (original equipment manufacture), industrial maintenance (required to maintain industrial plant and equipment), and industrial wood coatings (Metcalf, 2000, p. 9).

Paint manufacturers have found that producing large volumes of architectural white base paint and adding the pigmentation at the point of sale in the form of universal tinting pastes is increasingly efficient. This has led to a large variety of colors available to the customer. Aided by advancing technology and computer control, the growth in the use of iron oxides in universal tint systems has been substantial. Most yellow, earth-tone, and red trade sales paints contain some iron oxide, which had not been the case with prepackaged pigmented paints (Metcalf, 2000, p. 2).

## Prices

Yearend 1999 prices, converted to dollars per kilogram, in bags, per truckload, f.o.b. warehouse, were black, synthetic—\$1.85 to \$1.96; brown, synthetic—\$1.83 to \$1.94; red, natural—\$0.65 to \$1.10; ochre, natural—\$0.81; and yellow, synthetic—\$1.80 to \$1.94 (Chemical Market Reporter,

1999). These prices were essentially unchanged from those of 1998.

## Foreign Trade

U.S. exports of pigment grade IOP in 1999 were 13,800 t, or 5% less than those of 1998 (table 5). The largest recipients were Mexico with 56%; Japan, 12%; and Germany, 7%.

In 1999, U.S. imports of natural IOP were 7,450 t, or 52% higher than in 1998 (tables 6, 7). The 2,220 t of micaceous iron oxide (MIO) from the Netherlands in 1999, however, may not belong in this table, because that country is not known to be a supplier of MIO. This has yet to be verified with the Bureau of the Census; if verified, U.S. imports of MIO would drop to 558 t with a value of \$496,000. Imports of synthetic IOP were 77,600 t, or 24% higher than those of 1998. The major countries of origin were China with 52%; Germany, 22%; and Canada, 5%. The value of synthetic IOP imports was \$69.3 million, which was an increase of 12% compared with that of 1998.

Total U.S. imports of IOP (natural and synthetic) were 85,100 t, or 26% more than those of 1998. Total value of the imports was \$73 million, or 14% higher than that of 1998 (tables 6, 7).

## Current Research and Technology

A demonstration unit (oxidizer) to remove iron oxides from mine water was being tested in Pennsylvania by a private concern. The State has more than 3,800 kilometers of streams that contain discharge from abandoned mines. Drainage from the mines has been treated either chemically or passively. Chemical treatment is expensive because chemicals to precipitate iron and other metals are required. Passive treatment is much less expensive but requires large areas of ponds or wet lands. Also, the reacting of oxygen from the air with the pollutants takes place at a slow rate to form ferric hydroxide, which drops out of the water before it enters streams or rivers. The demonstration unit, by contrast, vigorously mixes air with mine discharge water. If the unit works successfully, then enough iron oxide could be deposited in the pond to dredge out and sell as pigment for such products as paint and cosmetics periodically. The revenue would help defray the treatment costs (Don Hopey, Post Gazette [Pittsburgh, PA] staff writer, May 3, 1999, Airing out the iron, accessed May 3, 1999, at URL <http://www.post-gazette.com/healthscience/19990503water.asp>).

## Outlook

China is thought to have significant synthetic IOP production capacity, although several factors could affect production and marketing activity. These include future trends of labor costs in China, the effect on production costs from environmental controls, and availability of energy and raw materials (Metcalf,

2000, p. 6).

The European market for roof tiles, pavers, and block has always been strong, although this market has not demanded the range of color as that of the U.S. market. The roof tile segment of the industry has shown significant growth in the United States. Significant housing construction activity, especially in the U.S. "sun belt" area, was already using iron oxide-pigmented stucco and colored concrete blocks. Concrete pavers can be used in streets and roadways, walkways, plazas, parking areas, driveways, and other areas. Concrete pavers have had stronger growth in Europe than in the United States, but the latter is showing growth. Concrete blocks containing IOP are commonly used as noise barriers along freeways in residential areas (Metcalf, 2000, p. 7).

The strength of the housing market in the United States will have a significant effect on IOP growth in the future. Worldwide, IOP demand will be affected by the degree of construction activity and use of pigmented construction products in such areas as Africa, China, Europe, and South America (Metcalf, 2000, p. 7).

## References Cited

- Adams, Reg, 2000, Iron oxide pigments in perspective, *in* Iron Oxides for Colorant & Chemical Applications, Berlin, March 9-10, 2000, Proceedings: Portland, ME, Intertech, 11 p.
- Chemical Market Reporter, 1999, Chemical prices: Chemical Market Reporter, v. 256, no. 26, December 27, p. 21.
- Galis, Moe, 2000, Spray roasted iron oxides for the pigments industry, *in* Iron Oxides for Colorant & Chemical Applications, Berlin, March 9-10, 2000, Proceedings: Portland, ME, Intertech, 12 p.
- Metcalf, G.L., 2000, Iron oxides—Lessons learned yesterday & today, applied to tomorrow, *in* Iron Oxides for Colorant & Chemical Applications, Berlin, March 9-10, 2000, Proceedings: Portland, ME, Intertech, 27 p.
- Paint & Coatings Industry, 1999, Company news: Paint & Coatings Industry, v. 15, no. 1, January, p. 24.
- Podolsky, George, and Keller, D.P., 1994, Pigments, iron oxide, *in* Carr, D.D., and others, eds., Industrial minerals and rocks, 6th ed.: Littleton, CO, Society for Mining, Metallurgy, and Exploration, Inc., p. 765-781.

## GENERAL SOURCES OF INFORMATION

### U.S. Geological Survey Publications

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

### Other

- Intertech conferences, Portland, ME.
- 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.
- Pigment Handbook (2d ed.), 1988.

TABLE 1  
SALIENT U.S. IRON OXIDE PIGMENTS STATISTICS 1/

(Metric tons, unless otherwise noted)

	1995	1996	1997	1998	1999	
Mine production	W	W	W	W	W	
Crude pigments sold or used	51,700	44,700	46,900	46,100	44,100	
Value	thousands	\$6,720	\$6,990	\$7,580	\$7,290	\$7,740
Finished pigments sold	151,000	163,000	176,000	180,000	194,000	
Value	thousands	\$160,000	\$183,000	\$193,000	\$193,000	\$207,000
Exports	17,500	16,000	16,600	14,600	13,800	
Value	thousands	\$24,900	\$23,200	\$20,600	\$18,200	\$15,200
Imports for consumption	59,300	59,600	68,200	67,500	85,100	
Value	thousands	\$77,600	\$72,800	\$75,400	\$64,200	\$73,000

W Withheld to avoid disclosing company proprietary data.

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

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

Kind	1998		1999	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
Natural:				
Black, magnetite	15,400	2,940	21,000	3,690
Umbers:				
Burnt	2,290	3,090	2,440	3,280
Raw	W	W	W	W
Red:				
Iron oxide 2/	54,600	10,900	55,700	11,800
Sienna, burnt	W	W	W	W
Yellow:				
Ocher	W	W	W	W
Sienna, raw	W	W	W	W
Undistributed	11,200	7,570	12,900	8,590
Total	83,500	24,500	92,000	27,300
Synthetic:				
Black, iron oxide	22,300	38,000	26,500	43,900
Brown, iron oxide	9,780	18,000	9,450	17,100
Red, iron oxide	W	W	W	W
Yellow, iron oxide	25,200	43,100	25,500	45,400
Mixtures of natural and synthetic:				
Iron oxides	2,600	3,610	4,210	6,640
Other, specialty oxides	W	W	W	W
Undistributed	36,300	66,000	36,700	67,100
Total	96,200	169,000	102,000	180,000
Grand total	180,000	193,000	194,000	207,000

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

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

2/ Includes pyrite cinder.

TABLE 3  
 PRODUCERS OF IRON OXIDE PIGMENTS, REGENERATOR IRON OXIDES,  
 AND STEEL PLANT WASTE IRON OXIDES IN THE UNITED STATES IN 1999

Producers	Plant location
<b>Finished pigments:</b>	
Alabama Pigments Co.	Green Pond, AL.
Arizona Oxides L.L.C.	El Mirage, AZ.
Bayer Corp.	New Martinsville, WV.
Blue Ridge Talc Co., Inc.	Henry, VA.
Dynamic Color Solutions, Inc.	Milwaukee, WI.
Elementis Pigments Inc.	Emeryville, CA; East St. Louis, IL; Easton, PA.
Hoover Color Corp.	Hiwassee, VA.
Laporte Pigments, Inc.	St. Louis, MO.
Do.	Beltsville, MD.
New Riverside Ochre Co., Inc.	Cartersville, GA.
Pea Ridge Iron Ore Co.	Sullivan, MO.
Prince Manufacturing Co., Inc.	Quincy, IL and Bowmanstown, PA.
Solomon Grind-Chem Services Inc.	Springfield, IL.
<b>Crude pigments:</b>	
Alabama Pigments Co.	Green Pond, AL.
Arizona Oxides L.L.C.	El Mirage, AZ.
Cleveland-Cliffs Iron Co., Mather Mine and Pioneer plant (closed July 31, 1979; shipping from stockpile.)	Negaunee, MI.
Hoover Color Corp.	Hiwassee, VA.
New Riverside Ochre Co., Inc.	Cartersville, GA.
Pea Ridge Iron Ore Co.	Sullivan, MO.
<b>Regenerator and steel plant waste iron oxides:</b>	
Bailey-PVS Oxides, L.L.C.	Fairfield, AL.
International Steel Services, Inc.	Allenport, PA.
Weirton Steel Corp.	Weirton, WV.

TABLE 4  
 ESTIMATED IRON OXIDE PIGMENT CONSUMPTION, BY END USE, AS A PERCENTAGE OF REPORTED SHIPMENTS

End use	All iron oxides		Natural iron oxides		Synthetic iron oxides	
	1998	1999	1998	1999	1998	1999
Coatings (industrial finishes and trade sales coatings: lacquers, paints, varnishes)	25	23	13	15	35	31
Construction materials (cement, mortar, preformed concrete, roofing granules)	32	33	21	20	41	44
Colorants for ceramics, glass, paper, plastics, rubber, textiles	10	9	W	W	W	11
Foundry sands	7	7	15	15	--	--
Industrial chemicals (such as catalysts)	6	7	W	W	W	W
Ferrites	W	W	W	W	W	W
Animal feed and fertilizers	W	W	W	W	W	W
Other (such as cosmetics, magnetic ink and toner, and polishing agents)	20	21	51	50	24	14
Total	100	100	100	100	100	100

W Withheld to avoid disclosing company proprietary data; included with "Other." -- Zero.

TABLE 5  
U.S. EXPORTS OF IRON OXIDES AND HYDROXIDES, BY COUNTRY 1/

Country	1998				1999			
	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)
Argentina	125	\$559	58	\$56	68	\$279	106	\$57
Australia	17	44	627	1,340	90	204	297	703
Belgium	106	771	67	82	86	672	90	417
Brazil	9	59	208	674	17	54	248	603
Canada	41	47	11,400	13,900	41	51	11,000	13,500
China	20	19	242	351	223	798	39	88
Colombia	21	33	177	210	33	57	63	69
France	46	113	238	396	35	81	278	1,450
Germany	395	285	202	640	976	1,430	767	4,840
Hong Kong	238	634	957	3,310	11	30	1,600	4,780
India	65	157	183	278	476	759	314	387
Indonesia	--	--	172	191	10	31	167	246
Italy	17	13	142	110	18	51	144	367
Japan	2,540	2,520	3,760	8,150	1,710	2,200	3,690	9,360
Korea, Republic of	1,640	4,180	2,160	5,880	327	484	2,860	10,500
Malaysia	27	69	105	125	--	--	27	22
Mexico	7,680	3,980	1,690	4,170	7,740	3,450	3,210	3,740
Netherlands	40	69	906	1,650	146	394	897	1,440
Russia	240	755	13	7	105	370	20	80
Singapore	12	44	91	206	16	41	118	228
South Africa	--	--	6	26	294	401	1	5
Taiwan	64	145	1,310	1,180	60	113	1,120	908
Thailand	53	153	66	112	41	141	500	2,130
Turkey	135	397	64	95	--	--	19	51
United Kingdom	887	2,570	2,100	3,150	821	2,400	2,080	3,150
Venezuela	49	92	107	310	13	45	23	134
Other	177	450	446	820	423	665	378	639
Total	14,600	18,200	27,500	47,400	13,800	15,200	30,100	59,800

-- Zero.

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

Source: Bureau of the Census.

TABLE 6  
U.S. IMPORTS FOR CONSUMPTION OF SELECTED IRON OXIDE PIGMENTS, BY TYPE 1/

Type	1998		1999		Principal sources, 1999 (metric tons)
	Quantity (metric tons)	Value 2/ (thousands)	Quantity (metric tons)	Value 2/ (thousands)	
Natural:					
Earth colors 3/	4,200	\$1,820	4,680	\$2,020	Cyprus 3,820; Germany 278; France 169; Spain 160; India 147; Colombia 67; Czech Republic 20; Canada 18; South Africa 1; United Kingdom (4/); Japan (4/); Poland (4/).
Micaceous	715	554	2,770	1,690	Netherlands 2,220; Austria 227; Australia 147; France 123; Mexico 21; Morocco 20; China 20.
Total	4,910	2,380	7,450	3,710	
Synthetic:					
Black	10,200	16,700	12,000	15,800	Germany 3,450; India 3,170; China 2,330; Japan 1,050; Mexico 948; Italy 780; United Kingdom 147; Hong Kong 75; Canada 50; Netherlands 18; Norway 6; Colombia 2; France (4/).
Red	26,400	19,000	35,000	25,700	China 22,100; Germany 5,240; Canada 3,410; Sweden 1,150; Italy 624; United Kingdom 439; Japan 383; Mexico 318; Brazil 291; Hong Kong 279; Spain 274; India 160; Netherlands 120; Morocco 100; Colombia 41; France 39; Republic of Korea 16; Belgium 15; Switzerland (4/).
Yellow	22,800	20,400	28,600	24,700	China 15,400; Germany 7,390; Brazil 1,980; Italy 1,410; Mexico 1,240; United Kingdom 383; Spain 256; Hong Kong 232; Canada 110; Colombia 70; Netherlands 35; Republic of Korea 35; Belgium 33; France 32; Ukraine 19; Japan 8; Switzerland 2.
Other 5/	3,120	5,700	1,960	3,110	Germany 1,140; Canada 494; China 209; United Kingdom 44; Mexico 29; Poland 19; Japan 14; Colombia 11; France 3; Italy 2; Belgium 1; Switzerland (4/).
Total	62,600	61,800	77,600	69,300	
Grand total	67,500	64,200	85,100	73,000	

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

2/ Customs value.

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

4/ Less than 1/2 unit.

5/ Includes synthetic brown oxides, transparent oxides, and magnetic and precursor oxides.

Source: Bureau of the Census.

TABLE 7  
U.S. IMPORTS FOR CONSUMPTION OF IRON OXIDE AND IRON HYDROXIDE PIGMENTS, BY COUNTRY 1/

Country	Natural				Synthetic			
	1998		1999		1998		1999	
	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	92	\$105	227	\$249	--	--	--	--
Belgium	19	19	--	--	78	\$416	49	\$321
Brazil	--	--	--	--	1,590	1,540	2,270	2,170
Canada	22	3	18	3	4,940	2,280	4,060	1,960
China	164	133	20	18	27,400	14,900	40,000	21,700
Colombia	86	110	67	112	45	50	124	155
Cyprus	3,510	1,120	3,820	1,280	--	--	--	--
France	268	186	292	225	58	623	74	711
Germany	171	246	278	364	11,500	16,000	17,200	22,800
Hong Kong	--	--	--	--	1,930	1,240	586	370
India	61	13	147	34	3,070	2,090	3,330	2,240
Italy	36	28	--	--	2,450	2,750	2,810	2,920
Japan	--	--	(3/)	2	2,760	12,600	1,450	7,670
Mexico	--	--	21	4	2,360	2,120	2,540	2,290
Netherlands	185	127	2,220	1,190	18	24	173	87
Spain	80	45	160	59	972	473	530	437
Sweden	10	21	--	--	600	146	1,150	307
United Kingdom	66	102	(3/)	6	2,550	4,250	1,010	2,880
Other	143 r/	213 r/	189	159	278 r/	276 r/	197	299
Total	4,910	2,380	7,450	3,710	62,600	61,800	77,600	69,300

r/ Revised. -- Zero.

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

2/ Customs value.

3/ Less than 1/2 unit.

Source: Bureau of the Census.

TABLE 8  
NATURAL IRON OXIDE PIGMENTS: WORLD PRODUCTION, BY COUNTRY 1/ 2/

(Metric tons)

Country 3/	1995	1996	1997	1998	1999 e/
Austria e/	8,000	7,500	7,500	7,000	7,000
Brazil e/	5,500	5,500	5,500	5,500	5,500
Chile	16,451	18,821	10,678 r/	10,449 r/	10,500
Cyprus (umber)	5,415	4,604	5,000 e/	5,000 e/	5,000
France e/	1,000	1,000	1,000	1,000	1,000
Germany 4/	7,500 e/	3,754	4,176	4,000 e/	4,000
India (ocher)	254,166	284,546	347,429 r/	351,704 r/	360,000
Iran e/	2,500	2,500	2,500	2,500	2,500
Italy e/	600	500	500	500	500
Pakistan (ocher) e/	6,000	6,100	2,600	3,180 r/	3,200
Paraguay (ocher) e/	300	300	300	300	300
South Africa	5,256	643	284	186 r/	216 5/
Spain: e/					
Ocher	8,000	7,000	7,000	7,000	7,000
Red iron oxide	16,000	15,000	15,000	15,000	15,000
United States	W	W	W	W	W
Zimbabwe	585	400 e/	--	--	--

e/ Estimated. r/ Revised. W Withheld to avoid disclosing company proprietary data. -- Zero.

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

2/ Table includes data available through June 2, 2000.

3/ 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, but are not limited to, Azerbaijan, China, Kazakhstan, Russia, and Ukraine. Unreported output is probably substantial.

4/ Includes Vandyke brown.

5/ Reported figure.