

IRON OXIDE PIGMENTS

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Natural iron oxides 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 Keller, 1994, p. 765, 772).

Production

U.S. output of finished natural (mined) iron oxide pigments (IOPs) sold by processors in 2002 was 60,000 metric tons (t), which was 14% less than that of 2001; this category accounted for 52% of the tonnage and 18% of the value of total IOP output. Output of finished synthetic IOPs was 54,600 t, which was a decrease of 16% from the tonnage in 2001, and accounted for about 48% of the tonnage and 82% of the value of total IOP output. The total quantity of finished natural and synthetic IOPs sold by processors (115,000 t) was 15% less than the output in 2001 (table 2).

Production data for crude IOPs sold or used were developed from a voluntary survey of four companies, three of which responded (table 1). By tonnage, the three companies represented 96% of the output. In a second voluntary survey, data were received from 11 of 12 known operations for finished IOPs by color (table 2). By tonnage, the 11 operations represented 99% of the output. In a survey of these same 11 operations for finished IOPs by end use, the response rate by tonnage was 72% (table 4).

Data were obtained from two producers (four operations) of regenerated iron oxide, which is obtained when spent pickle liquor from steelmaking is treated (table 3). A major end use for this material 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 cores for RF coils; inverter cores; memory cores; microwave ferrites for computers, telecommunications, microwave communication systems, and other industrial applications; pot cores; RM cores; and television deflection yokes (Govila, 1991, p. 2-3). Hard ferrites are used in flexible magnets, generators, loudspeakers, and motors. Regenerator iron oxide data are not included in tables 1, 2, and 4.

Consumption

The largest end-use categories for total U.S. IOP output (natural and synthetic) in 2002 continued to be construction (34%) and coatings (21%) (table 4). 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 (Bayer Corp., 2002§¹). Shipments of paint and coatings, comprising architectural coatings, original equipment manufacture (OEM) product coatings, and special-purpose coatings, increased by 5% in 2002 compared with those of 2001 (U.S. Census Bureau, 2003§).

Transparent IOPs, which have iron oxide of very small particle size, are widely used for automotive applications. The primary application of transparent IOPs is in basecoat formulations in combination with effect and/or organic pigments. Effect pigments include micaceous or aluminum flakes; used in combination with transparent IOPs, they form metallic effect finishes for automobiles. For example, transparent IOPs in combination with aluminum flakes can yield bronze, gold, and silver colors. These colors, which are often called “autumn” shades or earth tones, have been reemerging as popular colors in the U.S. automotive market (Wright, Thomas, and McKenna, 2002).

Transparent IOPs in coatings also provide protection against ultraviolet exposure, especially important for automobiles exposed to bright sunlight for long periods (Wright, Thomas, and McKenna, 2002).

Prices

Yearend 2002 IOP published prices, which are meant to serve as a general guideline only, converted to dollars per kilogram, in bags, per truckload, free on board warehouse were black, synthetic, \$2.07 per kilogram; buff, natural, domestic, which included dark and light, \$1.16 per kilogram to \$2.14 per kilogram; and yellow, synthetic, \$2.25 per kilogram to \$2.34 per kilogram (Chemical Market Reporter, 2002a). The average annual producer price index (PPI) for IOPs for 2002 was 178.0 compared with 167.4 in 2001. The PPI measures the average change over time in the selling prices received by domestic producers of IOPs. The base year for the IOP PPI is June 1983 (U.S. Bureau of Labor Statistics, 2002§).

Rockwood Pigments NA, Inc. raised prices for its pigment products in North America effective in May 2002. The increase, which averaged 5%, depended on the specific grade and order quantity (Chemical Market Reporter, 2002b).

Foreign Trade

U.S. exports of pigment-grade IOPs in 2002 were 6,270 t, which was 31% less than those of 2001 (table 5). Under

¹References that include a section mark (§) are found in the Internet References Cited section.

U.S. imports of natural IOPs in table 6, micaceous iron oxide (MIO) is shown as 3,160 t for 2002. Material from Austria, for example, was believed to be actual MIO, with a value of \$0.90 per kilogram. Material from Belgium (\$0.20 per kilogram) and the Netherlands (\$0.35 per kilogram), however, may be some other form of iron oxide.

U.S. imports of synthetic IOPs of 126,000 t in 2002 were 49% higher than those of 2001. China supplied 54%; Germany, 21%; and seven other countries, approximately 3% each.

Outlook

Automotive coatings manufacturers have been facing environmental restrictions and requirements. The OEM market has been under the greatest pressure to replace solvent-borne systems with alternatives, such as water-based systems. Approximately 50% of this market has moved to waterborne base coat formulations (Wright, Thomas, and McKenna, 2002).

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TABLE 1
 SALIENT U.S. IRON OXIDE PIGMENTS STATISTICS¹

(Metric tons, unless otherwise noted)

	1998	1999	2000	2001	2002
Crude pigments sold or used²					
Quantity	46,100	44,100	57,100	61,500	W
Value	thousands \$7,290	\$7,740	\$4,470	\$3,460	\$1,070
Finished pigments sold³					
Quantity	180,000	183,000	154,000	135,000	115,000
Value	thousands \$193,000	\$187,000	\$142,000	\$130,000	\$117,000
Exports					
Quantity	14,600	13,800	9,640	9,100	6,270
Value	thousands \$18,200	\$15,200	\$17,200	\$16,800	\$12,100
Imports for consumption					
Quantity	63,800	80,800	91,300	89,900	132,000
Value	thousands \$62,900	\$71,400	\$76,700	\$76,900	\$96,300

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	2001		2002	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
Natural:				
Black, magnetite	16,000	\$2,630	W	W
Umbers:				
Burnt	2,010	3,180	1,680	\$2,660
Raw	W	W	W	W
Red, iron oxide ²	38,900	8,020	W	W
Undistributed and other ³	13,000	8,680	58,200	17,800
Total	69,900	22,500	60,000	20,600
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	19,600	33,600	19,700	34,900
Mixtures of natural and synthetic, iron oxides	W	W	W	W
Total	64,700	107,000	54,600	96,000
Grand total	135,000	130,000	115,000	117,000

W Withheld to avoid disclosing company proprietary data; included with "Undistributed and other," and "Total."

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

²Includes pyrite cinder.

³Includes raw umber, burnt sienna, ochre, and raw sienna, and data indicated by W.

TABLE 3
PRODUCERS OF IRON OXIDE PIGMENTS AND REGENERATOR IRON OXIDES
IN THE UNITED STATES IN 2002

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

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	
	2001	2002	2001	2002	2001	2002
Coatings, industrial finishes and trade sales coatings: lacquers, paints, varnishes	19 ^r	21	10 ^r	14	29	30
Construction materials, cement, mortar, preformed concrete, roofing granules	34 ^r	34	W	W	W	W
Colorants for ceramics, glass, paper, plastics, rubber, textiles	9	12	W	W	W	W
Foundry sands	W	W	W	W	--	--
Industrial chemicals, such as catalysts	7	8	W	W	W	W
Other ¹	31 ^r	25	90 ^r	86	71 ^r	70
Total	100	100	100	100	100	100

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

¹Includes animal feed, cosmetics, ferrites, fertilizers, magnetic ink and toner, polishing agents, and data indicated by symbol W.

TABLE 5
U.S. EXPORTS OF IRON OXIDES AND HYDROXIDES, BY COUNTRY¹

Country	2001				2002			
	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	3	\$7	74	\$31	1	\$10	--	--
Australia	107	247	322	586	171	389	284	\$541
Belgium	83	237	567	2,170	448	1,560	2,160	6,170
Brazil	36	85	415	423	13	54	240	303
Canada	75	61	11,200	12,000	8	10	13,100	11,200
China	261	422	2,440	716	44	119	8,420	1,420
Colombia	73	334	86	70	54	104	98	95
France	11	37	85	230	4	22	191	262
Germany	280	369	1,930	4,270	82	195	1,720	3,260
Hong Kong	172	345	1,970	3,850	728	1,870	2,160	3,160
India	405	536	724	615	146	318	197	78
Indonesia	1	11	27	45	2	8	50	108
Italy	16	57	1,450	1,860	6	63	1,020	782
Japan	1,800	3,120	3,740	5,480	1,470	1,850	1,640	2,680
Korea, Republic of	1,190	1,880	3,380	3,320	1,200	1,710	3,130	1,910
Malaysia	--	--	146	436	--	3	147	320
Mexico	2,280	2,230	1,170	1,410	873	858	1,180	1,830
Netherlands	18	25	1,000	1,800	6	3	760	1,400
Russia	1,270	3,580	--	--	642	1,530	97	163
Singapore	--	--	365	223	21	35	1,650	508
South Africa	--	--	--	--	4	11	8	34
Taiwan	171	362	2,300	1,590	56	137	1,730	1,480
Thailand	114	74	130	204	5	13	617	382
Turkey	2	17	18	26	22	53	22	21
United Kingdom	289	1,280	3,360	5,940	31	66	2,990	5,230
Venezuela	67	63	102	26	8	31	139	80
Other	372	1,360	1,050	1,690	226	1,060	707	1,760
Total	9,100	16,800	38,100	49,000	6,270	12,100	44,400	45,100

-- Zero.

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

Source: U.S. Census Bureau.

TABLE 6
U.S. IMPORTS FOR CONSUMPTION OF SELECTED IRON OXIDE PIGMENTS, BY TYPE¹

Type	2001		2002		Principal sources, 2002 (metric tons)
	Quantity (metric tons)	Value ² (thousands)	Quantity (metric tons)	Value ² (thousands)	
Natural:					
Earth colors ³	4,200	\$1,910	2,870	\$1,220	Cyprus, 2,680; Spain, 131.
Micaceous	1,080	599	3,160	1,460	Netherlands, 1,210; Belgium, 1,050; Austria, 267; France, 224; Sweden, 154.
Total	5,280	2,510	6,020	2,680	
Synthetic:					
Black	17,000	25,900	31,200	31,800	China, 10,200; Germany, 7,900; Italy, 4,560; India, 3,490; Japan, 3,080; Sweden, 805; Mexico, 692; Canada, 406.
Red	33,900	22,400	52,000	29,900	China, 33,300; Germany, 12,500; Canada, 2,380; Hong Kong, 1,140; Mexico, 712; Italy, 617; India, 413; Spain, 399; Sweden, 185; Colombia, 118.
Yellow	31,500	23,100	39,100	26,700	China, 23,800; Germany, 6,120; Brazil, 5,150; Mexico, 1,410; Hong Kong, 959; Colombia, 685; Italy, 464; Canada, 208; India, 147; United Kingdom, 109.
Other ⁴	2,270	2,980	3,440	5,210	China, 953; Cyprus, 928; Germany, 593; Japan, 336; United Kingdom, 297; Hong Kong, 118; Canada, 118.
Total	84,700	74,400	126,000	93,600	
Grand total	89,900	76,900	132,000	96,300	

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 7
U.S. IMPORTS FOR CONSUMPTION OF IRON OXIDE AND IRON HYDROXIDE PIGMENTS, BY COUNTRY¹

Country	Natural				Synthetic			
	2001		2002		2001		2002	
	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	206	\$195	267	\$239	--	--	--	--
Belgium	20	6	1,050	305	70	\$425	74	\$306
Brazil	--	--	--	--	3,090	2,920	5,230	4,280
Canada	53	44	⁽³⁾	2	702	925	3,120	1,720
China	16	5	47	27	51,400	26,600	68,200	33,900
Colombia	--	--	--	--	174	262	812	766
Cyprus	2,830	1,160	2,680	1,100	237	82	928	349
France	135	75	224	115	38	357	44	427

See footnotes at end of table.

TABLE 7--Continued
U.S. IMPORTS FOR CONSUMPTION OF IRON OXIDE AND IRON HYDROXIDE PIGMENTS, BY COUNTRY¹

Country	Natural				Synthetic			
	2001		2002		2001		2002	
	Quantity (metric tons)	Value ² (thousands)	Quantity (metric tons)	Value ² (thousands)	Quantity (metric tons)	Value ² (thousands)	Quantity (metric tons)	Value ² (thousands)
Germany	353	378	24	24	16,400	18,200	27,100	22,800
Hong Kong	--	--	--	--	1,450	997	2,300	1,380
India	105	28	9	5	3,600	2,530	4,050	2,590
Italy	33	32	--	--	1,650	2,020	5,650	5,490
Japan	6	14	20	14	2,080	13,800	3,500	14,300
Mexico	--	--	19	15	2,180	1,950	2,830	2,450
Netherlands	596	244	1,210	424	60	29	5	2
Spain	698	161	179	70	474	385	408	185
Sweden	20	9	154	40	324	97	990	233
United Kingdom	16	35	24	117	379	2,270	492	2,360
Other	188	130	120	181	365	481	38	103
Total	5,280	2,510	6,020	2,680	84,700	74,400	126,000	93,600

-- Zero.

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

²Customs value.

³Less than 1/2 unit.

Source: U.S. Census Bureau.

TABLE 8
NATURAL IRON OXIDE PIGMENTS: ESTIMATED WORLD PRODUCTION, BY COUNTRY^{1,2}

(Metric tons)

Country ³	1998	1999	2000	2001	2002
Austria	7,000	6,000	6,000	5,000	5,000
Brazil	2,000	2,000	2,000	2,000	2,000
Chile	10,449 ⁴	9,992 ⁴	10,000	10,000	10,000
Cyprus, umber	6,056 ⁴	9,169 ⁴	7,500 ^{r,4}	4,800 ^{r,4}	5,000
France	2,000	1,500	1,500	1,000	1,000
Germany ⁵	4,000	4,000	4,000	4,000	4,000
India, ocher	351,704 ⁴	380,000 ^r	336,000 ^r	355,000 ^r	360,000
Iran	13,300	13,300	13,500	13,000 ^r	13,000
Italy	500	500	500	500	500
Pakistan, ocher	3,180 ⁴	3,200	4,747 ⁴	4,800	4,500
Paraguay, ocher	300	300	300	300	300
South Africa	1,352 ⁴	216 ⁴	568 ⁴	852 ⁴	252 ⁴
Spain:					
Ocher	70,000 ^r	70,000 ^r	87,000 ^{r,4}	87,000 ^r	87,000
Red iron oxide	15,000	15,000	-- ^r	-- ^{r,4}	--
United States	46,100 ⁴	44,100 ⁴	57,100 ⁴	61,500 ⁴	W

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

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

²Table includes data available through June 4, 2003.

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

⁴Reported figure.

⁵Includes Vandyke brown.