IRON OXIDE PIGMENTS

By Michael J. Potter

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Iron oxide materials yield pigments that are nontoxic, nonbleeding, weather resistant, and lightfast. Natural iron oxides include a combination of one or more ferrous or ferric oxides and impurities, such as manganese, clay, or organics. Synthetic iron oxides can be produced in various ways, including thermal decomposition of iron salts, such as ferrous sulfate, to produce reds; precipitation to produce yellows, reds, browns, and blacks (e.g., the Penniman-Zoph process); and reduction of organic compounds by iron (e.g., nitrobenzene reduced to aniline in the presence of particular chemicals) to produce yellows and blacks—reds can be produced by calcining either these yellow or blacks (Harben, 1995).

Production

In 1998, U.S. crude iron oxide pigments (IOP) sold or used totaled 46,100 metric tons (t), or about the same as in 1997 (table 1). The total output of finished IOP sold by processors in the United States was 180,000 t, or slightly higher than that of 1997. Finished natural IOP sold totaled 83,500 t, and finished synthetic IOP, 96,200 t (table 2).

Red was the largest natural finished IOP sold by processors in the United States, representing 65% of total natural material. In contrast, three categories of finished synthetic IOP sold had significant volume—black, red and other specialty oxides, and yellow.

Production data for crude IOP were developed by means of a voluntary survey. Of seven known companies, data were obtained from six, or an 86% response rate. By tonnage, the six companies represented 63% of the output. In a second voluntary survey, data were received from 16 of 17 known operations that produced finished IOP, a response rate of 94%. By tonnage, the 16 operations represented 90% 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 30,000 t of iron oxide with a value of $4.7 million. A major end use for this material was ferrites. Regenerator iron oxide data are not included in tables 1, 2, and 4.

Bayer Corp. completed a new IOP blending facility in Imperial, PA, that will make customized blends of pigments. In June 1998, Pea Ridge Iron Ore Co. added a high-temperature calciner to its facility outside Sullivan, MO. The new unit reportedly has a capacity of 30,000 metric tons per year, converts Fe_3O_4 into Fe_2O_3, and obtains red shades (Tullo, 1998).

Consumption

Coatings and construction materials are major end uses and made up 34% of natural IOP reported shipments in 1998, 76% of synthetic IOP shipments, and 57% of all IOP shipments (natural and synthetic) (table 4). These figures were similar to those for 1997.

To color concrete, powder, liquid, or granulated pigments are added. Although most concrete is colored by using pigments in powder form, granular pigments are said to be the fastest growing category for this end use. Liquid colors can be metered more accurately but cost more to manufacture and ship because of the weight of the added water that they contain. Granular pigments are very low in dust and disperse readily when added to a concrete mix (Paris and Chusid, 1998).

Micaceous iron oxide (MIO) is used by the paint industry because of its anticorrosion properties. In industrial uses, anticorrosion coatings may consist of a zinc primer, a MIO intermediate coating, and a urethane or epoxy coating to maintain a high gloss level or a MIO finish, which can give a metallic aspect (Houssa, 1998).

Prices

Yearend 1998 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, 1998). These prices were unchanged from those of 1997, except for synthetic black and yellow material, which were 2% to 3% higher.

Foreign Trade

U.S. exports of pigment-grade IOP in 1998 were 14,600 t, or 12% less than that of 1997 (table 5). The largest recipients were Mexico with 53%; Japan, 17%; and the Republic of Korea, 11%.

U.S. imports of natural IOP were 4,910 t, or 37% less than that of 1997 (tables 6 and 7). The largest supplier was Cyprus with 71%. Imports of synthetic IOP were 62,600 t, or 4% higher than that of 1997. The largest countries of origin were China with 44%; Germany, 18%; and Canada, 8%. The value of synthetic IOP imports was $61.8 million, a decrease of 15% from that of 1997. Much of the decrease resulted from smaller imports from Japan, which supplied material with a very high unit value, possibly iron oxide for magnetic tape recording.

Outlook

The output of total finished IOP sold by U.S. producers has shown an increase each year since 1991. This trend was supported in 1998 with strong construction activity and paint and coatings sales. In construction materials, iron oxides are used in such applications as red pigments for cement bricks and roofing tiles, and brown coloring for cement walls and stuccoes. According to an industry source, the Southwestern United States is leading the trend toward red and earth-tone pigments in construction, and the trend is said to be moving to the rest of the country (Tullo, 1998).

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

(Metric tons, unless otherwise noted)

		1994	1995	1996	1997	1998
Mine production		W	W	W	W	W
Crude pigments sold or used		46,400	51,700	44,700	46,900 r/	46,100
Value	thousands	$6,010	$6,720	$6,990	$7,580	$7,290
Finished pigments sold		139,000	151,000	163,000	176,000	180,000
Value	thousands	$143,000	$160,000	$183,000	$193,000	$193,000
Exports		21,300	17,500	16,000	16,600	14,600
Value	thousands	$30,700	$24,900	$23,200	$20,600	$18,200
Imports for consumption		51,400	59,300	59,600 r/	68,200 r/	67,500
Value	thousands	$61,400	$77,600	$72,800 r/	$75,400 r/	$64,200

r/ Revised. W Withheld to avoid disclosing company proprietary data.
1/ Data are rounded to three significant digits.

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

	1997		1998	
Kind	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
Natural:				
Black: Magnetite	15,400	$2,950	15,400	$2,940
Umbers:				
Burnt	2,060	2,810	2,290	3,090
Raw	W	W	W	W
Red:				
Iron oxide 2/	53,600	11,200	54,600	10,900
Sienna, burnt	W	W	W	W
Yellow:				
Ocher	W	W	W	W
Sienna, raw	W	W	W	W
Undistributed	10,500	6,700	11,200	7,570
Total	81,500	23,700	83,500	24,500
Synthetic:				
Black: Iron oxide	20,100	34,500	22,300	38,000
Brown: Iron oxide	10,000	18,900	9,780	18,000
Red: Iron oxide	W	W	W	W
Yellow: Iron oxide	25,700	44,400	25,200	43,100
Mixtures of natural and synthetic:				
Iron oxides	1,880	W	2,600	3,610
Other: Specialty oxides	W	W	W	W
Undistributed	36,900	71,100 r/	36,300	66,000
Total	94,600	169,000	96,200	169,000
Grand total	176,000	193,000	180,000	193,000

r/ Revised. W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
1/ Data are rounded to 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 1998

Producers	Plant location
Finished pigments:	
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.
Mapico, Inc.	St. Louis, MO.
New Riverside Ochre Co., Inc.	Cartersville, GA.
Pea Ridge Iron Ore Co.	Sullivan, MO.
Prince Manufacturing Co., Inc.	Quincy, IL, and Bowmanstown, PA.
Rockwood Pigments	Beltsville, MD.
Solomon Grind-Chem Services Inc.	Springfield, IL.
Swansea Minerals Inc.	Tempe, AZ.
Crude pigments:	
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.
Swansea Minerals Inc.	Tempe, AZ.
Regenerator and steel plant waste iron oxides:	
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

	All iron oxides		Natural iron oxides		Synthetic iron oxides	
End use	1997	1998	1997	1998	1997	1998
Coatings (industrial finishes and trade sales coatings: lacquers, paints, varnishes)	28	25	12	13	42	35
Construction materials (cement, mortar, preformed concrete, roofing granules)	29	32	19	21	38	41
Colorants for ceramics, glass, paper, plastics, rubber, textiles	W	10	W	W	8	W
Foundry sands	9	7	19	15	--	--
Industrial chemicals (such as catalysts)	4	6	W	W	W	W
Ferrites	W	W	W	W	W	W
Animal feed and fertilizers	W	W	W	W	W	W
Other (also includes cosmetics, magnetic ink and toner, and polishing agents)	30	20	50	51	12	24
Total	100	100	100	100	100	100

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

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

	1997				1998			
	Pigment grade		Other grade		Pigment grade		Other grade	
Country	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
Argentina	30	$44	331	$256	125	$559	58	$56
Australia	18	31	650	1,440	17	44	627	1,340
Belgium	352	511	517	608	106	771	67	82
Brazil	22	102	181	432	9	59	208	674
Canada	152	131	9,560	11,900	41	47	11,400	13,900
China	17	42	133	46	20	19	242	351
Colombia	13	90	302	202	21	33	177	210
France	23	58	307	599	46	113	238	396
Germany	306	1,180	337	1,520	395	285	202	640
Hong Kong	579	1,710	35	151	238	634	957	3,310
India	87	199	113	243	65	157	183	278
Indonesia	597	1,050	27	75	--	--	172	191
Italy	--	--	280	505	17	13	142	110
Japan	4,130	3,280	3,290	9,760	2,540	2,520	3,760	8,150
Korea, Republic of	1,260	3,300	885	3,710	1,640	4,180	2,160	5,880
Malaysia	23	63	51	62	27	69	105	125
Mexico	7,050	3,710	1,970	4,850	7,680	3,980	1,690	4,170
Netherlands	104	234	1,580	2,760	40	69	906	1,650
Russia	285	970	16	53	240	755	13	7
Singapore	52	62	390	748	12	44	91	206
South Africa	156	185	90	227	--	--	6	26
Taiwan	82	102	1,410	1,150	64	145	1,310	1,180
Thailand	74	214	115	194	53	153	66	112
Turkey	140	408	49	115	135	397	64	95
United Kingdom	721	2,370	2,370	3,660	887	2,570	2,100	3,150
Venezuela	15	16	250	99	49	92	107	310
Other	295 r/	511 r/	1,050 r/	983 r/	177	450	446	820
Total	16,600	20,600	26,300	46,400	14,600	18,200	27,500	47,400

r/ Revised.
1/ Data are rounded to 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	1997 Quantity (metric tons)	1997 Value 2/ (thousands)	1998 Quantity (metric tons)	1998 Value 2/ (thousands)	Principal sources, 1998 (metric tons)
Natural:					
Earth colors 3/	6,980 r/	$2,130 r/	4,200	$1,820	Cyprus 3,510; Germany 171; France 167; Colombia 86; Spain 80.
Micaceous	834 r/	882 r/	715	554	Netherlands 185; Australia 143; China 136; France 101; Austria 92.
Total	7,810 r/	3,010 r/	4,910	2,380	
Synthetic:					
Black	9,960	23,800	10,200	16,700	India 3,060; Germany 2,660; Japan 2,080; China 976; Mexico 773; Italy 481.
Red	25,900	20,400	26,400	19,000	China 15,100; Canada 4,070; Germany 2,850; Hong Kong 807; Spain 792; Italy 783; Sweden 600; Brazil 351; Japan 302; United Kingdom 191.
Yellow	19,200	19,500	22,800	20,400	China 11,100; Germany 4,380; United Kingdom 2,360; Brazil 1,230; Italy 1,150; Mexico 1,130; Hong Kong 1,030.
Other 4/	5,340	8,730	3,120	5,700	Germany 1,630; Canada 782; Japan 369; China 197.
Total	60,400	72,400	62,600	61,800	
Grand total	68,200 r/	75,400 r/	67,500	64,200	

r/ Revised.
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Customs value.
3/ Includes those earth colors not elsewhere specified or included.
4/ 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 1997 Quantity (metric tons)	Natural 1997 Value 2/ (thousands)	Natural 1998 Quantity (metric tons)	Natural 1998 Value 2/ (thousands)	Synthetic 1997 Quantity (metric tons)	Synthetic 1997 Value 2/ (thousands)	Synthetic 1998 Quantity (metric tons)	Synthetic 1998 Value 2/ (thousands)
Austria	202	199	92	105	--	--	--	--
Belgium	--	--	19	19	62	573	78	416
Brazil	--	--	--	--	1,290	1,260	1,590	1,540
Canada	2,600	314 r/	22	3	6,030	1,820	4,940	2,280
China	128	68	164	133	24,100	14,000	27,400	14,900
Cyprus	3,720	1,190	3,510	1,120	--	--	--	--
France	382	280	268	186	18	255	58	623
Germany	154	175	171	246	12,600	19,900	11,500	16,000
Hong Kong	--	--	--	--	389	309	1,930	1,240
Hungary	--	--	--	--	15	28	--	--
India	--	--	61	13	2,990	2,240	3,070	2,090
Italy	204	156	36	28	2,170	2,450	2,450	2,750
Japan	26	205	--	--	4,570	21,700	2,760	12,600
Mexico	7	27	--	--	1,330	1,320	2,360	2,120
Netherlands	(3/)	(3/)	185	127	61	68	18	24
Spain	176	108	80	45	1,050	557	972	473
Sweden	--	--	10	21	2	10	600	146
United Kingdom	21	25	66	102	3,690	5,340	2,550	4,250
Other	222	258 r/	229	223	130 r/	585 r/	323	326
Total	7,840 r/	3,010 r/	4,910	2,380	60,400	72,400	62,600	61,800

r/ Revised.
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Customs value.
3/ Revised to zero.

Source: Bureau of the Census.

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

(Metric tons)

Country 3/	1994	1995	1996	1997	1998 e/
Austria e/	8,000	8,000	7,500	7,500	7,000
Brazil e/	5,500	5,500	5,500	5,500	5,500
Chile	3,283	16,451	18,821	10,768 r/	11,000
Cyprus (umber)	9,000 e/	5,415	4,604	5,000 e/	5,000
France e/	1,000	1,000	1,000	1,000	1,000
Germany 4/	7,475	7,500 e/	3,754 r/	4,176 r/	4,000
India (ocher)	170,761	254,166	284,546	285,000 e/	286,000
Iran e/	2,500	2,500	2,500	2,500	2,500
Italy e/	600	600	500	500	500
Pakistan (ocher) e/	6,000	6,000	6,100	2,600 r/	3,200
Paraguay (ocher) e/	330	300	300	300	300
South Africa	2,084	5,256	643	284 r/	300
Spain: e/					
Ocher	7,000	8,000	7,000	7,000	7,000
Red iron oxide	15,000	16,000	15,000	15,000	15,000
United States	W	W	W	W	W
Zimbabwe	438	585	400 e/	-- r/	--

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

1/ Estimated data are rounded to three significant digits; may not add to totals shown.

2/ Table includes data available through June 4, 1999.

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. Because unreported output is probably substantial, this table is not summed to provide a world total.

4/ Includes Vandyke brown.