IRON OXIDE PIGMENTS

By Michael J. Potter

Iron oxide pigments (IOP) are said to be the largest-volume colored inorganic pigments used. They are nontoxic, relatively low cost, and have a wide range of applications. Natural iron oxides generally cost less than synthetic iron oxides; often, the two types are blended to make use of the advantages of each. The largest end-use areas for IOP in 1994 continued to be the construction and coatings industries. The former includes concrete, cement, mortars, paying, bricks, blocks, and roof tiles. The term coatings covers a wide range of paints, powder coatings, industrial finishes, lacquers, and varnishes. A journal article described IOP, including producing countries and companies; markets and end-uses such as construction, coatings, plastics, etc.; and micaceous iron oxides.1

Production

U.S. sales of crude IOP in 1994 were 46,400 metric tons (mt), according to the U.S. Bureau of Mines (USBM). Sales of finished natural IOP, 63,000 mt, were 13% higher than in 1993. The tonnage of finished synthetic IOP sold in 1994 was about the same as in 1993. (The quantity of 75,800 mt shown in table 2 is believed to contain a few thousand mt of low-value material which was inadvertently included.)

Sold-or-used data for crude IOP were developed by the USBM by means of a voluntary survey. Data were obtained from all six known companies, representing a 100% response rate. In a second voluntary survey, data were received by the close-out date for 12 of the 17 known operations, or 71%, which produced finished IOP. The 12 respondents reported a production of about 104,000 mt, or 75% of the finished pigments sold shown in tables 1 and 2. Estimates for the remaining five operations were derived from last year's production levels and trends.

World Review

A naturally occurring micaceous iron oxide (MIO), known as Ironor P, was being mined in Morocco and processed in northern France. Suitable processing of the crude ore produces a pigment consisting of lamellar particles which have a metallic sheen that resembles mica; thus

the term "micaceous." The British railway system has been a traditional user of MIO coatings.²

In northeastern England, a synthetic MIO pigment was being produced using scrap iron as the primary raw material. In this process, lamellar crystals of very pure iron oxide are formed. Bridges, towers, and other steel structures, large and small, in Britain and Europe have been painted with a protective system incorporating synthetic MIO.³

Outlook

Through product development, granular pigments produced by spray drying have recently been introduced to the construction industry. Compared with pigments in powder form, granular pigments are free flowing and almost dust free. This is said to make handling, storage, and metering simpler and cheaper. Liquid formulations, or slurries, also have been developed for ease of handling, along with chemical additives to improve overall pigment performance.⁴

For natural iron oxides, recent emphasis has included quality improvement, strong customer service, and technical assistance. Value-added pigments to be considered for future production and distribution may include surface coating of pigment particles for plastics and paints, calcination, pre-blended mixes, etc.⁵

IOP are partly replacing heavy metal-based pigments in certain applications as the manufacture and use of the latter have come under increasing legislative and regulatory control. IOP also can be used in aqueous systems, an advantage because of the current concern over volatile organic component (VOC) levels in paints and other coatings and the move toward water-based systems.

The Asia-Pacific region is thought to offer good potential for growth and product expansion over the next 5 to 10 years. In China, the automotive industry has been experiencing rapid expansion, and joint ventures between Western and Chinese coatings manufacturers have emerged. Vietnam, Indonesia, and Malaysia appear to have growth potential in paint and coatings consumption. South America, especially Brazil, is thought to be another promising region for automotive coatings and wood finishing products. ⁶

¹Kendall,T. Inorganic Coloured Pigments. Ind. Miner. (London), No. 317, Feb. 1994, pp.49-59.

 $^2 Duchan,\ J.C.\ Natural Micaceous Iron Oxide Yields Performance. Paint & Coatings Industry, v. 10, No. 10, p. 30.$

³Carter, E. Synthetic Micaceous Iron Oxide for Anticorrosion Coatings. American Paint & Coatings Journal, v. 78, No. 32, Jan. 31, 1994, pp. 43,46.

⁴P. 56 of work cited in footnote 1.

⁵Mauney, S.S. Natural Iron Oxide Pigments-Rebirth Through Innovation. Mining Engineering, v. 46, No. 1, Jan. 1994, p. 73.

⁶Pp. 53 and 56 of work cited in footnote 1.

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

(Metric tons, unless otherwise noted)

		1990	1991	1992	1993	1994
Mine production		32,400	34,100	37,300	36,200	W
Crude pigments sold or used		37,100	40,200	39,300	35,800	46,400
Value	thousands	\$4,620	\$4,480	\$4,670	\$5,020	\$6,010
Finished pigments sold		125,000	117,000	121,000	126,000	139,000
Value	thousands	\$139,000	\$133,000	\$136,000	\$140,000	\$143,000
Exports		9,540	20,600	21,100	22,400	21,300
Value	thousands	\$18,700	\$33,800	\$32,200	\$32,000	\$30,700
Imports for consumption		34,100	34,700	45,100	43,600	51,400
Value	thousands	\$37,300	\$39,400	\$49,900	\$57,300	\$61,400

W Withheld to avoid disclosing company proprietary data.

 ${\it TABLE~2} \\ {\it FINISHED~IRON~OXIDE~PIGMENTS~SOLD~BY~PROCESSORS~IN~THE~UNITED~STATES,~BY~KIND~1/2} \\ {\it TABLE~2} \\ {\it FINISHED~IRON~OXIDE~PIGMENTS~SOLD~BY~PROCESSORS~IN~THE~UNITED~STATES,~BY~KIND~1/2} \\ {\it TABLE~2} \\ {\it TAB$

Kind	1993		1994		
	Quantity	Value	Quantity	Value	
	(metric tons)	(thousands)	(metric tons)	(thousands)	
Natural					
Black: Magnetite	W	W	W	W	
Brown: Iron oxide	W	W	W	\mathbf{W}	
Umbers:					
Burnt	W	W	W	W	
Raw	W	W	W	W	
Red:					
Iron oxide 2/	28,300	\$5,400	30,300	\$5,840	
Sienna, burnt	W	W	W	W	
Yellow:					
Ocher	W	W	W	W	
Sienna, raw	W	W	W	W	
Undistributed	27,500 r/	11,700 r/	32,600	13,200	
Total	55,800 r/	17,100 r/	63,000	19,100	
Synthetic					
Black: Iron oxide	17,500	27,800	16,600	26,800	
Brown: Iron oxide 3/	6,960	13,200	6,670	12,900	
Red: Iron oxide	W	W	W	W	
Yellow: Iron oxide	W	W	W	W	
Mixtures of natural and synthetic:					
Iron oxides	(4/)	(4/)	(4/)	(4/)	
Other: Specialty oxides	(4/)	(4/)	(4/)	(4/)	
Undistributed	45,400	81,800	52,500	84,200	
Total	69,800	123,000	75,800	124,000	
Grand total	126,000	140,000	139,000	143,000	

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

^{1/} Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits.

^{1/} Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits; may not add to totals shown.

^{2/} Includes pyrite cinder.

^{3/} Includes "Other: Specialty oxides," and "Mixtures of natural and synthetic: Iron oxides."

^{4/} Included with "Synthetic: Brown Iron oxide" to avoid disclosing company proprietary data.

TABLE 3 PRODUCERS OF IRON OXIDE PIGMENTS, REGENERATOR IRON OXIDES, AND STEEL-PLANT WASTE IRON OXIDES IN THE UNITED STATES IN 1994

Blue Ridge Talc Co., Inc. Columbian Chemicals Co.	Camden, NJ Henry, VA St. Louis, MO Milwaukee, WI
Blue Ridge Talc Co., Inc. Columbian Chemicals Co. DCS Color & Supply Co., Inc.	Henry, VA St. Louis, MO Milwaukee, WI
Columbian Chemicals Co. DCS Color & Supply Co., Inc.	St. Louis, MO Milwaukee, WI
DCS Color & Supply Co., Inc.	Milwaukee, WI
	·
Harcros Pigments Inc.	E THE CAPE (CLI THE COM
	Emeryville, CA; East St. Louis, IL; Easton, PA
Hilton-Davis Co.	Newark, NJ
Hoover Color Corp.	Hiwassee, VA
Miles Inc., Industrial Chemicals Div.	New Martinsville, WV
Mineral Pigments Corp.	Beltsville, MD
New Riverside Ochre Co., Inc.	Cartersville, GA
Pea Ridge Iron Ore Co.	Sullivan, MO
Prince Manufacturing Co.	Quincy, IL and Bowmanstown, PA
Solomon Grind-Chem Services Inc.	Springfield, IL
Swansea Minerals Inc.	Tempe, AZ
Crude pigments:	
Cleveland-Cliffs Iron Co., Mather Mine and	Negaunee, MI
Pioneer plant (closed July 31, 1979; shipping from stockpile.)	
Hoover Color Corp.	Hiwassee, VA
New Riverside Ochre Co., Inc.	Cartersville, GA
Pea Ridge Iron Ore Co.	Sullivan, MO
Swansea Minerals Inc.	Tempe, AZ
Virginia Earth Pigments Co.	Hillsville, VA
Regenerator and steel plant waste iron oxides:	
Armco Inc.	Ashland, KY
Shance Chemical Corp.	Philadelphia, 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 oxi	das	Natural iron oxides		Syntheti- iron oxid	
Elid use	1993	1994	1993	1994	1993	1994
Coatings (industrial finishes, trade sales:	1775	1// 1	1775	1///	1775	1///
lacquers, paints, varnishes)	19	19	15	14	22	23
Construction materials (cement, mortar, preformed						
concrete, roofing granules)	34	32	W	W	W	W
Colorants for ceramics, glass, paper, plastics, rubber,						
textiles	13	12	12	12	14	12
Foundry sands	8	8	17	17		
Industrial chemicals (such as catalysts)	6	5	2	W	10	W
Ferrites	W	W	W	W	W	W
Animal feed and fertilizers	W	\mathbf{W}	W	W	W	2
Other (also including cosmetics, magnetic ink and toner,						
and polishing agents)	20 1/	24 1/	54 2/	57 3/	54 2/	63 4/
Total	100	100	100	100	100	100

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

^{1/} Includes ferrites and animal feed and fertilizers iron oxide usage.

^{2/} Includes construction materials, ferrites, and animal feed and fertilizers iron oxide usage.

^{3/} Includes construction materials, industrial chemicals, ferrites, and animal feed and fertilizers iron oxide usage.

^{4/} Includes construction materials, industrial chemicals, and ferrites iron oxide usage.

 ${\bf TABLE~5} \\ {\bf U.S.~EXPORTS~OF~IRON~OXIDES~AND~HYDROXIDES,~BY~COUNTRY~1/}$

		19	93		1994				
	Pigmen	t grade	Other	grade	Pigment grade		Other grade		
Country	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	
	(metric tons)	(thousands)							
Argentina	3	\$11	121	\$377	3	\$10	513	\$284	
Australia	2,090	2,830	1,450	2,400	1,570	1,940	1,290	2,250	
Austria			929	2,010			39,200	3,430	
Belgium	4	33	304	684	13	73	1,330	2,680	
Brazil	49	345	1,100	2,290	147	868	1,060	1,730	
Canada	174	149	87,700	19,400	213	247	104,000	24,000	
Ecuador	31	13	2,140	172			1,330	208	
Germany	1,870	1,310	2,320	4,590	543	820	1,330	4,040	
Hong Kong	1,100	2,520	611	559	1,240	3,060	881	448	
Indonesia	1,220	1,940	195	327	1,080	1,730	80	118	
Italy	45	81	1,550	1,110	19	23	638	431	
Japan	3,330	4,410	8,820	16,200	4,380	4,440	5,660	18,900	
Korea, Republic of	2,690	7,090	2,910	10,900	3,130	8,610	1,290	4,660	
Malaysia	608	749	165	316	1,000	721	215	238	
Mexico	3,150	755	12,900	6,410	3,640	1,060	8,790	6,830	
Netherlands	272	676	1,000	1,570	324	677	17,400	2,610	
Singapore	96	227	1,980	4,730	129	21	2,490	3,320	
South Africa, Republic of	1,050	1,510	81	123	915	1,270	214	384	
Spain			84	222			24,900	451	
Taiwan	677	704	1,580	2,970	231	265	2,190	1,910	
Thailand	1,110	1,680	430	700	943	1,350	279	642	
Trinidad and Tobago			839	51	20	4	733	77	
United Kingdom	924	1,940	2,980	4,850	890	1,740	6,720	6,580	
Venezuela	107	75	1,220	1,740	14	21	2,000	1,160	
Other	1,790 1	/ 2,990 r/	6,100 r	/ 7,870 r/	862	1,740	3,900	7,400	
Total	22,400	32,000	139,000	92,500	21,300	30,700	229,000	94,800	

r/ Revised.

Source: Bureau of the Census.

 ${\bf TABLE~6}$ U.S. IMPORTS FOR CONSUMPTION OF SELECTED IRON OXIDE PIGMENTS, BY TYPE 1/

	1	1993		94	
Type	Quantity	Value	Quantity	Value	Sources, 1994
	(metric tons)	(thousands)	(metric tons)	(thousands)	(metric tons)
Natural:	_				
Earth colors 2/	300	184	185	185	France 159; United Kingdom 18; Germany 8; Russia 1;
					Japan (3/).
Micaceous	100	208	2,660	796	France 2,150; Canada 360; Austria 77; Netherlands 20; Germany 19;
					Australia 17; Spain 16; Japan 1; United Kingdom 1.
Umber	4,380	931	3,500	1,080	Cyprus 3,430; Germany 49; United Kingdom 20;
					Poland (3/); Russia (3/).
Vandyke brown	58	52	76	73	Germany 76.
Total	4,840	1,380	6,420	2,140	
Synthetic:	_				
Black	6,750	25,100	9,190	26,100	Japan 4,700; Germany 1,330; Sweden 1,070; China 1,040;
					India 399; Italy 233; Mexico 91; Canada 82; Hong Kong 63;
					United Kingdom 59; Austria 19; Brazil 15; Netherlands 14;
					Australia 1, Ireland 1.
Red	16,900	11,900	16,400	10,900	China 7,430; Canada 4,700; Germany 1,540; Spain 590;
					Japan 439; Mexico 399; United Kingdom 351; Hong Kong 311;
					Brazil 260; Italy 135; Sweden 120; Belgium 50; Netherlands 22;
					Colombia 7; Australia 1; Ireland 1; Switzerland (3/).
Yellow	11,900	12,500	15,800	16,200	Germany 6,020; China 4,800; United Kingdom 2,760;
		,	,,,,,,,	, , , ,	Italy 638; Brazil 595; Mexico 396; Spain 280; Belgium 107;
					France 57; India 42; Hungary 34; Hong Kong 33; Japan 4;
					Switzerland 2; Niger 1.
Other 4/	3,250	6,500	3,690	6.010	Germany 1,670; Canada 1,180; Japan 482; China 193;
	_ ′	*	,	· ·	United Kingdom 66; Italy 46; Netherlands 19; Belgium 18;
					Mexico 9; Australia 4.
Total	38,800	55,900	45,000	59,300	
Grand total	43,600	57,300	51,400	61,400	

^{1/} Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits; may not add to totals shown.

^{1/} Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits; may not add to totals shown.

^{2/} Includes those earth colors not elsewhere specified or included.

^{3/} Less than 1/2 unit.

^{4/} Includes synthetic brown oxides, transparent oxides, and magnetic and precursor oxides.

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

		Natui	al		Synthetic			
	1993	1993			199	1993		
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Country	(metric	(thou-	(metric	(thou-	(metric	(thou-	(metric	(thou-
	tons)	sands)	tons)	sands)	tons)	sands)	tons)	sands)
Australia	(2/)	\$5	17	\$25	19	\$17	6	\$11
Austria	8	10	77	63	76	71	19	18
Belgium					63	97	175	560
Brazil					878	829	870	831
Canada	16	2	360	29	5,030	1,450	5,970	1,280
China					10,800	6,390	13,500	7,840
Cyprus	4,210	791	3,430	996				
France	255	199	2,310	685	190	349	57	123
Germany	163	223	152	197	11,700	18,200	10,600	16,300
Hong Kong					536	376	407	290
Hungary	1	6			196	310	34	52
India					47	13	441	212
Italy	1	5			588	686	1,050	1,130
Japan	2	45	1	9	4,330	23,700	5,690	26,000
Mexico	103	13			959	959	895	820
Netherlands	7	10	20	8	346	499	55	75
Russia			1	32				
Spain			16	8	425	193	871	594
Sweden					840	199	1,190	335
United Kingdom	77	60	39	60	1,700	1,550	3,240	2,720
Other	(2/)	7	(2/)	26	53	37	12	97
Total	4,840	1,380	6,420	2,140	38,800	55,900	45,000	59,300

^{1/} Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits; may not add to totals shown.

Source: Bureau of the Census.

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

(Metric tons)

Country 3/	1990	1991	1992	1993	1994 e/
Argentina (ocher)	36 r/	77 r/	40 r/	28 r/	35
Austria	9,940	10,200	9,480	8,400 r/	8,000
Bosnia and Herzegovina e/	XX	XX	200		
Brazil e/	5,500	5,500	5,500	5,500	5,500
Chile	15,600	6,760	22,900	7,110 r/	8,000
Cyprus (umber)	7,700	5,800	5,000	6,000 r/	9,000 4/
France e/	15,000	14,000	12,000	1,000 r/	1,000
Germany 5/	6,220 r/	7,040	10,100	7,710 r/	8,000
India (ocher)	126,000	156,000	160,000 e/	175,000 e/	175,000
Iran	3,720	3,750	2,310	2,500 e/	2,500
Italy e/	850	800	700	700	600
Pakistan (ocher)	1,380	1,890	5,130	6,200 r/	6,000
Paraguay (ocher) e/	330	330	330	330	330
South Africa, Republic of	2,910	1,120	1,110	1,190 r/	1,200
Spain: e/					
Ocher	8,990 4/	8,600	8,200	8,000	7,000
Red iron oxide	20,000	20,000	18,000	16,000	15,000
United States	32,400	34,100	37,300	36,200 r/	W
Yugoslavia 6/	1,210	800	XX	XX	XX
Zimbabwe	416	400 e/	538	550 e/	550

e/ Estimated. r/ Revised. W Withheld to avoid disclosing company proprietary data. XX Not applicable.

^{2/} Less than 1/2 unit.

^{1/} Previously published and 1994 data are rounded by U.S. Bureau of Mines to three significant digits.

^{2/} Table includes data available through June 9, 1995.

^{3/} In addition to the countries listed, a considerable 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/} Reported figure.

^{5/} Includes Vandyke brown.

^{6/} Dissolved in Apr. 1992. All production in Yugoslavia from 1990-91 came from Bosnia and Herzegovina.