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IRON OXIDE PIGMENTS

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Iron Oxide Pigments

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In 2011, natural iron oxide pigment (IOP) production in the United States increased slightly compared with that of 2010. U.S. production data are withheld to avoid disclosing company proprietary data. Finished natural and synthetic IOPs sold by processors decreased to about 48,000 metric tons (t) valued at $73.9 million in 2011 from 54,700 t valued at $80.7 million in 2010 (table 1). Exports of all grades of IOPs and hydroxides increased to 62,000 t valued at about $51.7 million in 2011 compared with 53,400 t valued at $50.1 million in 2010 (table 3), and significantly higher than from the 17,000 t valued at $34 million of 2009. Imports of natural and synthetic IOPs increased to 158,000 t valued at $188 million in 2011 compared with 151,000 t valued at $167 million in 2010 (tables 4, 5).

Production

Natural IOPs are probably the most important of the natural minerals suitable for use as pigments after milling because they are low cost, color stable, and nontoxic. They are derived from hematite, which is a red iron oxide mineral; limonite, a mineral that varies from yellow to brown, such as ochers, siennas, and umbers; and magnetite, a black iron oxide mineral. Synthetic IOPs are widely used as colorants and compete with natural IOPs in many color applications. They are manufactured using three methods: thermal decomposition of iron salts or iron compounds; precipitation of iron salts, usually accompanied by oxidation; and reduction of organic compounds by iron. Organic colorants are used for some colorant applications but several organic compounds fade over time from exposure to sunlight.

U.S. production data for crude (natural) IOPs sold or used in 2011 were developed from a U.S. Geological Survey (USGS) voluntary survey of three companies, of which two responded. These data collected through the USGS survey are withheld to avoid disclosing company proprietary data. With marginal increase in production in 2011, sales remained less than 50,000 t.

In a second voluntary USGS survey, production data for finished (natural and synthetic) IOPs received from six of eight known processing operations, represented about 90% of the tonnage shown in table 1. Data for the nonrespondents were estimated based upon prior-year output levels and industry trends. Based upon this survey, sales of finished pigments were 48,000 t in 2011, down from 54,700 t in 2010. Production data for finished IOPs are collected only from operations that process material, such as the crushing and grinding of natural IOPs, or that synthesize IOPs, not operations that simply blend, mix, repackage, and (or) resell IOP material.

At least four U.S. companies, operating nine plants, produced regenerated iron oxide during steelmaking (table 2). Iron oxide is obtained during steelmaking when steel is treated with hydrochloric acid to remove surface oxides. Iron oxide is formed when the spent pickle liquor is treated to recycle the acid. Regenerated iron oxide data were not included in table 1 because it must be processed before it is suitable for use in typical IOP applications.

In 2011, Alabama Pigments Co. (APC) began the largest mining campaign in the company's 17-year history on its 80-hectare site in McCalla, AL. APC's natural IOP production includes red IOPs (hematite), which was the company's primary product, black IOPs (magnetite), and smaller quantities of yellow IOPs. APC mined, processed, blended, and distributed natural red IOPs, typically for use in brick, colored mortar, and tile. The company also manufactured synthetic IOPs (Alabama Pigments Co., 2011 a, b).

Consumption

End-use data for IOPs are not surveyed by the USGS or other organizations. Will (2008, p. 12) estimated that world consumption of natural IOPs and synthetic IOPs in 2006 was 167,000 t and 1.13 million metric tons (Mt), respectively. About 90% of natural IOPs was used in construction materials and coatings and nearly 75% of synthetic IOPs was used in the same. More recent data are unavailable, but the global economic downturn of 2008–09 likely resulted in decreased consumption of IOPs in those years as may be inferred by the decrease in reported world production of natural IOPs in 2009. In 2011, global consumption of natural IOPs likely increased slightly as compared with that of the year before based on reported and estimated increases in world production.

Construction materials included concrete products such as block, brick, or segmental retaining wall units; mortar; paving stones; precast products of various sizes or dimensions; ready-mixed concrete; and roofing tiles. IOPs are used almost exclusively to color decorative concrete. The tinted concrete is often stamped so that it resembles brick, slate, stone, and many more shapes and forms found in nature, including wood (Pinto, 2008, p. 4, 6).

Sales of IOPs in these construction markets decreased because of the lingering negative effects from the sharp decline in domestic and foreign construction activity since 2008. In the United States, construction starts for new privately owned housing increased by about 4% to 609,000 units in 2011 from 587,000 units in 2010, higher than the 554,000 units in 2009, but remaining significantly lower than the 906,000 units started in 2008. Completions of privately owned housing decreased by about 10% to 585,000 units in 2011, down from 652,000 units in 2010, 794,000 units in 2009, and 1.12 million units in 2008 (U.S. Census Bureau, 2012b). The value of all (private and public) residential and commercial construction, both of which use tinted brick and concrete products, continued to trend downward, decreasing to $778 billion in 2011 from $805 billion

in 2010. Total construction spending peaked at $1.17 trillion in 2006 (U.S. Census Bureau, 2012a).

The second largest market for IOPs is as a tint in paints and coatings. The paint and coatings market experienced a decrease in estimated shipments in 2011 owing to decreased construction and manufacturing activity, partly offset by increased automobile production. Shipments of total paint and allied products (comprising architectural coatings, original equipment manufacture product coatings, special-purpose coatings, and miscellaneous allied paint products) were estimated at 4.26 billion liters (1.13 billion gallons) in 2011, unchanged from that of 2010 (U.S. Census Bureau, 2011). Other end uses of IOPs included colorants for ceramics, glass, paper, plastics, rubber, and textiles; in foundry sands; industrial chemicals, such as catalysts; animal feed; cosmetics; ferrites; fertilizers; and magnetic ink and toner.

A major end use for regenerator iron oxides was ferrite ceramic magnets. Two types of ferrites are used—hard, which retain magnetism permanently, and soft, which do not. Hard ferrites are used in flexible magnets, generators, loudspeakers, and motors. Uses of soft ferrites include computers, cores for radio frequency coils, microwave communication systems, microwave ferrites for telecommunications, and other industrial applications.

Rockwood Holdings Inc. announced that its Color Pigments and Services Division would build a new synthetic IOP production plant at its site in Augusta, GA. Rockwood planned to invest $115 million in the advanced technology facility, to be completed during the first half of 2013, which would be the first new IOP production plant built in the United States in nearly 35 years. The company expected to close its existing plant in St. Louis, MO, and part of its Beltsville, MD, facility (Rockwood Holdings, Inc., 2011).

Prices

The annual average producer price index (PPI) for IOPs under North American Industry Classification System code 325131–72 (U.S. Bureau of Labor Series ID WPU06220206) was 211.6 in 2011 (1983=100) compared with 202.1 in 2010. The PPI ranged between 205.7 and 220.4 in 2011, the high being reached in September and the low in February. The PPI measured the average change in the selling prices charged by domestic producers of IOPs over time (U.S. Bureau of Labor Statistics, 2012). Unit values for finished natural and synthetic IOP sold by domestic producers ranged from $0.33 to $3.73 per kilogram, with an average unit value of $1.54 per kilogram.

Rockwood Pigments announced global price increases that became effective in mid-February, of up to 10% for selected products in its full range of pigments including natural and synthetic IOPs. Rockwood Pigments, which similarly increased prices in 2010 following 2 years of stable pricing, cited increased raw material costs, energy prices, and transportation charges as reasons for the increases (Rockwood Pigments, NA, Inc., 2011).

Foreign Trade

In 2011, U.S. exports of IOPs rose. Exports of all grades combined increased with the largest increases being to Canada, Mexico, and Spain. Even with a marginal decrease in 2011 from that of 2010, exports to China continued to be 50% more than to any other single country (table 3).

U.S. exports of pigment-grade IOPs and hydroxides decreased slightly to 8,650 t valued at $14.9 million in 2011; the average unit value decreased by about 4% compared with that of 2010. Mexico was the leading destination of pigment-grade IOPs, accounting for 41% of U.S. exports, and China was second with 27% (tables 1, 3).

Exports of other grades of IOPs and hydroxides rose by nearly 20% to 53,400 t valued at $36.7 million. Spain and Canada, in descending order, accounted for the largest increases in exports of other grades of IOPs. China, Canada, and Spain, in descending order, were the major destinations for export of other grades of IOPs and hydroxides, accounting for 43%, 24%, and 23% of the export tonnage, respectively (tables 1, 3).

U.S. imports of all IOPs and hydroxides rose nearly 5% in 2011 from that of 2010 and were nearly 50% higher than that of 2009 (tables 1, 4). Imports of natural IOP grades decreased slightly. The leading source was Cyprus, with 60% of the tonnage, followed by France with nearly 13%. Imports of synthetic IOP grades increased by about 5%. The leading sources of synthetic IOP imports were China with 50% of the tonnage; Germany, 26%; Canada, 8%; and Brazil, 7% (table 5).

World Review

Natural IOPs were produced in at least 16 countries in 2011 (table 6). Several countries not listed in table 6, including Azerbaijan, China, Honduras, Kazakhstan, Russia, and Ukraine, were thought to produce iron oxide pigments, but output, which may have been substantial, was not reported, and no basis was available for estimating output levels.

In the European Union, construction increased slightly in 2011, following a slight decline in spending in the construction industries in 2010. Consumption of construction-focused pigments in 2011 was more than that of 2010 and 2009. Consumption of pigment minerals increased in emerging markets, such as Africa, Brazil, China, and India, but are still smaller markets than Europe and the United States (Roberts, 2011).

In a study of the European coatings industry, Information Research Ltd. identified factors that continued to influence the market for pigments in the coatings industry. These included the elimination of heavy metals and heavy-metal salts as pigments and an increase in competitively priced high-performance pigments from the Far East. IOPs and other inorganic pigments, although losing some appeal owing to barium, cadmium, or chromium content, continued to be preferred where heat, light, and chemical resistance properties were required. Growth in most sectors of the paint pigments market was between 2% and 4%. Innovation in the pigment industry in Europe is being driven by increasingly restrictive legislation, changing formulation practices, and increased use in functional applications (Paint & Coatings Industry, 2010).

China.—China likely increased its IOP production beginning in about 2006, as partly evidenced by a steady and substantial decrease in IOP imports from the United States through 2009, in spite of the country's ongoing urbanization. A rising demand for IOPs in China mainly was driven by continued rising levels of construction activity and economic recovery from the global recession. In 2010, China significantly increased IOP imports from the United States followed by a slight decrease in 2011, although these levels still were only about two-thirds those seen from 2005–07 (U.S. International Trade Commission, undated) (table 3).

The Synergy Co. (parent company of Synergy Pigments Shanghai Ltd.) estimated that China annually supplies as much as 50% of world consumption of IOPs, influencing global prices. From the latter months of 2010 to May 2011, Synergy estimated that the prices for IOPs in China and the rest of the world rose by an average of about 18%. The causes for the volatile price movement, beyond that of raw material and labor costs, were that IOP supplies were not keeping up with demand, in particular for red IOPs; significant increases in domestic consumption caused by the surging Asian economy; and tightening Ministry of Environmental Protection controls greatly restricting new or expanded IOP plant construction, again especially for red IOP plants (Chen, 2011).

India.—DCW Ltd., an Indian conglomerate with primary business interests in chemicals, reported significant progress in the construction of its 32,000-metric-ton-per-year synthetic iron oxide plant in Sahupuram, Tamilnadu. The plant will use DCW's patented yellow IOP technology in conjunction with red IOP technology licensed from Rockwood Italia S.p.A.; commercial production for use in the coating and construction industry is expected to begin by the end of 2013 (DCW Ltd., 2011).

Spain.—Promindsa sales were 15,500 t of iron oxide in each of 2010 and 2011; the company anticipated sales of about the same through 2013. Previous higher expectations were diminished by continued international monetary difficulties. Promindsa's Santa Rosa Mine, an underground mine outside Zaragoza, accounted for about 80% of the company's IOP output and sales. Santa Rosa consists of a seam of hematite with an average purity of 85% to 90% iron (III) oxide at depths of up to 250 meters. Promindsa sold its Santa Rosa iron oxide as a red pigment for use in paints, roof tile, brick, and asphalt and recently entered new markets in glass and ceramics. Promindsa also mined black (magnetite), brown (oolitic iron ore), and yellow (goethite) IOPs in Spain (Fernando Prada, President, Promindsa SA, written commun., August 6, 2012).

Outlook

IOP production was estimated to have increased slightly worldwide in 2011 from that of 2010, based on continued moderate growth in construction activity in Asia and the continued slow recovery in the United States and European economies. The global economic recession caused decreased construction activity and lower demand for IOPs for coloring concrete and paint, the two major markets for IOPs.

Rockwood Holdings Inc. (parent company to Rockwood Pigments NA, Inc.) reported that a general slowdown in the domestic construction market negatively affected construction sales in 2011, and thus, the demand for IOPs used in colored concrete products declined. European construction spending increased slightly in 2011 after holding steady in 2009–10. Construction in North America remained sluggish in 2011, after decreasing in 2010 from that in 2009. Rockwood expected an upward trend in IOP construction sales in 2012 across all regions based on projections of increases in construction that the company expected. Demand for coatings and specialties products also was expected to increase in 2012 (Rockwood Holdings, Inc., 2012, p. 54).

The International Monetary Fund expected the global economy to increase about 3.5% in 2012 and 3.9% in 2013, with advanced economies continuing to increase more than emerging and developing economies (International Monetary Fund, 2012). Continued improvement in the global economy may result in increased activity in IOP markets in 2012–13, especially where the construction industry continues to recover.

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TABLE 1
SALIENT U.S. IRON OXIDE PIGMENTS STATISTICS[1]

		2007	2008	2009	2010	2011
Crude pigments sold or used:[2]						
Quantity	metric tons	W	W	W	W	W
Value	thousands	W	W	W	W	W
Finished pigments sold:[3]						
Quantity	metric tons	88,100	83,300	50,800	54,700	48,000
Value	thousands	$122,000	$116,000	$74,000	$80,700	$73,900
Exports:[4]						
Quantity	metric tons	5,410	4,740	5,640	8,750	8,650
Value	thousands	$15,900	$12,100	$15,500	$15,700	$14,900
Imports for consumption:[3]						
Quantity	metric tons	178,000	155,000	106,000	151,000	158,000
Value	thousands	$154,000	$164,000	$127,000	$167,000	$188,000

W Withheld to avoid disclosing company proprietary data.
[1]Data are rounded to no more than three significant digits.
[2]Mined.
[3]Natural (mined) and synthetic.
[4]Pigment grade.

TABLE 2
PRODUCERS OF IRON OXIDE PIGMENTS AND REGENERATED IRON OXIDES
IN THE UNITED STATES IN 2011

Producers	Plant location
Crude pigments:	
Alabama Pigments Co., LLC	Green Pond, AL.
Hoover Color Corp.	Hiwassee, VA.
New Riverside Ochre Co., Inc.	Cartersville, GA.
Finished pigments:	
Alabama Pigments Co., LLC	Green Pond, AL.
Dynamic Color Solutions, Inc.	Milwaukee, WI.
Hoover Color Corp.	Hiwassee, VA.
New Riverside Ochre Co., Inc.	Cartersville, GA.
Prince Minerals, Inc.	Quincy, IL; and Bowmanstown, PA.
Rockwood Pigments NA, Inc.	Beltsville, MD; Cartersville, GA; King of Prussia, PA; Los Angeles, CA; and St. Louis, MO.
Regenerator iron oxides:	
American Iron Oxide Co.[1]	Allenport, PA; Portage, IN; and Rockport, IN.
ArcelorMittal Weirton Inc.	Weirton, WV.
Bailey-PVS Oxides, L.L.C.	Decatur, AL; Fairfield, AL; and Delta, OH.
International Steel Services, Inc.	Burns Harbor, IN; and Warren, OH.

[1]Division of International Steel Services, Inc.

TABLE 3
U.S. EXPORTS OF IRON OXIDES AND HYDROXIDES, BY COUNTRY[1]

	Pigment grade				Other grade			
	2010		2011		2010		2011	
Country	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
Australia	443	$1,220	74	$220	70	$74	82	$179
Belgium	862	3,630	1,240	4,410	19	109	117	503
Brazil	172	883	182	898	274	595	252	749
Canada	61	114	39	69	9,390	15,400	12,600	13,900
China	3,250	2,730	2,350	2,460	22,600	5,520	23,200	7,260
Colombia	86	371	121	506	565	347	81	203
France	44	144	31	118	35	572	115	654
Germany	47	69	48	68	59	625	45	291
Hong Kong	389	1,050	225	809	936	867	760	777
India	71	277	86	341	19	76	27	109
Israel	81	183	4	10	2	26	122	55
Italy	43	165	9	59	783	613	102	100
Japan	56	109	11	31	64	92	14	16
Korea, Republic of	--	--	17	51	63	513	58	638
Mexico	1,970	1,440	3,560	2,450	2,500	1,540	1,970	1,550
Singapore	2	9	6	29	183	737	99	509
Spain	65	143	45	106	5,540	1,270	12,200	3,060
Taiwan	161	716	62	169	202	2,060	211	2,420
Thailand	8	44	28	111	35	26	21	16
United Kingdom	159	681	105	369	627	1,540	718	1,810
Venezuela	4	34	113	254	3	14	176	353
Other	776 r	1,670 r	289	1,410	692 r	1,820 r	466	1,530
Total	8,750	15,700	8,650	14,900	44,700	34,400	53,400	36,700

rRevised. -- Zero.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.

Source: U.S. Census Burea; data adjusted by the U.S. Geological Survey.

TABLE 4

U.S. IMPORTS FOR CONSUMPTION OF SELECTED IRON OXIDE AND HYDROXIDE PIGMENTS, BY TYPE[1]

Type	2010 Quantity (metric tons)	2010 Value[2] (thousands)	2011 Quantity (metric tons)	2011 Value[2] (thousands)	Principal sources, 2011 (metric tons)
Natural:					
Earth colors[3]	2,330	$1,160	2,280	$1,190	Cyprus, 1,980; Italy, 203; Spain, 94.
Micaceous	1,030	1,230	1,020	1,130	France, 413; Germany, 259; Spain, 174; Austria, 117.
Total	3,360	2,390	3,310	2,310	
Synthetic:					
Black	34,200	38,900	44,200	47,500	Germany, 14,300; Canada, 11,900; China, 10,800.
Red	62,900	63,500	58,600	69,900	China, 39,100; Germany, 16,100.
Yellow	49,100	58,700	49,800	64,800	China, 26,900; Brazil, 10,700; Germany, 9,250.
Other[4]	1,520	3,130	1,810	3,320	China, 1,110; Brazil, 262; Italy, 134.
Total	148,000	164,000	154,000	186,000	
Grand total	151,000	167,000	158,000	188,000	

[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]Includes synthetic brown oxides, transparent oxides, and magnetic and precursor oxides.

Source: U.S. Census Bureau.

TABLE 5

U.S. IMPORTS FOR CONSUMPTION OF IRON OXIDE AND IRON HYDROXIDE PIGMENTS, BY COUNTRY[1]

	Natural				Synthetic			
	2010		2011		2010		2011	
Country	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	137	$197	117	$217	6	$61	13	$33
Belgium	--	--	--	--	14	85	10	22
Brazil	--	--	--	--	10,100	11,900	11,000	14,700
Canada	(3)	9	--		7,830	3,560	12,600	3,730
China	158	166	39	25	78,300	73,800	77,800	87,400
Colombia	--	--	--	--	2,020	2,460	1,750	2,700
Cyprus	2,180	1,030	1,980	935	--	--	--	--
France	414	326	417	379	166	998	190	1,100
Germany	208	268	259	324	37,300	44,300	39,700	48,900
Italy	35	163	203	113	6,420	12,200	6,250	12,300
Japan	1	11	1	58	3,620	12,700	3,500	13,300
Spain	219	164	268	236	308	193	274	190
Sweden	--	--	--	--	285	47	285	44
Other	5	53	19	24	1,400	1,900	1,040	1,130
Total	3,360	2,390	3,310	2,310	148,000	164,000	154,000	186,000

-- Zero.

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

[2]Customs value.

[3]Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 6
NATURAL IRON OXIDE PIGMENTS: ESTIMATED WORLD PRODUCTION, BY COUNTRY[1, 2]

(Metric tons)

Country[3]	2007	2008	2009	2010	2011
Austria	3,510 [r, 4]	3,420 [r, 4]	2,840 [r, 4]	3,420 [r, 4]	3,400
Brazil	2,000	2,000	2,000	2,000	2,000
Cyprus, umber	12,000	12,000	12,000	12,000	12,000
France	2,800	2,800	2,800	2,800	2,800
Germany[5, 6]	240,310 [4]	251,412 [4]	209,172 [4]	233,909 [4]	220,000
India, ocher	375,000	380,000	385,000	390,000	395,000
Iran	2,600	2,600	2,600	2,600	2,600
Italy	500	500	500	500	500
Lithuania	4	4	4	4	4
Pakistan, ocher	6,000	6,000	6,200	6,000	6,100
Paraguay, ocher	250	250	250	250	250
South Africa	232 [4]	39 [4]	183 [4]	244	25
Spain, ocher	140,000	140,000	140,000	140,000	140,000
Turkey[7]	260,000	220,000	100,000	100,000	100,000
United Kingdom, iron oxides and hydroxides[8]	8,000	8,000	8,000	8,000	8,000
United States	W	W	W	W	W

[r]Revised. W Withheld to avoid disclosing company proprietary data.
[1]Estimated data are rounded to no more than three significant digits.
[2]Table includes data available through April 3, 2012.
[3]In addition to the countries listed, a number of others 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, Honduras, Kazakhstan, Russia, and Ukraine. Unreported output is probably substantial.
[4]Reported figure.
[5]Accurate information concerning exactly how much of this production translates into iron oxide pigments is not available.
[6]Production includes natural and synthetic iron oxide pigments.
[7]Production includes micaceous iron oxide pigment and earth paints.
[8]Includes iron oxide pigments.