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2014 Minerals Yearbook

IRON OXIDE PIGMENTS [ADVANCE RELEASE]

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Iron Oxide Pigments

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In 2014, natural crude iron oxide pigment (IOP) production in the United States was virtually unchanged compared with that of 2013, but actual U.S. production data are withheld to avoid disclosing company proprietary data. Finished natural and synthetic IOPs sold by processors decreased by 4% to 45,300 metric tons (t) valued at $71.5 million in 2014 from 47,200 t valued at $75.4 million in 2013 (table 1). Exports of pigment-grade iron oxides increased by nearly 8% to 8,790 t valued at $16 million in 2014 compared with 8,170 t valued at $13.4 million in 2013. Exports of other grades of iron oxides and hydroxides increased by about 4% to 60,600 t valued at a value of $32.4 million in 2014 compared with 58,500 t valued at $34.9 million in 2013 (table 3). Imports of natural and synthetic IOPs combined increased by nearly 6% to 175,000 t valued at $208 million in 2014 compared with 165,000 t valued at $190 million in 2013 (tables 1, 4, 5).

Natural IOPs are inorganic compounds that are suitable for use as pigments after milling and minimal processing. They commonly are the preferred choice of the natural minerals for pigmentation because they are low cost, inherently color stable, and nontoxic. Typically, they are derived from hematite (Fe_2O_3), which is a red iron oxide mineral; goethite or limonite (Fe-OH), minerals that vary from yellow to brown, which include ochers and siennas (yellow) and umbers (brown); and magnetite (Fe_3O_4), a black iron oxide mineral. A wider variety of colors can be produced from natural IOPs by blending various IOPs or by calcination of hydrated natural IOPs.

Synthetic IOPs are widely used as colorants and compete with natural IOPs in many color applications, in part because colors can be more precisely duplicated and a substantially wider variety of colors can be produced. They are manufactured using the following three methods: precipitation of iron salts, usually accompanied by oxidation; reduction of organic compounds by iron; and thermal decomposition of iron salts or iron compounds. Organic colorants can be used for some applications, but they tend to fade over time from exposure to sunlight.

Production

Domestic production data for natural crude IOPs were derived from voluntary responses to a U.S. Geological Survey (USGS) canvass of two domestic producers. U.S. production data for crude (natural) IOPs sold or used in 2014 were developed using reported data from one company and estimates for the nonrespondent on the basis of previously reported data adjusted according to industry trends. These data are withheld from publication to avoid disclosing company proprietary data. Estimated production was unchanged in 2014 compared with that of 2013.

In a second voluntary USGS survey, sales data for finished (natural and synthetic) IOPs were received from five of eight known processing operations, representing nearly 60% of the tonnage shown in table 1. Data for the nonrespondents were estimated on the basis of prior-year sales levels, employment hours, and industry trends. Sales of finished pigments were 45,300 t in 2014, down by 4% from 47,200 t in 2013. Sales data for finished IOPs were collected only from operations that process material, such as the crushing and grinding of natural IOPs, or that make synthetic 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 when steel is treated with hydrochloric acid to remove surface oxides. Iron oxide is separated from the spent pickle liquor when it is treated to recycle the acid and reduce waste. Regenerated iron oxide data were not included in table 1 because the iron oxides are not natural (mined) or synthetic (manufactured) and must undergo additional processing before being suitable for use in typical IOP applications.

Applied Minerals, Inc.'s Dragon Mine property in Utah contains high-purity iron oxide consisting of hematite, goethite, and limonite along with halloysite clay; the total measured iron oxide resource was 3.3 million metric tons. Applied Minerals began production of its iron oxide product toward the end of 2014 at its 40,000-metric-ton-per-year (t/yr) processing plant. Applied Minerals produced an advanced IOP product with high iron oxide content, chemical purity, and color saturation with low heavy-metals content under the AMIRON™ trade name. The transparent IOP products were promoted primarily to the woodstains market and for foundry sand additives, and additionally, near yearend, as a desulfurization catalyst to the energy and biogas industries as a cost-effective scavenger of highly corrosive hydrogen sulfide gas, a byproduct of the anaerobic conversion of biomass (Applied Minerals, Inc., 2015c). Applied Minerals received interest from potential IOP customers in Asia and Europe and from domestic companies that have traditionally been dependent on imported IOP products from Asia (Applied Minerals, Inc., 2015a, b; Patel, 2015).

Texas-based Huntsman Corp., a global specialty chemical company, completed the acquisition from Rockwood Holdings, Inc. of its performative additives (including Rockwood Pigments NA, Inc. plants in the United States) and titanium dioxide businesses for about $1 billion (Paint & Coatings Industry, 2014). Huntsman Corp. continued to construct the new $115 million synthetic IOP production plant, near Augusta, GA, previously begun by Rockwood Pigments. Operations at the advanced technology facility were expected to begin in the latter half of 2015 with a capacity of 30,000 t/yr of black, red, and yellow synthetic IOPs. Completion of the new plant, which would be the first new synthetic IOP production plant built in the United States in nearly 35 years, had been delayed

by adverse weather conditions, a change in engineering firms, and the transition in ownership. When completed, Huntsman Corp. was expected to close its existing plants in Cartersville, GA, East St. Louis, IL, and King of Prussia, PA, and part of its Beltsville, MD, facility to produce IOPs primarily from the new Augusta facility (Martin, 2013; Rausch, 2015).

Consumption

In 2014, consumption of IOPs increased slightly from that of 2013. IOPs were used in construction materials, including concrete products such as block, brick, or segmental retaining wall units; decorative concrete; mortar; paving stones; precast products of various sizes or dimensions; ready-mixed concrete; and roofing tiles. Tinted concrete is often stamped to resemble brick, slate, stone, and many more shapes and forms found in nature, including wood (Pinto, 2008, p. 4, 6).

The second-ranked market for IOPs is as a tint in paints and coatings. Other end uses included colorants for ceramics, glass, paper, plastics, rubber, and textiles and in animal feed, cosmetics, and fertilizers as well as other-than-colorant uses in ferrites; foundry sands; industrial chemicals, such as catalysts; and magnetic ink and toner.

A major end use for regenerated iron oxides was in 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. Soft ferrites are used in computers, cores for radio frequency coils, microwave communication systems, microwave ferrites for telecommunications, and other industrial applications. Other end uses for regenerated iron oxides include color pigments in construction materials, cosmetic preparations, dyes and paints, and plastic products.

Prices

The annual average producer price index (PPI) for IOPs (U.S. Bureau of Labor Statistics Series ID WPU06220206) was 235.1 in 2014 compared with 226.4 in 2013. The PPI ranged between 232.5 and 236.7 in 2014, the high being reached in November through December and the low in January. The PPI measured the average change in the selling prices charged by domestic producers of IOPs over time (U.S. Bureau of Labor Statistics, 2015). Unit values for finished natural and synthetic IOPs reported by domestic producers ranged from $0.33 to $3.77 per kilogram, with an average unit value of $1.58 per kilogram (table 1).

Foreign Trade

In 2014, U.S. exports of pigment-grade and other iron oxides and hydroxides combined increased by 4%. IOPs were exported primarily to China, 50%, and Spain, 20% (table 3).

U.S. exports of pigment-grade iron oxides increased by 7.6% to 8,790 t valued at $16 million in 2014, and the unit value increased by nearly 11%. Mexico was the leading destination, accounting for more than 47% of U.S. exports, China was second with 15%, and Belgium was third with nearly 14% (tables 1, 3). Exports of other grades of iron oxides and hydroxides increased by nearly 4% to more than 60,600 t in 2014 with a total value of $32.4 million; the unit value decreased by 10%. China, Spain, Canada, and Mexico were, in descending order, the major destinations for export of other grades of IOPs and hydroxides, accounting for 55%, 23%, 7%, and 5% of the export tonnage, respectively (table 3).

U.S. imports of all IOPs and hydroxides increased by about 6% to 175,000 t in 2014 from those of 2013, and were about 65% higher than the recent low of 107,000 in 2009 (tables 1, 4).

Imports of natural IOPs increased by about 5%. The leading source was Cyprus, with 63% of the tonnage, followed by France with 17% and Austria with 16%. Imports of synthetic IOPs increased by nearly 6%. The leading sources of synthetic IOP imports were China with 53% of the tonnage; Germany, 25%; Canada, 8%; Brazil, 6%, and Italy, 5% (table 5).

World Review

Natural IOPs were produced in at least 10 countries in 2014 (table 6). Several other countries 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.

Because many of Europe's IOP producers supplied external markets, they were not expected to be affected significantly by sluggish European construction markets. In general, IOP companies with a global customer base were less vulnerable to regional economic fluctuations. Consumption of pigment minerals was expanding significantly for certain emerging markets, such as Latin America and Asia, especially China (Ollett, 2013c).

Austria.—In 2014, Kärntner Montanindustrie GmbH continued production of micaceous iron oxide (MIO) from its underground mine in Waldenstein, accounting for up to 90% of the global MIO market. It exported its products to as many as 80 different countries (Kärntner Montanindustrie GmbH, 2015, p. 12). According to the United Nations UN Comtrade database, 89,000 t of IOP products (unspecified) were exported from Austria in 2014, down from nearly 142,000 t in 2013. MIOs have a horizontal layering of flaky, lamellar, "micaceous" particles that overlap like scales on a fish and give strength and corrosion resistance to paints and coatings. Standard-grade MIOs are used on bridges, oil rigs, and other structural steel and as protective coatings on electrical and industrial equipment. Micronized grades are used in anticorrosive decorative coatings, including water-based coatings; in prime coatings, as partial replacement of zinc dust; and in certain applications requiring a degree of friction (O'Driscoll, 2012).

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 to a negligible quantity in 2009, despite the country's ongoing urbanization. In 2010–14, IOP imports from the United States increased to 34,800 t (high of 37,700 t in 2013), returning to nearly 85% of the average annual level for 2005–07 (U.S. International Trade Commission, undated). An assumed increase in demand for IOPs in China mainly was driven by increased construction activity.

Hong Kong-based Cathay Industries Group and the Tonghua Group commenced production at their new synthetic iron oxide plant in Tonglin, Anhui Province, in eastern China. The

60,000-t/yr plant could produce black, red, and yellow IOPs. By yearend, Cathay planned to install spray driers at the plant to produce 20,000 t/yr of pigment granules. When completed, the joint-venture plant, to be known as Rely Science & Technology Co., Ltd., would have a 100,000-t/yr capacity with plans to expand to 150,000 t/yr. Products would be targeted for markets in China, where consumption had been increasing at a rate of 7% to 8% per year in most IOP-consuming industries. The new plant was designed to use a new direct precipitation process, an all-liquid phase method, which enhances water and waste gas treatment and significantly reduces liquid and solid waste. This plant would be Cathay Industries' eighth IOP plant in China. Its other major plants are in Shenzhen, Guangdong Province, and Shanghai and Wuxi, Anhui Province (Cathay Industries Europe N.V., 2013; Ollett, 2013a; Lismore-Scott, 2014).

Lanxess AG continued construction of its 25,000-t/yr red synthetic IOP plant at the Ningbo Chemical Park in Ningbo, Zhejiang Province, at an estimated cost of $74 million. The new plant was to place particular emphasis on water treatment; waste gas cleaning, including a reduction of nitrous oxides generated; and lower energy consumption. Lanxess also began construction of a 70,000-t/yr mixing and milling plant. Upon completion of both plants scheduled for yearend 2015, initial production at both plants was expected to begin in the first quarter of 2016 (RTTNews, 2014). Lanxess also operated a 38,000-t/yr IOP plant in Jinshan, Shanghai Province, where it produced black and yellow iron oxide pigments (Lanxess AG, 2013; Ollett, 2013b, c; Patel, 2014).

Spain.—Promindsa SA, the country's leading producer of IOPs, produced and sold about 16,000 t of IOPs in 2014, down slightly from that of 2013, 85% of which was exported to more than 50 countries. The company expected to maintain production and sales at the same level in 2015. About 80% of Promindsa's IOP output and sales was red hematite. Promindsa sold its Santa Rosa iron oxide as a red pigment for use in asphalt, brick, glass and ceramics, paints, and roof tile. Promindsa also mined black (magnetite), brown (oolitic iron ore), and yellow (goethite) IOPs in Spain. The company worked to complete the development of its Ojos Negros Mine goethite iron ore project; production of 600 to 1,000 t/yr of brown IOP was expected to commence in the spring of 2015 (Fernando Prada, President, Promindsa SA, written commun., September 10, 2015).

Outlook

Although the global economic situation was gradually improving, construction activity and consequent consumption of IOPs for coloring concrete and paint remained sluggish overall. On a global scale, growth in the IOP market is expected to continue to increase during the next several years, mostly because of increased construction activity in China, India, Indonesia, Latin America, and the United States. Because economic uncertainties have continued following the regional debt crisis in Europe, capital spending on construction projects that use IOPs is expected to vary by region and country and to be limited overall (Ollett, 2013b; Patel, 2015).

The International Monetary Fund predicted that the global economy would increase by about 3.3% in 2015 and 3.8% in 2016. Growth was projected to be stronger in the advanced economies in 2015 compared with that of 2014, while slowing somewhat in the emerging markets and developing economies where growth was expected to pick up again in 2016. The U.S. economy was expected to increase by 2.5% in 2015 and 3.0% in 2016 compared with 2.4% in 2014, with a continuing solid recovery spurred by continued increasing employment, lower fuel prices, easy financial conditions, wage growth, and strengthening of the housing market (International Monetary Fund, 2015). Continued improvement in the global and U.S. economies may result in increased activity in IOP markets in 2015–16, especially in those regions where the construction industry is expanding.

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

		2010	2011	2012	2013	2014
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	54,700	48,000	48,400	47,200	45,300
Value	thousands	$80,700	$73,900	$77,700	$75,400	$71,500
Exports:[4]						
Quantity	metric tons	8,750	8,660	8,950	8,170	8,790
Value	thousands	$15,700	$15,000	$13,500	$13,400	$16,000
Imports for consumption:[3]						
Quantity	metric tons	151,000	158,000	151,000	165,000	175,000
Value	thousands	$167,000	$188,000	$182,000	$190,000	$208,000

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 2014

Producers	Plant location
Pigments:	
Crude:	
Alabama Pigments Co., LLC	Green Pond, AL.
Applied Minerals, Inc.	Eureka, UT.
New Riverside Ochre Co., Inc.	Cartersville, GA.
Finished:	
Alabama Pigments Co., LLC	Green Pond, AL.
Applied Minerals, Inc.	Eureka, UT.
Dynamic Color Solutions, Inc.	Milwaukee, WI.
New Riverside Ochre Co., Inc.	Cartersville, GA.
Prince Minerals, Inc.	Quincy, IL; and Bowmanstown, PA.
Huntsman Corp. (formerly Rockwood Pigments NA, Inc.)	Beltsville, MD; Cartersville, GA; King of Prussia, PA; Los Angeles, CA; and East St. Louis, MO.
Regenerated iron oxides:	
American Iron Oxide Co.[1]	Allenport, PA; Portage, IN; and Rockport, IN.
ArcelorMittal Weirton Inc.	Weirton, WV.
Bailey-PVS Oxides, LLC	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			
	2013		2014		2013		2014	
Country	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
Argentina	2	$17	(2)	$5	76	$41	--	--
Australia	120	334	86	272	959	338	1,420	$389
Belgium	789	3,720	1,200	4,760	68	324	74	291
Brazil	139	817	183	700	287	275	234	156
Canada	2	4	--	--	5,070	9,540	4,110	8,110
Chile	95	228	57	28	246	152	142	368
China	1,510	2,530	1,350	3,090	36,200	12,500	33,400	10,100
Colombia	109	270	82	273	29	64	11	95
France	36	221	44	225	2	22	61	34
Germany	5	22	4	32	839	505	819	370
Haiti	4	14	3	11	6	26	10	46
Hong Kong	50	167	2	14	10	27	10	24
India	65	210	103	218	79	332	93	440
Indonesia	3	22	2	27	(2)	8	11	55
Israel	16	43	13	31	101	39	620	201
Italy	162	129	4	60	33	89	20	17
Jamaica	16	19	11	45	17	40	--	--
Japan	3	8	10	63	27	32	41	37
Korea, Republic of	73	411	195	443	35	587	14	295
Malaysia	62	35	93	55	6	30	9	22
Mexico	4,280	2,730	4,160	2,820	2,560	1,840	3,290	2,390
Netherlands	2	5	21	121	36	116	44	115
Peru	28	24	22	36	(2)	4	(2)	6
Singapore	1	7	1	12	84	183	119	157
South Africa	14	89	4	24	3	6	--	--
Spain	7	39	20	64	9,860	2,480	14,200	3,860
Taiwan	2	11	17	110	90	523	106	644
Thailand	104	288	7	51	639	2,140	1,140	2,110
Trinidad and Tobago	1	10	1	3	5	16	15	16
United Arab Emirates	41	22	162	88	141	114	(2)	7
United Kingdom	131	508	331	604	615	1,790	451	1,270
Uruguay	28	102	99	374	1	16	43	162
Venezuela	172	165	236	611	231	101	27	32
Other	100 r	215 r	273	751	199 r	537 r	130	544
Total	8,170	13,400	8,790	16,000	58,500	34,900	60,600	32,400

rRevised. -- Zero.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Less than ½ unit.

Source: U.S. Census Bureau; 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	2013 Quantity (metric tons)	2013 Value[2] (thousands)	2014 Quantity (metric tons)	2014 Value[2] (thousands)	Principal sources, 2014 (metric tons)
Natural:					
Earth colors[3]	2,270	$1,200	2,240	$1,170	Cyprus, 2,200.
Micaceous	1,070	1,110	1,270	1,610	France, 589; Austria, 549; Spain, 76.
Total	3,340	2,310	3,510	2,780	
Synthetic:					
Black	47,700	46,600	49,200	50,300	Germany, 15,100; China, 15,000; Canada, 12,300.
Red	60,500	70,700	67,600	82,700	China, 46,600; Germany, 16,600.
Yellow	53,000	69,000	53,900	70,600	China, 29,000; Brazil, 10,700; Germany, 10,500.
Other[4]	743	1,620	459	1,310	China, 240; Canada, 141.
Total	162,000	188,000	171,000	205,000	
Grand total	165,000	190,000	175,000	208,000	

[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Customs value.
[3]Includes those 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			
	2013		2014		2013		2014	
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	353	$408	549	$1,020	1	$2	18	$72
Belgium	--	--	--	--	8	24	4	17
Brazil	--	--	--	--	10,800	15,100	10,700	15,200
Canada	--	--	--	--	13,500	3,940	13,100	3,950
China	23	19	23	21	81,800	88,200	90,900	99,600
Colombia	--	--	--	--	2,400	3,610	2,440	3,670
Cyprus	2,270	1,100	2,210	1,060	--	--	--	--
France	545	443	590	485	131	995	249	1,880
Germany	--	--	1	4	43,600	57,900	42,200	54,100
Italy	3	10	1	5	7,440	13,300	8,560	19,000
Japan	1	90	1	81	1,210	3,610	1,750	5,790
Spain	129	153	76	49	389	241	425	279
Other	20	86	57	59	696	1,060	830	1,270
Total	3,350	2,310	3,510	2,780	162,000	188,000	171,000	205,000

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

Source: U.S. Census Bureau.

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

(Metric tons)

Country[3]	2010	2011	2012	2013	2014
Austria, micaeous iron oxide	3,430 [r]	3,590 [r]	3,400 [r]	3,400 [r]	3,500
Cyprus, umber	4,125 [r]	3,219 [r]	3,394 [r]	4,016 [r]	4,000
France	1,000 [r]	1,000 [r]	900 [r]	900 [r]	1,000
Germany	233,909 [4]	223,288 [4]	204,198 [4]	205,000 [4]	200,000
India, ocher[5]	1,218,000 [r, 4]	1,576,000 [r, 4]	1,834,000 [r, 4]	1,555,000 [r, 4]	1,600,000
Italy	117 [4]	112	118	137 [r]	140
Pakistan, ocher[6]	55,352 [r, 4]	36,078 [r, 4]	42,107 [r, 4]	37,769 [r, 4]	33,000
South Africa	244 [4]	266 [4]	-- [4]	--	--
Spain, ocher and red iron oxide	15,500 [4]	15,000 [4]	16,500 [4]	16,400	16,000
United States	W	W	W	W	W

[r]Revised. W Withheld to avoid disclosing company proprietary data. -- Zero.
[1]Estimated data are rounded to no more than three significant digits, unless otherwise noted.
[2]Includes data available through September 3, 2015.
[3]In addition to the countries listed, a number of others likely continue to produce iron oxide pigments, but output is not reported and no basis is available for formulating estimates of output levels. Such countries include Azerbaijan, Brazil, China, Honduras, Iran, Kazakhstan, Lithuania, Paraguay, Russia, Turkey, Ukraine, and the United Kingdom. Unreported output is probably substantial.
[4]Reported figure.
[5]Data are for fiscal year ending March 31 of the following year.
[6]Data are for fiscal year ending June 30 of the following year.