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2018 Minerals Yearbook

IRON OXIDE PIGMENTS [ADVANCE RELEASE]

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Iron Oxide Pigments

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In 2018, natural crude iron oxide pigment (IOP) production in the United States increased compared with that of 2017. U.S. production data were withheld to avoid disclosing company proprietary data. Finished natural and synthetic IOPs sold by processors increased slightly to 48,200 metric tons (t) valued at $76.1 million in 2018 from 47,300 t valued at $69.2 million in 2017 (table 1). Exports of pigment-grade iron oxides decreased by nearly 18% to 11,100 t valued at $24.0 million in 2018 compared with 13,500 t valued at $36.4 million in 2017. Imports of natural and synthetic IOPs were unchanged at 179,000 t but were valued slightly higher at $206 million in 2018 compared with $200 million in 2017 (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 and include ochers, 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 synthetic IOPs duplicate colors more precisely and produce a substantially wider variety of colors. These IOPs 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. These data are withheld from publication to avoid disclosing company proprietary data.

In another voluntary USGS survey, sales data for finished (natural and synthetic) IOPs were received from eight of nine known processing operations, representing more than 90% of the tonnage shown in table 1. Data for the nonrespondent were estimated on the basis of prior-year sales levels and industry trends. Sales of finished pigments were 48,200 t in 2018, up slightly from 47,300 t in 2017 (table 1). 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; these data were not collected from operations that blend, mix, repackage, or resell IOP material.

Four U.S. companies, operating nine plants, produced regenerated iron oxides during steelmaking (table 2). Iron oxide is obtained during steelmaking 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. One company produced iron oxide pigments mostly by recovering iron oxide from waste streams and drainage and iron-bearing waste piles from current and closed coal and iron ore mines, especially in Eastern States. Regenerated iron oxides data were not included in table 1 because the iron oxide is not natural (mined) or synthetic (manufactured) and must undergo additional processing before being suitable for use in typical IOP applications.

Venator Materials PLC, which was spun off from Huntsman Corp. in 2017, continued to ramp up production at its new $172 million synthetic IOP production plant near Augusta, GA. Production included black, red, and yellow synthetic IOPs at the 30,000-metric-ton-per-year (t/yr) advanced technology facility, the first new synthetic IOP plant built in the United States in nearly 35 years. Venator Materials expected to concentrate the production of IOPs at the new facility in Georgia by 2020 (Rausch, 2015). Venator continued to produce synthetic IOPs at the East St. Louis, MO, plant location (table 2). The Easton, PA, and Beltsville, MD, plants shut down operations during 2018. Despite being closed, these plants continued to produce from their stocks of raw materials (table 2).

Hong Kong-based Cathay Industries Group, who completed the acquisition of Hoover Color Corp. (Hiwassee, VA) in 2017, sold its iron oxide operations in Valparaiso, IN, to DIC Corp.'s Sun Chemical Corp. in 2018 (Stuart, 2018). The agreement included the Valparaiso plant and all cosmetic-related business operations worldwide. This divestment allows Cathay Industries to focus on other iron oxide pigment applications, such as construction and paint and coating (Cathay Industries Europe N.V., 2018). Cathay Industries' Hoover Color partnered with the Commonwealth of Virginia and continued the transformation of 100 hectares (250 acres) of its mine property, including the colorful Hoover Color canyon mine site, into an extension of the New River Trail State Park (Moseley, 2018).

Consumption

The USGS obtained end-use data through a survey of finished (natural and synthetic) IOP producers. Of the 48,200 t of finished natural and synthetic IOPs that were sold or used by processors, an estimated 59% of sales were for use in concrete and other construction products; 11% for plastics; 7% in paints and coatings; 5% for foundry sands and other foundry uses; 3% each in animal foods, industrial chemicals, and glass and ceramics; and the remaining 9% in other uses.

The leading use of IOPs was in a variety of 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 was 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, fertilizers, other-than-colorant uses for ferrites, foundry sands, industrial chemicals (such as catalysts), and magnetic ink and toner.

A significant 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 radiofrequency 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 264.5 in 2018 compared with 249.9 in 2017. The PPI measured the average change in the selling prices charged by domestic producers of IOPs over time. The PPI was 255.6 in January, about 262.1 in February through May, 266.4 in June through October, and about 269.4 in November and December (U.S. Bureau of Labor Statistics, 2018). Unit values for finished natural and synthetic IOPs reported by domestic producers ranged from $0.39 to $4.89 per kilogram, with an average unit value of $1.92 per kilogram.

Foreign Trade

U.S. exports of pigment-grade iron oxides decreased by 18% to 11,100 t valued at $24.0 million in 2018, and the average unit value decreased by 20% (tables 1, 3). Mexico was the leading destination, accounting for 40% of United States exports, followed by China, 20%; Belgium, 12%; Brazil and Chile, 4% each; and Thailand and the United Kingdom, 3% each (table 3). Exports of other grades of iron oxides and hydroxides decreased by nearly 19% to 32,300 t in 2018 with a total value of $23.1 million; the average unit value increased by 20%. Spain, at 43%; Canada, 31%; China, 12%; and Mexico, 8%; were, in descending order, the major destinations for export of other grades of IOPs and hydroxides (table 3).

Total U.S. imports of all IOPs and iron hydroxide pigments were unchanged at 179,000 t in 2018 from those of 2017 (tables 1, 4). Imports of natural IOPs were nearly 2.5 times those of the previous year at 8,170 t. The leading source of natural IOP imports was Spain with 59% of the tonnage, followed by Cyprus with 26%, and Austria and France with 6% each. Imports of synthetic IOPs decreased slightly to 171,000 t. The leading sources of synthetic IOP imports were China with 51% of the tonnage; Germany, 31%; Brazil, 6%; Italy, 5%; and Canada, 4% (table 5).

World Review

Natural IOPs were produced in at least nine countries in 2018 (table 6). In addition to the countries and localities discussed in this chapter or listed in table 6, other countries may have produced IOPs, but available information was inadequate to make reliable estimates. Available data indicated that world production in 2018 decreased by 7% to an estimated 2.51 million metric tons (Mt) from 2.71 Mt in 2017.

Austria.—In 2018, Kärntner Montanindustrie GmbH continued production of micaceous iron oxide (MIO) from its underground mine and nearby processing plant in Waldenstein, State of Carinthia, from which it exported about 95% of its MIO products to the global market. 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 surfaces, including water-based coatings; in prime coatings, as partial replacement of zinc dust; and in applications requiring a degree of friction (O'Driscoll, 2012).

China.—After 6 years of increased imports of IOPs from the United States, averaging about 31,600 t/yr and reaching a high of nearly 40,000 t in 2015, imports decreased to 15,500 t in 2017 and 6,000 t in 2018, suggesting increased production of IOPs in China to supply the demand for IOPs driven by the country's increasing construction activity (table 3). China is not included in the world production table (table 6) because IOPs produced in the country are primarily synthetic.

Lanxess AG (Germany) produced IOPs at its 25,000-t/yr red synthetic IOP plant and its 70,000-t/yr inorganic pigment mixing and milling plant at the Ningbo Chemical Park in Ningbo, Zhejiang Province. Highly saturated red IOPs and yellowish-red IOPs referred to by the company as the "New Reds" were produced using a patented "Ningbo Process," developed specifically for this plant that emphasized water treatment, waste gas cleaning (including a reduction of nitrous oxides generated), and lower energy consumption (Lanxess AG, 2018b). Lanxess also operated a 38,000-t/yr IOP plant in Jinshan, Shanghai Province, where it produced black and yellow IOPs (Lanxess AG, 2018c).

Germany.—Lanxess increased the production of red pigments at its Krefeld-Uerdingen synthetic iron oxide site by about 5,000 t/yr (Ondrey, 2018). Krefeld-Uerdingen is Lanxess' Inorganic Pigments headquarters and the world's largest inorganic iron oxide pigment production facility. A maximum of 1,600 t of pigment can be shipped from this site daily (Lanxess AG, 2018a). Lanxess' Bayferrox and Colortherm micronized red pigments can resist color change under high shear forces and temperatures. These pigments were used in technical and colorant applications (Ondrey, 2018).

Outlook

New residential construction and commercial and residential remodeling are expected to continue to increase, creating higher consumption of IOPs as coloring agents in concrete products and ceramic tiles. This expected increase is partly owing to an

increase in construction and refurbishment projects resulting from significant damage to structures that took place in 2018 as the result of hurricanes along the gulf coast and the southeastern United States and extensive wildfires in some Western States. With the continued, gradual growth of the global economy, construction activity is expected to increase over the coming years, consequently increasing the consumption of IOPs for coloring concrete, paints, and coatings.

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

(Metric tons and thousand dollars)

	2014	2015	2016	2017	2018
Crude pigments sold or used:[2]					
Quantity	W	W	W	W	W
Value	W	W	W	W	W
Finished pigments sold:[3]					
Quantity	45,300	53,500	48,500	47,300 r	48,200
Value	$71,500	$77,900	$71,000	$69,200 r	$76,100
Exports:[4]					
Quantity	8,790	8,930	15,800	13,500	11,100
Value	$16,000	$17,200	$45,600	$36,400	$24,000
Imports for consumption:[3]					
Quantity	175,000	176,000	179,000	179,000	179,000
Value	$208,000	$209,000	$197,000	$200,000	$206,000
World, production	2,920,000 r	2,670,000 r	2,720,000 r	2,710,000 r	2,510,000 e

eEstimated. rRevised. W Withheld to avoid disclosing company proprietary data.
[1]Table includes data available through September 12, 2019. 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 2018[1]

Producers	Plant location
Pigments:	
Crude:	
Alabama Pigments Co., LLC	Green Pond, AL.
New Riverside Ochre Co., Inc.	Cartersville, GA.
Finished:	
Alabama Pigments Co., LLC	Green Pond, AL.
Dynamic Color Solutions, Inc.	Milwaukee, WI.
New Riverside Ochre Co., Inc.	Cartersville, GA.
Prince Minerals, Inc.	Quincy, IL; and Bowmanstown, PA.
Venator Materials PLC. (formerly Huntsman Corp.)	Beltsville, MD; Augusta, GA; Easton, PA; and East St. Louis, MO.
Regenerated iron oxides:	
American Iron Oxide Co.[2]	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]Table includes data available through September 12, 2019.
[2]Division of International Steel Services, Inc.

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

	Pigment grade				Other grade			
	2017		2018		2017		2018	
Country or locality	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
Argentina	10	$47	18	$102	49	$623	272	$173
Australia	84	211	40	174	1,400	865	282	483
Barbados	(2)	5	4	12	--	--	2	20
Belgium	1,930	14,600	1,360	8,670	74	395	217	1,410
Brazil	544	1,740	435	1,370	158	561	37	466
Canada	8	11	22	31	4,420	9,660 r	9,980	10,500
Chile	563	659	399	256	11	128	25	256
China	3,290	5,420	2,250	2,950	12,200	3,500	3,750	2,180
Colombia	90	395	94	397	47	173	28	234
Costa Rica	--	--	7	24	(2) r	16 r	2	5
Czechia	--	--	--	--	7	100	2	25
Dominican Republic	1	4	2	12	--	--	--	--
Ecuador	1	13	8	77	--	--	--	--
France	45	246	190	758	--	--	3	74
Germany	897	4,690	248	939	(2)	16	6	33
Guatemala	13	22	9	16	(2)	13	--	--
Haiti	5	23	--	--	3	11	70	242
Hong Kong	10	56	44	105	2	23	82	100
India	196	594	121	453	6	72	7	139
Indonesia	6	27	54	117	5	81	7	117
Ireland	10	35	--	--	--	--	9	84
Israel	6	22	12	36	1,670	534	607	187
Italy	69	159	90	191	80	19	95	19
Jamaica	2	9	1	5	2	7	2	4
Japan	20	80	11	75	66 r	19 r	34	38
Korea, Republic of	128	685	155	886	51	607 r	52	436
Kuwait	121	74	26	32	--	--	--	--
Malaysia	5	11	14	38	4	29	18	65
Mexico	4,260	2,970	4,470	3,370	2,820	2,160	2,600	2,030
Netherlands	--	--	30	62	--	--	(2)	12
New Zealand	7	51	2	38	108	127	60	80
Norway	--	--	13	38	--	--	--	--
Pakistan	--	--	21	74	--	--	72	128
Panama	--	--	--	--	(2)	16	10	48
Peru	2	12	8	20	19	13	1	14
Philippines	1	10	3	12	1	19	12	53
Russia	19	9	--	--	35	20	--	--
Singapore	5	34	--	--	10	133	11	173
South Africa	3	22	6	36	2	3	--	--
Spain	18	76	15	80	16,200	2,640	13,800	2,680
Taiwan	589	1,470	233	627	11	195	21	215
Thailand	177	214	347	445	2	13	2	22
Trinidad and Tobago	6	29	5	15	2	15	(2)	13
United Kingdom	320	1,500	353	1,430	166	522	19	160
Uruguay	22	88	10	28	63	182	--	--
Venezuela	--	--	--	--	6	19	(2)	7
Vietnam	--	--	(2)	6	--	--	36	116
Other	16 r	71 r	19	19	1 r	71 r	5	16
Total	13,500	36,400	11,100	24,000	39,700 r	23,600	32,300	23,100

rRevised. -- Zero.
[1]Table includes data available through September 12, 2019. 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.

TABLE 4
U.S. IMPORTS FOR CONSUMPTION OF SELECTED IRON OXIDE AND HYDROXIDE PIGMENTS, BY TYPE[1]

Type	2017 Quantity (metric tons)	2017 Value[2] (thousands)	2018 Quantity (metric tons)	2018 Value[2] (thousands)	Principal sources, 2018 (metric tons)
Natural:					
Earth colors[3]	1,840	$901	6,900	$2,230	Spain, 4,750; Cyprus, 2,120.
Micaceous	1,500	1,820	1,280	1,270	Austria, 529; France, 492; Mexico, 136.
Total	3,340	2,720	8,170	3,500	
Synthetic:					
Black	48,100	46,900 r	48,300	50,900	China, 20,300; Germany, 17,900; Italy, 4,920; Canada, 4,810.
Red	73,600 r	83,600	75,300	87,500	China, 45,000; Germany, 23,400; India, 2,100; Italy, 1,450.
Yellow	52,600	65,600	46,200	62,300	China, 21,300; Germany, 11,300; Brazil, 10,000.
Other[4]	995	1,600 r	845	1,610	Canada, 374; China, 264; India, 104.
Total	175,000	198,000 r	171,000	202,000	
Grand total	179,000	200,000	179,000	206,000	

rRevised.
[1]Table includes data available through September 12, 2019. 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 OR LOCALITY[1]

	Natural				Synthetic			
	2017		2018		2017		2018	
Country or locality	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	655	$1,130	529	$733	--	--	--	--
Belgium	(3)	3	(3)	2	40	$53	8	$56
Brazil	--	--	--	--	11,200	15,000	10,000	12,400
Canada	(3)	5	--	--	7,320 r	4,760 r	6,230	5,870
China	9	16	28	53	91,700	92,200	86,800	89,500
Colombia	--	--	--	--	1,770	2,290	1,430	2,050
Cyprus	1,690	828	2,120	1,030	213	220	--	--
France	511	411	492	402	239	1,630	230	1,870
Germany	228	210	--	--	53,200	63,600	52,600	64,700
Hong Kong	--	--	--	--	198	295	287	522
India	--	--	--	--	1,950	1,170	2,480	1,850
Italy	4	15	1	14	5,520	11,200	8,480	17,300
Japan	(3)	5	--	--	1,190	3,970	1,260	4,730
Korea, Republic of	--	--	--	--	32	349	12	132
Mexico	20	18	136	50	--	--	--	--
Netherlands	5	3	4	3	61	77	58	53
Norway	--	--	--	--	55	42	21	18
Poland	2	9	--	--	--	--	(3)	3
South Africa	--	--	--	--	1	23	2	50
Spain	214	70	4,840	1,180	627	338	718	463
Taiwan	--	--	--	--	80	168	35	89
Trinidad and Tobago	--	--	8	18	--	--	--	--
United Kingdom	--	--	4	3	13	200	90	595
Other	-- r	-- r	1	11	2	4	20	33
Total	3,340	2,720	8,170	3,500	175,000	198,000	171,000	202,000

rRevised. -- Zero.
[1]Table includes data available through September 12, 2019. 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: WORLD PRODUCTION, BY COUNTRY OR LOCALITY[1]

(Metric tons)

Country or locality[2]	2014	2015	2016	2017	2018[e]
Austria, micaceous iron oxide[e]	3,500	3,500	3,500	3,500	3,500
Cyprus, umber and ocher	3,793	3,503	3,816	3,335 [r]	3,300
France	28,701 [r]	8,010 [r]	7,876 [r]	8,287 [r]	8,000
Germany[3]	340,000 [r, e]	346,496 [r]	362,915 [r]	372,771 [r]	370,000
India, ocher[4]	2,467,767	2,203,708	2,200,000 [e]	2,200,000 [e]	2,000,000
Italy	30,000 [r]	37,962 [r]	36,837 [r]	34,902 [r]	35,000
Pakistan, ocher[5]	27,507	51,534	90,424	71,779 [r]	70,000
Spain, ocher and red iron oxide pigment	16,000	16,000	16,000 [e]	18,000 [r, e]	18,000
United States	W	W	W	W	W
Total	2,920,000 [r]	2,670,000 [r]	2,720,000 [r]	2,710,000 [r]	2,510,000

[e]Estimated. [r]Revised. W Withheld to avoid disclosing company proprietary data.
[1]Table includes data available through July 2, 2019. All data are reported unless otherwise noted. Totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.
[2]In addition to the countries and (or) localities listed, other countries and (or) localities may have produced iron oxide pigments, but available information was inadequate to make reliable estimates of output.
[3]Production includes natural and synthetic iron oxide pigments.
[4]Production is based on fiscal year, with a starting date of March 31 of the year shown.
[5]Production is based on fiscal year, with a starting date of June 30 of the year shown.