

IRON OXIDE PIGMENTS

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In 2004, total iron oxide pigment (IOP) production, using partly estimated data, decreased by 6% to 85,000 metric tons (t) valued at \$77 million. Exports of IOPs decreased by 31% to 3,120 t valued at about \$7.4 million. IOP imports increased by 21% to 170,000 t with China being the leading supplier.

Natural iron oxides are derived from hematite, which is a red iron oxide mineral; limonites, which vary from yellow to brown, such as ochers, siennas, and umbers; and magnetite, which is black iron oxide. Synthetic iron oxide pigments are produced from basic chemicals. The three major methods for the manufacture of synthetic iron oxides are thermal decomposition of iron salts or iron compounds; precipitation of iron salts, usually accompanied by oxidation; and reduction of organic compounds by iron (Podolsky and Keller, 1994, p. 765, 772).

Production

U.S. production data for crude (natural) IOPs sold or used in 2004 were developed by the U.S. Geological Survey (USGS) from a voluntary survey of four companies, of which three responded (table 1). Data are withheld to avoid disclosing company proprietary data. In a second voluntary survey, data were received from 8 of 12 known processing operations (67%) for finished (natural and synthetic) IOPs (table 2). By tonnage, the 8 operations represented 53% of the output. Data for nonrespondents were estimated on the basis of prior-year levels of output.

At least three U.S. companies produced regenerated iron oxide, which is obtained when spent pickle liquor from steelmaking is treated (table 3). Data were obtained from one company. Regenerator iron oxide data were not included in tables 1, 2, and 4. A major end use for this material was ferrites, which are magnetic ceramic oxides. There are two types of ferrites—soft, which do not retain permanent magnetism, and hard, which retain permanent magnetism. Uses of soft ferrites include computers, cores for radio frequency coils, inverter cores, memory cores, microwave communication systems, microwave ferrites for telecommunications, pot cores, rectangular modulus cores, television deflection yokes, and other industrial applications (Govila, 1991, p. 2-3). Hard ferrites are used in flexible magnets, generators, loudspeakers, and motors.

Bayer AG formed a new company, Lanxess AG, by combining most areas of its chemicals business, including IOPs, and large parts of its polymer activities. Lanxess AG was scheduled to be listed on the Frankfurt Stock Exchange at the beginning of 2005 (Bayer Corp., 2004§¹).

New Riverside Ochre Co., Cartersville, GA, was planning to introduce a new product, which will be a high-purity, micron-

sized natural IOP. This micronized product will be directed toward the paint, paper, and plastic markets (O'Driscoll, 2004).

Rockwood Pigments NA, Inc. (a subsidiary of Rockwood Specialties Group, Inc.) acquired the business and assets of Hamburger Color Co. along with its plant and equipment in King of Prussia, PA. Hamburger has been an innovator in coloring concrete for more than 30 years, including the development of liquid IOP color suspensions and technologies to enhance concrete appearance (Rockwood Specialties Group, Inc., 2004a§).

Consumption

Because of a low response rate, no 2004 U.S. data are included in IOP consumption, by end use (table 4). Typically, construction materials and paints and coatings have been the leading end uses of IOPs.

Construction applications included such concrete products as block, brick or segmental retaining wall units, mortar, paving stones, precast products of various sizes or dimensions, ready-mixed concrete, and roofing tiles (Bayer Corp., 2002§). Shipments of total paint and coatings, comprising architectural coatings, original equipment manufacture product coatings, and special-purpose coatings, increased by about 1% in 2004 compared with those of 2003 (U.S. Census Bureau, 2005§).

Prices

In January, Rockwood Pigments raised prices worldwide for its iron oxide and natural color pigments. Reasons cited for the increase were the increase in costs of raw materials, such as scrap steel, natural gas and other energy-related costs, and ocean transportation (O'Driscoll, 2004).

Yearend 2004 IOP published prices, which are meant to serve as a general guideline only, converted from dollars per pound, in bags, per truckload, free on board warehouse, were black, synthetic, \$2.07 per kilogram; buff, natural, domestic, which included dark and light, \$1.16 to \$2.14 per kilogram; and yellow, synthetic, \$2.25 to \$2.34 per kilogram (Chemical Market Reporter, 2004). The average annual producer price index (PPI) for IOPs for 2004 was 180.2 compared with 178.1 in 2003. The PPI measures the average change over time in the selling prices received by domestic producers of IOPs. The base year for the IOP PPI is June 1983 (U.S. Bureau of Labor Statistics, 2005§).

Foreign Trade

U.S. exports of pigment-grade IOPs in 2004 totaled 3,120 t, 31% less than those of 2003 (table 5). U.S. imports of IOPs of 170,000 t in 2004 were 21% higher than those of 2003 (table

¹References that include a section mark (§) are found in the Internet References Cited section.

6). By tonnage, the three leading sources were China with 57%; Germany, 26%; and Italy, 4% (table 7).

World Review

Although production data have not been obtained by the USGS, Italy reportedly produces natural iron oxide, with cement being the leading market. Likewise, in Spain, most of the output is sold to cement producers. In Norway, Rana Gruber AS mines and refines magnetite and hematite. A subsidiary company, Rana Mineral AS, produces special products and has custom grinding. Most of Rana's products are sold as colorant for construction materials, paint, plastics, and rubber (O'Driscoll, 2004).

In Western Europe, the leading market segment for IOPs is said to be construction. Other end uses include paints and coatings, plastics, and paper. Although IOPs traditionally have been marketed in basic powder form, an increasing number of manufacturers are now also offering higher value-added granular or micronized grades. Some advantages of micronized grades compared with standard grades are said to be higher tinting strength, lower oil absorption, and easier dispersion (Will, Schlag, and Kishi, 2004, p. 575.0003O, 575.0003Y–575.0003Z).

Rockwood Specialties Group, Inc.'s subsidiary Rockwood Pigments (UK) Ltd. completed the acquisition of the pigments and dispersions business of Johnson Matthey PLC for about \$50 million. This acquisition comprises the production of transparent IOPs, color concentrates, and complex inorganic color pigments servicing the wood coatings, plastics, building materials, and printing inks markets. Included are manufacturing facilities in Kidsgrove and Sudbury, United Kingdom, and Braeside, Victoria, Australia (Rockwood Specialties Group, Inc., 2004b§).

Some price data, converted from euros per metric ton, were for natural IOPs, ex-works, about \$232 to \$378 per metric ton; for high-quality, high-lamellar content micaceous iron oxide (MIO) from Austria, free on board, about \$732 to \$976 per ton; and for milled MIO, ex-works Europe, about \$549 to \$732 per ton (O'Driscoll, 2004).

Austria.—Kärntner Montanindustrie GmbH (KMI) continued to be the world's leading producer of MIO. Output was about 5,000 t in 2004, with about 80% going into the anticorrosion coatings market. In early 2004, KMI began small-volume production of micronized MIO grades using proprietary technology. The material will be for the anticorrosion and other market sectors. The company also developed a cubical iron oxide for the paint and varnish markets (O'Driscoll, 2004).

Outlook

China continues to be the leading producer and single leading consumer of IOPs. However, a number of issues are facing the industry, including increased manufacturing costs owing to rising steel and fuel costs and environmental costs. This has

resulted in increasing Chinese IOP prices. Numerous mergers have taken place in the domestic industry (O'Driscoll, 2004).

IOP producers in Western Europe also have been dealing with several challenges, including relatively mature markets, large number of producers and traders, oversupply and low overall capacity utilization, and increased Asian competition, especially from China and India (Will, Schlag, and Kishi, 2004, p. 575.0003 N).

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TABLE 1
SALIENT U.S. IRON OXIDE PIGMENTS STATISTICS¹

| | | 2000 | 2001 | 2002 | 2003 | 2004 |
|---------------------------------|-------------|-----------|-----------|-----------|-----------------------|-----------------------|
| Sold or used by producers: | | | | | | |
| Crude pigments: ² | | | | | | |
| Quantity | metric tons | 57,100 | 61,500 | W | W | W |
| Value | thousands | \$4,470 | \$3,460 | \$1,070 | W | W |
| Finished pigments: ³ | | | | | | |
| Quantity | metric tons | 154,000 | 135,000 | 115,000 | 90,000 ^e | 85,000 ^e |
| Value | thousands | \$142,000 | \$130,000 | \$117,000 | \$89,000 ^e | \$77,000 ^e |
| Exports: | | | | | | |
| Quantity | metric tons | 9,640 | 9,100 | 6,270 | 4,500 | 3,120 |
| Value | thousands | \$17,200 | \$16,800 | \$12,100 | \$11,000 | \$7,380 |
| Imports for consumption: | | | | | | |
| Quantity | metric tons | 91,300 | 89,900 | 132,000 | 140,000 ^r | 170,000 |
| Value | thousands | \$76,700 | \$76,900 | \$96,300 | \$96,600 ^r | \$116,000 |

^eEstimated. ^rRevised. W Withheld to avoid disclosing company proprietary data.

¹Data are rounded to no more than three significant digits.

²Mined.

³Natural (mined) and synthetic.

TABLE 2
FINISHED IRON OXIDE PIGMENTS SOLD BY PROCESSORS IN THE UNITED STATES, BY KIND¹

| Kind | 2003 | | 2004 | |
|--|---------------------------|----------------------|---------------------------|----------------------|
| | Quantity (metric tons) | Value (thousands) | Quantity (metric tons) | Value (thousands) |
| Natural: | | | | |
| Black, magnetite | W | W | W | W |
| Umbers: | | | | |
| Burnt | W | W | W | W |
| Raw | 2,610 | \$4,320 | W | W |
| Red, iron oxide ² | W | W | W | W |
| Undistributed and other ^{e,3} | 49,900 | 16,200 | 52,000 | \$20,000 |
| Total ^e | 52,500 | 20,500 | 52,000 | 20,000 |
| Synthetic: | | | | |
| Black, iron oxide | W | W | W | W |
| Brown, iron oxide | -- | -- | -- | -- |
| Red, iron oxide | W | W | W | W |
| Yellow, iron oxide | 22,400 | 39,100 | 21,300 | 35,600 |
| Mixtures of natural and synthetic, iron oxides | W | W | W | W |
| Total | 37,100 | 68,900 | 32,300 | 57,700 |
| Grand total ^e | 90,000 | 89,000 | 85,000 | 77,000 |

^eEstimated. W Withheld to avoid disclosing company proprietary data; included with "Natural, undistributed and other" or "Synthetic, total." -- Zero.

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

²Includes pyrite cinder.

³Includes brown, burnt sienna, ocher, raw sienna, and data indicated by symbol W.

TABLE 3
PRODUCERS OF IRON OXIDE PIGMENTS AND REGENERATOR IRON OXIDES IN THE UNITED STATES IN 2004

| Producers | Plant location |
|---|--|
| Finished pigments: | |
| Alabama Pigments Co. | Green Pond, AL. |
| Lanxess AG | New Martinsville, WV. |
| Dynamic Color Solutions, Inc. | Milwaukee, WI. |
| Elementis Pigments Inc. | East St. Louis, IL; Easton, PA. |
| Hoover Color Corp. | Hiwassee, VA. |
| New Riverside Ochre Co., Inc. | Cartersville, GA. |
| Prince Manufacturing Co., Inc. | Quincy, IL; Bowmanstown, PA. |
| Rockwood Pigments Inc. | Beltsville, MD; St. Louis, MO. |
| Solomon Grind-Chem Services Inc. | Springfield, IL. |
| Crude pigments: | |
| Alabama Pigments Co. | Green Pond, AL. |
| Cleveland-Cliffs Iron Co., Mather Mine and Pioneer plant ¹ | Negaunee, MI. |
| Hoover Color Corp. | Hiwassee, VA. |
| New Riverside Ochre Co., Inc. | Cartersville, GA. |
| Regenerator iron oxides: | |
| Bailey-PVS Oxides, L.L.C. | Decatur, AL; Fairfield, AL; Delta, OH. |
| International Steel Services, Inc. | Allenport, PA. |
| Weirton Steel Corp. | Weirton, WV. |

¹Closed July 31, 1979; shipping from stockpile.

TABLE 4
ESTIMATED IRON OXIDE PIGMENT CONSUMPTION, BY END USE, AS A PERCENTAGE OF REPORTED SHIPMENTS

| End use | All iron oxides | | Natural iron oxides | | Synthetic iron oxides | |
|---|-----------------|------|---------------------|------|-----------------------|------|
| | 2003 | 2004 | 2003 | 2004 | 2003 | 2004 |
| Coatings (industrial finishes and trade sales coatings—lacquers, paints, varnishes) | 24 | NA | 16 | NA | 31 ^r | NA |
| Construction materials (cement, mortar, preformed concrete, roofing granules) | 27 | NA | W | NA | W | NA |
| Colorants for ceramics, glass, paper, plastics, rubber, textiles | 12 | NA | W | NA | W | NA |
| Foundry sands | W | NA | W | NA | -- | NA |
| Industrial chemicals (such as catalysts) | 10 | NA | W | NA | W | NA |
| Other ¹ | 27 | NA | 84 | NA | 69 ^r | NA |
| Total | 100 | 100 | 100 | 100 | 100 | 100 |

^rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; included with "Other." -- Zero.

¹Includes animal feed, cosmetics, ferrites, fertilizers, magnetic ink and toner, polishing agents, and data indicated by symbol W.

TABLE 5
U.S. EXPORTS OF IRON OXIDES AND HYDROXIDES, BY COUNTRY¹

| Country | 2003 | | | | 2004 | | | |
|--------------------|---------------------------|----------------------|---------------------------|----------------------|---------------------------|----------------------|---------------------------|----------------------|
| | Pigment grade | | Other grade | | Pigment grade | | Other grade | |
| | Quantity (metric tons) | Value (thousands) | Quantity (metric tons) | Value (thousands) | Quantity (metric tons) | Value (thousands) | Quantity (metric tons) | Value (thousands) |
| Australia | 124 | \$230 | 222 | \$366 | 17 | \$70 | 308 | \$595 |
| Belgium | 487 | 2,290 | 205 | 793 | 492 | 1,920 | 68 | 152 |
| Brazil | 18 | 108 | 238 | 305 | 16 | 90 | 232 | 254 |
| Canada | 9 | 12 | 11,300 | 10,700 | 39 | 50 | 11,100 | 12,600 |
| China | 86 | 146 | 21,200 | 2,950 | 219 | 275 | 43,600 | 8,080 |
| Colombia | 26 | 87 | 147 | 105 | 19 | 60 | 151 | 67 |
| France | 117 | 371 | 132 | 500 | 275 | 839 | 355 | 946 |
| Germany | 123 | 220 | 340 | 742 | 17 | 33 | 260 | 650 |
| Hong Kong | 544 | 1,320 | 1,100 | 1,650 | 84 | 109 | 1,500 | 2,040 |
| India | 223 | 431 | 308 | 94 | 170 | 349 | 320 | 311 |
| Indonesia | -- | -- | 214 | 286 | 46 | 37 | 115 | 207 |
| Italy | 5 | 19 | 1,080 | 783 | -- | -- | 1,910 | 1,240 |
| Japan | 12 | 60 | 1,340 | 1,030 | 52 | 80 | 710 | 500 |
| Korea, Republic of | 1,080 | 2,400 | 1,670 | 1,350 | 445 | 584 | 1,950 | 2,220 |
| Malaysia | -- | -- | 195 | 491 | -- | -- | 287 | 698 |
| Mexico | 603 | 293 | 1,440 | 1,720 | 437 | 492 | 1,690 | 1,610 |
| Netherlands | 2 | 7 | 634 | 1,170 | 8 | 20 | 643 | 1,180 |
| Russia | 536 | 1,350 | 241 | 408 | 296 | 668 | 220 | 411 |
| Singapore | 90 | 216 | 1,240 | 759 | 1 | 6 | 994 | 383 |
| Taiwan | 2 | 7 | 1,460 | 1,070 | -- | -- | 2,170 | 1,650 |
| Thailand | 23 | 43 | 816 | 451 | 18 | 29 | 918 | 334 |
| United Kingdom | 74 | 106 | 2,560 | 4,070 | 134 | 329 | 2,420 | 4,710 |
| Other | 313 ^r | 1,330 ^r | 671 ^r | 938 ^r | 335 | 1,350 | 769 | 1,050 |
| Total | 4,500 | 11,000 | 48,800 | 32,700 | 3,120 | 7,380 | 72,700 | 41,800 |

^rRevised. -- Zero.

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

Source: U.S. Census Bureau.

TABLE 6
U.S. IMPORTS FOR CONSUMPTION OF SELECTED IRON OXIDE PIGMENTS, BY TYPE¹

| Type | 2003 | | 2004 | | Principal sources, 2004 (metric tons) |
|---------------------------|---------------------------|-----------------------------------|---------------------------|-----------------------------------|--|
| | Quantity (metric tons) | Value ² (thousands) | Quantity (metric tons) | Value ² (thousands) | |
| Natural: | | | | | |
| Earth colors ³ | 3,410 | \$1,420 | 3,270 | \$1,410 | Cyprus, 3,030; Germany, 83. |
| Micaceous | 591 | 735 | 833 | 690 | Austria, 307; Spain, 279. |
| Total | 4,000 | 2,150 | 4,100 | 2,100 | |
| Synthetic: | | | | | |
| Black | 36,500 | 31,900 | 41,700 | 31,100 | Germany, 16,900; China, 14,400; Italy, 5,190; Japan, 1,830; India, 1,800; Mexico, 902; Canada, 364. |
| Red | 54,900 | 30,700 | 67,900 | 41,200 | China, 43,600; Germany, 18,000; Canada, 896; Italy, 873; Sweden, 710; Hong Kong, 637; Belgium, 502; India, 303; Mexico, 274. |
| Yellow | 41,600 | 27,500 | 52,600 | 36,700 | China, 37,000; Germany, 8,290; Brazil, 2,390; Italy, 1,550; Mexico, 1,350; Colombia, 711; Hong Kong, 511. |
| Other ⁴ | 2,960 | 4,370 | 3,330 | 4,950 | China, 1,790; Germany, 540; Japan, 417; Canada, 400. |
| Total | 136,000 | 94,500 | 166,000 | 114,000 | |
| Grand total | 140,000 | 96,600 | 170,000 | 116,000 | |

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

²Customs value.

³Includes those earth colors not elsewhere specified or included.

⁴Includes synthetic brown oxides, transparent oxides, and magnetic and precursor oxides.

Source: U.S. Census Bureau.

TABLE 7
U.S. IMPORTS FOR CONSUMPTION OF IRON OXIDE AND IRON HYDROXIDE PIGMENTS, BY COUNTRY¹

| Country | Natural | | | | Synthetic | | | |
|----------------|---------------------------|-----------------------------------|---------------------------|-----------------------------------|---------------------------|-----------------------------------|---------------------------|-----------------------------------|
| | 2003 | | 2004 | | 2003 | | 2004 | |
| | 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 | 314 | \$321 | 307 | \$309 | -- | -- | -- | -- |
| Belgium | -- | -- | 9 | 12 | 1,160 | \$791 | 533 | \$437 |
| Brazil | -- | -- | -- | -- | 2,970 | 2,570 | 3,020 | 2,520 |
| Canada | -- | -- | -- | -- | 1,410 | 2,100 | 1,970 | 3,230 |
| China | -- | -- | -- | -- | 72,800 | 36,100 | 96,800 | 52,800 |
| Colombia | -- | -- | -- | -- | 1,070 | 1,290 | 1,190 | 1,330 |
| Cyprus | 3,360 | 1,350 | 3,030 | 1,230 | 491 | 190 | 20 | 10 |
| France | 38 | 24 | 54 | 32 | 44 | 337 | 246 | 818 |
| Germany | 38 | 38 | 197 | 239 | 35,600 | 23,200 | 43,700 | 29,600 |
| Hong Kong | -- | -- | -- | -- | 2,490 | 1,400 | 1,200 | 638 |
| India | 5 | 3 | 11 | 6 | 5,040 | 2,790 | 2,240 | 1,380 |
| Italy | -- | -- | -- | -- | 5,390 | 6,260 | 7,620 | 8,750 |
| Japan | 20 | 14 | 59 | 102 | 2,740 | 12,500 | 2,800 | 7,810 |
| Mexico | -- | -- | -- | -- | 2,610 | 2,280 | 2,540 | 2,200 |
| Spain | 20 | 7 | 279 | 87 | 301 | 136 | 418 | 202 |
| Sweden | -- | -- | -- | -- | 1,360 | 330 | 750 | 175 |
| United Kingdom | 23 | 155 | -- | -- | 255 | 1,880 | 274 | 1,840 |
| Other | 182 | 239 | 155 | 86 | 237 ^r | 221 ^r | 203 | 129 |
| Total | 4,000 | 5,150 | 4,100 | 2,100 | 136,000 | 94,500 | 166,000 | 114,000 |

^rRevised. -- Zero.

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

²Customs value.

Source: U.S. Census Bureau.

TABLE 8
NATURAL IRON OXIDE PIGMENTS: ESTIMATED WORLD PRODUCTION, BY COUNTRY^{1,2}

(Metric tons)

| Country ³ | 2000 | 2001 | 2002 | 2003 | 2004 |
|----------------------|-----------------------|----------------------|----------------------|-----------------------|------------------|
| Austria | 6,000 | 5,000 | 5,000 | 5,000 | 4,000 |
| Brazil | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 |
| Chile | -- ^r | -- ^r | -- ^r | -- ^r | -- |
| Cyprus, umber | 12,300 ^{r,4} | 7,800 ^{r,4} | 8,200 ^{r,4} | 11,900 ^{r,4} | 12,000 |
| France | 1,500 | 1,000 | 1,000 | 1,000 | 1,000 |
| Germany | 400 ^r | 400 ^r | 419 ^{r,4} | 429 ^{r,4} | 430 |
| India, ocher | 336,000 | 355,000 | 360,000 | 365,000 | 360,000 |
| Iran | 13,500 | 1,000 ⁴ | 2,300 ⁴ | 2,300 | 2,500 |
| Italy | 500 | 500 | 500 | 500 | 500 |
| Pakistan, ocher | 4,747 ⁴ | 4,800 | 4,500 | 4,500 | 4,500 |
| Paraguay, ocher | 300 | 300 | 300 | 300 | 300 |
| South Africa | 568 ⁴ | 852 ⁴ | 252 ⁴ | 643 ⁴ | 421 ⁴ |
| Spain, ocher | 87,000 ⁴ | 87,000 | 80,000 ^r | 80,000 | 75,000 |
| United States | 57,100 ⁴ | 61,500 ⁴ | W | W | W |

^rRevised. W Withheld to avoid disclosing company proprietary data. -- Zero.

¹Estimated data are rounded to no more than three significant digits.

²Table includes data available through June 4, 2005.

³In 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 Azerbaijan, China, Kazakhstan, Russia, Turkey, and Ukraine. Unreported output is probably substantial.

⁴Reported figure.