

Iron Oxide Pigments

By Henry E. Stipp¹

Sales of finished iron oxide pigments in 1972 increased to record levels as the result of a rapidly expanding business cycle. Demand for iron oxide pigments, especially manufactured yellow, was very strong. Increased utilization of yellow iron oxide pigment was attributed to its application in paint formulations to replace lead compounds such as lead chromate, or chrome yellow. Paint containing lead concentrations greater than 0.06% lead has been banned for use in household interiors after December 31, 1973, by the U.S. Food and

Drug Administration.

Although imports of iron oxide pigments increased substantially, they were not sufficient to satisfy the strong domestic demand. Imports of iron oxide pigments were curtailed by the strong economic expansion that occurred in West European countries in 1972, and by the effects of dollar devaluation and U.S. price controls. Normally, imports supplement domestic production of iron oxide pigments and supply a significant part of the domestic market.

DOMESTIC PRODUCTION

Production of finished iron oxide pigments, as indicated by sales in 1972, increased 35.9% to a record 174,392 short tons. The value of finished iron oxide pigments in 1972 increased 30% to \$40.3 million. Yellow iron oxide recorded the greatest percentage increase among the manufactured varieties, and metallic brown oxide showed the largest increase among the natural iron oxide colors. Twelve companies operated 18 plants in nine States in 1972. Pfizer, Inc. was the major producer, with plants in California, Illinois, and Pennsylvania.

Production of crude iron oxide pigments decreased substantially for the fourth con-

secutive year. Figures for production and sales were withheld in 1972 to avoid disclosing company confidential data. Five companies operating mines or plants in five States reported production of crude iron oxide pigments. The Cleveland-Cliffs Iron Co. produced the largest quantity from mines in Michigan.

Expansion of facilities by Pfizer, Inc. in Illinois and California was completed by August, and supplies of finished iron oxide pigments were expected to increase substantially by yearend.

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Table 1.—Salient iron oxide pigments statistics in the United States

| | 1968 | 1969 | 1970 | 1971 | 1972 |
|--|----------|----------|----------|----------|----------|
| Mine production.....short tons.. | 57,600 | 40,600 | 38,600 | W | W |
| Crude pigments sold or used.....do.... | 57,600 | 40,800 | 39,200 | W | W |
| Value.....thousands.. | \$457 | \$362 | \$442 | r \$415 | \$418 |
| Finished pigments sold.....short tons.. | 132,400 | 142,900 | 124,000 | 128,300 | 174,400 |
| Value.....thousands.. | \$31,000 | \$32,000 | \$28,000 | \$31,300 | \$40,300 |
| Exports.....short tons.. | 3,000 | 4,000 | 5,000 | 4,000 | 4,000 |
| Value.....thousands.. | \$1,000 | \$1,000 | \$2,000 | \$2,000 | \$2,000 |
| Imports for consumption.....short tons.. | 30,000 | 33,000 | 33,000 | 36,000 | 47,000 |
| Value.....thousands.. | \$4,000 | \$5,000 | \$6,000 | \$6,000 | \$9,000 |

r Revised. W Withheld to avoid disclosing individual company confidential data.

CONSUMPTION AND USES

Consumption of iron oxide pigments increased sharply in 1972 as the result of high levels of paint, lacquer, and varnish sales. Record high construction activity for the second consecutive year and increased sales of automobiles, appliances and furniture reportedly were responsible for the increased consumption of paint, lacquer, and varnish. Shortages of some grades of iron oxide pigments occurred as a result of overall economic expansion, dollar devaluation, and price controls. Domestic supplies of yellow iron oxide were inadequate and imports were curtailed by decreased shipments from abroad. Foreign producers preferred to sell their products overseas where they could obtain a higher price. Several new paint formulas were introduced that incorporated yellow iron oxide and yellow organic pigments as a replacement for yellow lead chromate. Inventories depleted in the last quarter of 1971 were being replaced during most of 1972, however increased consumption slowed inventory rebuilding. Micaceous iron oxide, imported

from Austria, was gaining increasing acceptance as a primer for protection of iron and steel structures against corrosion. A new group of red and yellow synthetic iron oxides became available for use in automobile finishes, aluminum coatings, and stains.

Iron oxide pigments were used in paints, rubber, plastics, concrete products, paper, magnetic ink, fertilizers, and animal food. They were used also in ferrite applications such as television components, filters in radio equipment, computer memory cores, door latches and seals, small electric motors, and inductor and microwave devices. Iron oxide material was used in miscellaneous applications such as abrasives, welding rod coatings, soil conditioners, foundry sands, and automobile brake linings.

Data are not collected by the Bureau of Mines on specific uses for iron oxide pigments, and the figures given in table 2 do not necessarily reflect all sales of iron oxide pigment material for uses other than pigments.

Table 2.—Finished iron oxide pigments sold by processors in the United States, by kind

| Pigment | 1971 | | 1972 | |
|---|--------------------------|----------------------|--------------------------|----------------------|
| | Quantity (short tons) | Value (thousands) | Quantity (short tons) | Value (thousands) |
| Natural: | | | | |
| Brown: | | | | |
| Iron oxide (metallic) ¹ | 13,453 | \$2,109 | 19,074 | \$3,467 |
| Umbers: | | | | |
| Burnt..... | 4,441 | 1,136 | 5,376 | 1,441 |
| Raw..... | 1,196 | 309 | 1,541 | 435 |
| Red: | | | | |
| Iron oxide..... | 27,518 | 1,938 | 35,541 | 2,547 |
| Sienna, burnt..... | 903 | 401 | 1,201 | 531 |
| Pyrite cinder..... | (²) | (²) | (²) | (²) |
| Yellow: | | | | |
| Ocher ³ | 10,181 | 2,088 | 6,223 | 495 |
| Sienna, raw..... | 787 | 277 | 992 | 389 |
| Total natural | 58,479 | 8,258 | 69,948 | 9,305 |
| Manufactured: | | | | |
| Black: Magnetic..... | 3,692 | 2,384 | 3,149 | 1,376 |
| Brown: Iron oxide..... | 6,272 | 2,284 | 6,539 | 2,748 |
| Red: | | | | |
| Pure red iron oxides: | | | | |
| Calcined copperas..... | 20,540 | 6,696 | 19,185 | 6,499 |
| Other chemical processes..... | 11,492 | 2,861 | 14,426 | 4,531 |
| Venetian red..... | 467 | 106 | 505 | 135 |
| Yellow: Iron oxide..... | 22,469 | 7,643 | 31,867 | 11,118 |
| Total manufactured | 64,932 | 21,974 | 75,671 | 26,407 |
| Unspecified including mixtures of natural and manufactured red iron oxides | 4,897 | 1,105 | 28,773 | 4,618 |
| Grand total | 128,308 | 31,337 | 174,392 | 40,330 |

¹ Includes black magnetite and Vandyke brown.

² Pyrite cinder included with red iron oxide for 1971 and 1972.

³ Includes yellow iron oxide.

PRICES

Increases in price ranging from 1/2 cent per pound up to 1 1/2 cents per pound were reported effective March 1 on selected items of manufactured iron oxide pigments. Further increases in price ranging from 1/4 cent per pound to 2 1/2 cents per pound were reported effective July 28 on

most items of manufactured iron oxide pigments. Natural iron oxide pigment prices remained steady throughout the year, with the exception of imported Vandyke brown, which increased by 3 1/2 cents per pound in October.

Table 3.—Prices quoted on finished iron oxide pigments, per pound, in bags, unless otherwise noted, as of December 31, 1972 ¹

| Pigment | Low | High | Pigment | Low | High |
|--------------------------------------|----------|----------|---|----------|----------|
| Black: | | | Red: | | |
| Pure..... | \$0.1625 | \$0.1925 | Domestic primers..... | \$0.0775 | \$0.1050 |
| Synthetic..... | .1788 | .1875 | Persian Gulf..... | .1375 | .1400 |
| Brown: | | | Pure synthetic..... | .1675 | .1825 |
| Pure, synthetic..... | .1775 | .2125 | Spanish, exdock, N.Y. ² | .1100 | .1175 |
| Metallic..... | .0850 | .1025 | Yellow: | | |
| Umber, American, burnt.... | .1225 | .1450 | Ocher, domestic..... | .0540 | .0550 |
| Umber, American, raw.... | .1250 | .1450 | Ocher, French type..... | .0975 | .1175 |
| Vandyke, imported ² | .1550 | .1900 | Pure, light lemon..... | .1600 | .1800 |
| Sienna, American, burnt.... | .1750 | .2000 | Other shades..... | .1500 | .1700 |

¹ Low and high range covers prices for carlots and less than carlots, at the works.
² Barrels.

Sources: Chemical Marketing Reporter and American Paint Journal.

FOREIGN TRADE

United States exports of iron oxide pigments in 1972 increased 7% to 4,268 short tons compared with exports of 3,984 short

tons in 1971. Canada received the major share in 1972.

Imports of natural and manufactured

Table 4.—U.S. exports of iron oxide and hydroxides, by country

| Destination | Pigment grade | | Other grades | |
|--------------------------------|-----------------------|-------------------|-----------------------|-------------------|
| | Quantity (short tons) | Value (thousands) | Quantity (short tons) | Value (thousands) |
| Argentina..... | 121 | \$39 | 27 | \$16 |
| Australia..... | 163 | 131 | 46 | 31 |
| Belgium-Luxembourg..... | 61 | 26 | 21 | 11 |
| Brazil..... | 155 | 99 | 50 | 44 |
| Canada..... | 1,777 | 633 | 894 | 475 |
| Colombia..... | 16 | 8 | 18 | 16 |
| France..... | 213 | 131 | 85 | 54 |
| Germany: | | | | |
| East..... | -- | -- | 120 | 57 |
| West..... | 45 | 73 | 256 | 126 |
| Guatemala..... | 24 | 8 | 4 | 2 |
| India..... | 8 | 7 | 32 | 29 |
| Italy..... | 82 | 55 | 604 | 749 |
| Japan..... | 80 | 37 | 534 | 479 |
| Mexico..... | 161 | 88 | 185 | 138 |
| Netherlands..... | 5 | 8 | 236 | 282 |
| Netherlands Antilles..... | 8 | 3 | 2 | 1 |
| New Zealand..... | 12 | 4 | -- | -- |
| Panama..... | 11 | 5 | 12 | 7 |
| Peru..... | 9 | 4 | 17 | 15 |
| Philippines..... | 44 | 18 | -- | -- |
| Portugal..... | -- | -- | 29 | 22 |
| South Africa, Republic of..... | 2 | 5 | 31 | 26 |
| Spain..... | 15 | 8 | 28 | 7 |
| Sweden..... | 19 | 8 | 8 | 4 |
| U.S.S.R..... | -- | -- | 230 | 172 |
| United Kingdom..... | 528 | 212 | 301 | 299 |
| Venezuela..... | 151 | 62 | 71 | 46 |
| Vietnam, South..... | 433 | 184 | -- | -- |
| Other..... | 125 | 70 | 85 | 53 |
| Total..... | 4,268 | 1,926 | 3,926 | 3,161 |

iron oxide pigments in 1972 increased 29.5% to 47,271 short tons compared with 36,496 short tons in 1971. The value of imports increased 38.6% in 1972 to \$8.5 million compared with \$6.2 million in 1971. Manufactured (synthetic) material constituted 72.5% of total U.S. imports. Crude and refined umber made up 63.4% of im-

ports of natural iron oxide pigments. The major part of manufactured iron oxide pigments imported into the United States in 1972 came from West Germany, Canada, and the United Kingdom. U.S. imports of natural iron oxide came mainly from Spain, Iran, and France in 1972.

Table 5.—U.S. imports for consumption of selected iron oxide pigments

| Kinds | 1971 | | 1972 | |
|---------------------------------|-----------------------|-------------------|-----------------------|-------------------|
| | Quantity (short tons) | Value (thousands) | Quantity (short tons) | Value (thousands) |
| Natural: | | | | |
| Ocher, crude and refined..... | -- | -- | 93 | \$6 |
| Siennas, crude and refined..... | 1,427 | \$125 | 1,272 | 196 |
| Umbre, crude and refined..... | 4,681 | 228 | 8,234 | 412 |
| Vandyke brown..... | 358 | 39 | 621 | 77 |
| Other ¹ | 1,794 | 171 | 2,777 | 236 |
| Total..... | 8,260 | 563 | 12,997 | 927 |
| Manufactured (synthetic)..... | 28,236 | 5,592 | 34,274 | 7,602 |
| Grand total..... | 36,496 | 6,155 | 47,271 | 8,529 |

¹ Classified by the Bureau of the Census as "Natural iron oxide and iron hydroxide pigments, n.s.p.f."

Table 6.—U.S. imports for consumption of iron oxide and iron hydroxide pigments, n.s.p.f., by country

| Country | Natural | | | | Synthetic | | | |
|-------------------------|-----------------------|-------------------|-----------------------|-------------------|-----------------------|-------------------|-----------------------|-------------------|
| | 1971 | | 1972 | | 1971 | | 1972 | |
| | Quantity (short tons) | Value (thousands) | Quantity (short tons) | Value (thousands) | Quantity (short tons) | Value (thousands) | Quantity (short tons) | Value (thousands) |
| Austria..... | 14 | \$2 | 15 | \$2 | -- | -- | -- | -- |
| Belgium-Luxembourg..... | -- | -- | -- | -- | 16 | \$3 | 19 | \$9 |
| Canada..... | -- | -- | -- | -- | 9,210 | 1,476 | 11,782 | 1,744 |
| Cyprus..... | 2 | (¹) | -- | -- | -- | -- | -- | -- |
| France..... | 97 | 15 | 149 | 17 | -- | -- | 23 | 12 |
| Germany: | | | | | | | | |
| East..... | -- | -- | -- | -- | 36 | 6 | -- | -- |
| West..... | 72 | 54 | 3 | 5 | 17,147 | 3,686 | 19,751 | 5,028 |
| Iran..... | -- | -- | 254 | 9 | -- | -- | -- | -- |
| Italy..... | (¹) | (¹) | -- | -- | 2 | (¹) | -- | -- |
| Japan..... | 1 | 1 | -- | -- | 115 | 106 | 121 | 272 |
| Mexico..... | -- | -- | -- | -- | -- | -- | 5 | 1 |
| Netherlands..... | 1 | 1 | -- | -- | 21 | 29 | 137 | 88 |
| Spain..... | 1,598 | 92 | 2,234 | 168 | 85 | 5 | 20 | 2 |
| Sweden..... | 8 | 2 | 40 | 7 | -- | -- | -- | -- |
| Switzerland..... | 1 | 4 | -- | -- | -- | -- | -- | -- |
| United Kingdom..... | -- | -- | 82 | 28 | 1,604 | 281 | 2,416 | 446 |
| Total..... | 1,794 | 171 | 2,777 | 236 | 28,236 | 5,592 | 34,274 | 7,602 |

¹ Less than ½ unit.

TECHNOLOGY

A method of selecting pigments for manufacturing powder coatings was described.² The final selection of a pigment was reportedly dependent upon end-use requirements, application method, proper resin system, and method of manufacturing. Pigment properties that entered into the

selection process were color, heat stability, chemical reactivity, hiding power, particle size, surface area, oil absorption, electrical

² American Paint Journal. The Colorful Choice In Powder Coatings. V. 56, No. 46, May 1, 1972, pp. 16-22.

properties, migratory properties, and weatherability.

Ferrites were proposed for use in identifying tanker ships involved in oil spills.³ The ferrite powder would be introduced into the oil when the tanker took on its load of petroleum. Each batch of ferrites would have different magnetic properties. When an oil spill occurred, the various magnetic properties of the ferrites could be decoded and the polluting ship identified by the code assigned to it. During unloading of the oil cargo the suspended ferrites could be removed by a magnetic filter. Scientists estimate that 11 variations of the ferrite composition would yield 2,000 different codes. About 1 ton of ferrite material would be required for a 100,000-ton vessel.

Iron oxide powders of submicron size were prepared by precipitation of iron hydroxide with ammonium hydroxide from a solution of iron chloride. The colloidal precipitate was heat treated in a fluidized bed.⁴ The iron oxide of submicron size gave superior performance when utilized as a pigment material in paint and when sintered with other metal oxides in preparing ferrite compounds.

A new ferrite material that was less sensitive to temperature changes was developed.⁵ Lower memory core manufacturing costs and improved computer reliability was indicated by use of the new ma-

terial. The new ferrite enables memory cores to operate from -25°C to 100°C without special temperature-controlling equipment.

A relatively low-cost process for regenerating pickle liquor with the production of iron oxide as a byproduct was reported.⁶ Armco Steel Corp. started up a \$4.25 million system at its Ashland, Ky., works that converts all the plant's spent pickle liquor into fresh hydrochloric acid. The system will regenerate about 90% of all the hydrochloric acid consumed at the Ashland works. Iron oxide is precipitated in the form of a fine powder of nearly pure grade. The process, sublicensed to Pennsylvania Engineering Corp., Pittsburgh, Pa., makes use of new technology and both plastic and titanium materials. Use of the process reportedly could save up to \$7 per ton to dispose of the spent pickle liquor and \$28 per ton for new hydrochloric acid. In addition, sale of the iron oxide would supplement the other savings.

³ Wall Street Journal. Culprits In Oil Spills Face GE Sleuthing by Magnetic Seeding. V. 180, No. 92, Nov. 10, 1972, p. 25.

⁴ Materials Science And Engineering. Some Developments in Iron Oxide and Iron Metal Submicron Powder Preparation Technology. V. 9, No. 2, February 1972, pp. 87-95.

⁵ Wall Street Journal. Ampex Says New Material Will Help Memory Cores. V. 179, No. 90, May 9, 1972, p. 16.

⁶ American Metal Market. Solution For Pollution—Pickle Liquor Recovery Saves \$\$\$. V. 79, No. 190, Oct. 17, 1972, pp. 12-13.

