Phosphorus and Phosphorus Chemicals

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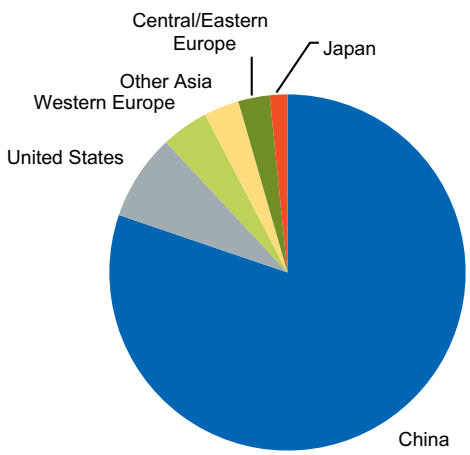
Abstract

Elemental phosphorus (P_4) is the starting material for phosphorus-containing chemicals used in a wide range of industrial markets. The most important chemicals derived directly from P_4 are phosphorus trichloride (PCl_3), phosphorus pentasulfide, phosphorus pentoxide and sodium hypophosphite, a relatively small-volume chemical used primarily in electroless nickel plating solutions. Phosphorus trichloride, phosphorus pentasulfide, and phosphorus pentoxide are the building blocks for a large number of derivative inorganic and organic chemicals, which in turn are used in a wide variety of high-value specialized applications.

There has been significant rationalization in the phosphorus industry during the past 10 to 20 years, largely because of the diminishing use of sodium phosphates in home laundry detergent powders. The phosphorus industry has undergone a dramatic shift away from Western countries to Asian countries during this period as a result of changes in technology and the increasing cost of electricity. The development of capacity to produce technical-grade phosphoric acid from wet agricultural acid has also resulted in the loss of market share for thermal acid, which is produced from elemental phosphorus. The decline in elemental phosphorus demand resulted in significant capacity decreases in both Europe and North America during the 1980s and 1990s and, in combination with high electric power costs, caused Japan to cease yellow phosphorus production entirely in 1987. In contrast, China's elemental phosphorus capacity has increased rapidly, and its exports of elemental phosphorus and derivatives have impacted the industry in other parts of the world.

The following pie chart shows consumption of elemental phosphorus by major region:

World consumption of elemental phosphorus—2016



Source: IHS

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In 2016, elemental phosphorus facilities were operating in China, Kazakhstan, the United States, Vietnam, and India. China accounts for the largest share at about 87% in 2016, followed by Kazakhstan, the United States, Vietnam, and India. China increased capacity by nearly 9% per year in 2002–12, but expansion has slowed in the past four years as the government has sought to protect the country's phosphorus resources. Vietnam, a relative newcomer to the phosphorus market, has increased capacity rapidly in the last 10 years, to become the largest supplier to the global market in 2016.

The production of thermal phosphoric acid (covered in the CEH *Industrial Phosphates* report), accounted for about 54% of global elemental phosphorus consumption in 2016. This has been a declining market and is forecast to continue to decline globally at 1.5% per year over the next five years. Traditionally, the major end use for thermal phosphoric acid was for industrial phosphates, including sodium tripolyphosphate (STPP). Following bans on STPP in household laundry detergent formulations and other domestic uses in many world regions over the last 15–20 years, consumption declined sharply. In most regions, industrial phosphates are now made from purified wet phosphoric acid. However, as China lacks technology for purified wet phosphoric acid, most industrial phosphates are still made from thermal acid and the country represents nearly 90% of the global consumption of phosphorus for thermal acid.

After thermal phosphoric acid, phosphorus trichloride is the largest chemical market for elemental phosphorus, accounting for nearly 27% of the total elemental phosphorus produced in 2016. China is again the largest consumer, accounting for more than two-thirds of the global market. Chinese capacity for phosphorus trichloride grew at double-digit rates in 2000–10, but slowed to less than 1% per year between 2011 and 2016, when the large overcapacity led the Chinese government to restrict expansion of phosphorus chemical production facilities beginning in 2014. Glyphosate and other pesticide intermediates are by far the largest market for phosphorus trichloride in China, accounting for 81% of consumption in 2016; about 80% of the glyphosate produced in China is destined for the export market. Over the next five years, Chinese consumption of phosphorus trichloride for glyphosate production is forecast to grow at nearly 4% per year.

Red phosphorus is consumed mainly for flame retardants for plastics. Other uses include safety matches, pharmaceuticals, pesticides, and bronze, as well as for the production of ultrapure red phosphorus for electronic applications. Currently, Western Europe is the primary market for red phosphorus, followed by China and India.

Further growth is expected for the phosphorus chemicals covered in this report—principally the phosphorus chlorides—over the next five years. However, demand for thermal phosphoric acid is expected to decline in all regions. In fact, the impact of slowing thermal phosphoric acid demand is expected to result in an overall decline in world elemental phosphorus consumption of about 0.2% per year over the next five years. This decline will be most pronounced in China, where the decline in thermal phosphoric acid production will outpace the growth of the other phosphorus chemicals. The increase in demand for PCl_3 derivatives—organophosphate herbicides (specifically glyphosate), plastics and elastomer additives, and sequestrants and surfactants—will be seen predominantly in China.

Contents

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