

CHEMICAL INDUSTRY

The Chemical Industry comprises the companies that produce industrial chemicals. It is central to modern world economy, converting raw materials (oil, natural gas, air, water, metals, minerals) into more than 70,000 different products.

Products

Polymers and plastics, especially polyethylene, polypropylene, polyvinyl chloride, polyethylene terephthalate, polystyrene and polycarbonate comprise about 80% of the industry's output worldwide. Chemicals are used to make a wide variety of consumer goods, as well as thousands inputs to agriculture, manufacturing, construction, and service industries. The chemical industry itself consumes 26 percent of its own output. Major industrial customers include rubber and plastic products, textiles, apparel, petroleum refining, pulp and paper, and primary metals. Chemicals is nearly a \$3 trillion global enterprise, and the EU and U.S. chemical companies are the world's largest producers.

Product Category Breakdown

Sales of the chemical business can be divided into a few broad categories, including basic chemicals (about 35 to 37 percent of the dollar output), life sciences (30 percent), specialty chemicals (20 to 25 percent) and consumer products (about 10 percent).

Basic chemicals, or “commodity chemicals” are a broad chemical category including polymers, bulk petrochemicals and intermediates, other derivatives and basic industrials, inorganic chemicals, and fertilizers. Typical growth rates for basic chemicals are about 0.5 to 0.7 times GDP. Product prices are generally less than fifty cents per pound. Polymers, the largest revenue segment at about 33 percent of the basic chemicals dollar value, includes all categories of plastics and man-made fibers. The major markets for plastics are packaging, followed by home construction, containers, appliances, pipe, transportation, toys, and games. The largest-volume polymer product, polyethylene (PE), is used mainly in packaging films and other markets such as milk bottles, containers, and pipe. Polyvinyl chloride (PVC), another large-volume product, is principally used to make pipe for construction markets as well as siding and, to a much smaller extent, transportation and packaging materials. Polypropylene (PP), similar in volume to PVC, is used in markets ranging from packaging, appliances, and containers to clothing and carpeting. Polystyrene (PS), another large-volume plastic, is used principally for appliances and packaging as well as toys and recreation. The leading man-made fibers include polyester, nylon, polypropylene, and acrylics, with applications including apparel, home furnishings, and other industrial and consumer use. The principal raw materials for polymers are bulk petrochemicals.

Chemicals in the bulk petrochemicals and intermediates are primarily made from liquefied petroleum gas (LPG), natural gas, and crude oil. Their sales volume is close to 30 percent of overall basic chemicals. Typical large-volume products include ethylene, propylene, benzene, toluene, xylenes, methanol, vinyl chloride monomer (VCM), styrene, butadiene, and ethylene oxide. These chemicals are the starting points for most polymers and other organic chemicals as well as much of the specialty chemicals category.

Other derivatives and basic industrials include synthetic rubber, surfactants, dyes and pigments, turpentine, resins, carbon black, explosives, and rubber products and contribute about 20 percent of the basic chemicals' external sales. Inorganic chemicals (about 12 percent of the revenue output) make up the oldest of the chemical categories. Products include salt, chlorine, caustic soda, soda ash, acids (such as nitric, phosphoric, and sulfuric), titanium dioxide, and hydrogen peroxide. Fertilizers are the smallest category (about 6 percent) and include phosphates, ammonia, and potash chemicals.

Life sciences (about 30 percent of the dollar output of the chemistry business) include differentiated chemical and biological substances, pharmaceuticals, diagnostics, animal health products, vitamins, and crop protection chemicals.

While much smaller in volume than other chemical sectors, their products tend to have very high prices—over ten dollars per pound—growth rates of 1.5 to 6 times GDP, and research and development spending at 15 to 25 percent of sales. Life science products are usually produced with very high specifications and are closely scrutinized by government agencies such as the Food and Drug Administration. Crop protection chemicals, about 10 percent of this category, include herbicides, insecticides, and fungicides.

Specialty chemicals are a category of relatively high valued, rapidly growing chemicals with diverse end product markets. Typical growth rates are one to three times GDP with prices over a dollar per pound. They are generally characterized by their innovative aspects. Products are sold for what they can do rather than for what chemicals they contain. Products include electronic chemicals, industrial gases, adhesives and sealants as well as coatings, industrial and institutional cleaning chemicals, and catalysts. Coatings make up about 15 percent of specialty chemicals sales, with other products ranging from 10 to 13 percent.

Specialty Chemicals are sometimes referred to as “fine chemicals”

Consumer products include direct product sale of chemicals such as soaps, detergents, and cosmetics. Typical growth rates are 0.8 to 1.0 times GDP.

Every year, the American Chemistry Council tabulates the U.S. production of the top 100 basic chemicals. In 2000, the aggregate production of the top 100 chemicals totaled 502 million tons, up from 397 million tons in 1990. Inorganic chemicals tend to be the largest volume, though much smaller in dollar revenue terms due to their low prices. The top 11 of the 100 chemicals in 2000 were sulfuric acid (44 million tons), nitrogen (34), ethylene (28), oxygen (27), lime (22), ammonia (17), propylene (16), polyethylene (15), chlorine (13), phosphoric acid (13) and diammonium phosphates (12).

Technology

As accepted by chemical engineers, the chemical industry involves the use of chemical processes such as chemical reactions and refining methods to produce a wide variety of solid, liquid, and gaseous materials. Most of these products are used in manufacture of other items, although a smaller number are used directly by consumers. Solvents, pesticides, lye, washing soda, and portland cement are a few examples of product used by consumers. The industry includes manufacturers of inorganic- and organic-industrial chemicals, ceramic products, petrochemicals, agrochemicals, polymers and rubber (elastomers), oleo chemicals (oils, fats, and waxes), explosives, fragrances and flavors. Examples of these products are shown in the Table below.

Product Type	Examples
inorganic industrial	ammonia, nitrogen, sodium hydroxide, sulfuric acid, nitric acid
organic industrial	acrylonitrile, phenol, ethylene oxide, urea
ceramic products	silica brick, frit
petrochemicals	ethylene, propylene, benzene, styrene
agrochemicals	fertilizers, insecticides, herbicides
polymers	polyethylene, Bakelite, polyester
elastomers	polyisoprene, neoprene, polyurethane
oleochemicals	lard, soybean oil, stearic acid
explosives	nitroglycerin, ammonium nitrate, nitrocellulose
fragrances and flavors	benzyl benzoate, coumarin, vanillin

Although the pharmaceutical industry is often considered a chemical industry , it has many different characteristics that puts it in a separate category. Other closely related industries include petroleum, glass, paint, ink, sealant, adhesive, and food processing manufacturers.

Chemical processes such as chemical reactions are used in chemical plants to form new substances in various types of reaction vessels.

In many cases the reactions are conducted in special corrosion resistant equipment at elevated temperatures and pressures with the use of catalysts. The products of these reactions are separated using a variety of techniques including distillation especially fractional distillation, precipitation, crystallization, adsorption, filtration, sublimation, and drying. The processes and product are usually tested during and after manufacture by dedicated instruments and on-site quality control laboratories to insure safe operation and to assure that the product will meet required specifications. The products are packaged and delivered by many methods, including pipelines, tank-cars, and tank-trucks (for both solids and liquids), cylinders, drums, bottles, and boxes. Chemical companies often have a research and development laboratory for developing and testing products and processes. These facilities may include pilot plants, and such research facilities may be located at a site separate from the production plant(s).

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