

The Chemicals Industry in South Africa

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Built upon the nation's abundant coal reserves, South Africa's chemicals industry spent much of the 20th century isolated from world trade. The abolishment of apartheid opened doors to its full participation in global markets.

South Africa's chemicals industry dates back to the third quarter of the 19th century. That era could reasonably be described as the South African industrial revolution, as it led to the proliferation of industries that forever changed the way South Africans would live and work.

South Africa's desire to exploit opportunities provided by the mining of diamonds and gold necessitated the emergence of a strong and highly diversified industrial sector. Sustained access to those minerals demanded the establishment of an explosives industry, which was soon followed by a chlor-alkali industry and industrial specialty and fine chemicals sectors. Now, more than a century later, this picture still characterizes South Africa's chemicals industry — in spite of the recent sociopolitical factors that have led to major restructuring and repositioning to render it more competitive in today's global markets.

This article describes the evolution of the South African chemicals industry — from its inception in 1868 to the present — and projects that are leading it into the future.

Historical overview

South Africa is situated at the southern end of the African continent (Figure 1). Its economy is the most-developed in Africa, mainly due to the efficient exploitation of its abundant mineral resources and its highly diversified

manufacturing sector. Gauteng province dominates South Africa's chemicals manufacturing, with 47% of the companies based there, followed by KwaZulu-Natal with 18% of the companies, and Western Cape, home to about 16% of the chemicals companies.

South Africa's chemicals industry was founded in the latter part of the 19th century to fill the demand for explosives and chemicals needed by the mining industry. Because the country has no significant upstream oil reserves, its chemicals industry has primarily developed around the gasification of the nation's abundant coal reserves.

In 1878, George William Stow, a British geologist, discovered coal near Vereeniging on the banks of South Africa's Vaal River (1), which borders the Gauteng, Mpumalanga, North West, and Free State provinces. By the early 20th century, cities in the coal-rich Vaal River valley, such as Vereeniging, Vanderbijlpark, and Sasolburg, became centers of new industry, with the establishment of electric power and water purification stations, engineering firms, and plants for making steel, synthetic fuels, and chemicals. These businesses and their related industries thrived, and the local populations prospered.

South Africa's petrochemicals industry started in the 1950s, when the first coal-to-liquids (CTL) plant was built at Sasolburg. It was not until more recently, however, that a chemicals industry based on local raw materials rather than imported feedstocks became possible. This strategic

Note: Monetary values have been converted from £ or rand (ZAR) to U.S. dollars using the exchange rates in effect during the pertinent year.

self-sufficiency in fuels followed the establishment of two large CTL plants built by Sasol at Secunda during the early 1980s. Today, the synfuels sector serves as a source of energy, and is also the country's major source of chemical feedstocks and intermediates.

The nation's chemicals industry has been shaped by the political and regulatory environment of the apartheid era — 1948 to 1994 — during which a white minority government implemented laws to enforce racial separation, to the disadvantage of the majority black population. The world reacted by isolating South Africa economically, technologically, and militarily through international sanctions — an unsustainable situation that impeded the nation's prosperity and emergence on the world stage. The apartheid years, marked by South Africa's near-total isolation from international trade, fostered a necessary self-reliance and a focus on replacing previously imported commodities, such as energy, armaments, chemicals, and appliances, with domestically produced goods. By extension, this approach also encouraged the building of small-scale plants with capacities geared only to meeting domestic demand.

In that era of import replacement, chemical plants were built at inland locations, close to the coal-based synthetic fuels plants that provided their feedstocks. The plants were clustered around the heavily populated Gauteng province, South Africa's largest domestic market both for industrial and consumer goods. Those plants are generally smaller than world-scale, and their cost structures are not highly competitive in export markets, partly because of the high costs to transport products to coastal ports. They are, nevertheless, well placed for exports to the neighboring African countries of Zimbabwe, Namibia, Swaziland, Mozambique, and Botswana.

During apartheid, the isolation of South Africa's chemicals industry from international competition, together with high raw material prices, helped to make the country's domestically produced goods less than competitive in export markets.

That changed in the 1990s, when South Africa's then-president Frederik Willem de Klerk began negotiations with the African National Congress (ANC), under the leadership of Nelson Mandela, to end apartheid. Those efforts culminated in 1994 with multiracial democratic elections, a new ANC-led government, and the lifting of international sanctions. Now that South Africa is once more a participant in the global community, the nation's chemicals companies are focusing on the need to be internationally competitive, and the industry is reshaping itself accordingly. In 2004, the South African Dept. of Trade and Industry (2) convened workshops devoted to petrochemicals, plastics, and synthetic fibers — sectors of the South African economy that are considered to have great potential for the future — to develop a path forward.



▲ **Figure 1.** South Africa consists of nine provinces. Most of the country's chemicals manufacturing is situated near the coal-rich and densely populated Vaal River valley.

Mining and the birth of an industry

The 1868 discovery of diamonds near Kimberley, followed by an 1886 gold boom in the Witwatersrand hills near Johannesburg and the exploitation of the coalfields of Witbank and Vryheid, sparked South Africa's industrial revolution. These discoveries gave rise to a full-fledged mining industry, the sustenance of which mandated a reliable explosives industry. The first 40 years of the South African chemicals industry were dominated by the explosives sector.

By 1911, the explosives industry was by far the largest manufacturing sector in the country, with an initial investment of approximately US\$10 million and more than 3,000 employees. Stiff competition within the burgeoning explosives industry necessitated diversification, and companies began expanding into fertilizers, paints, veterinary preparations, and insecticides to meet the growing domestic demand for chemical products.

Many of those diversified companies still exist. Foremost among them are African Explosives Ltd. (AECI), which was founded in the 1970s to manufacture nitric acid and ammonia; the Sentrachem group of companies (which were eventually acquired by Dow Chemical); and SAPPI-SAICCOR, which was founded in 1988 after the acquisition of South African Industrial Cellulose Corp. (SAICCOR) by South African Pulp and Paper Industries Ltd. (SAPPI).

AECI — which had revenue of US\$1.4 billion in 2014 and remains a key player in the mining, manufacturing, and agricultural sectors — is an example of a company that has evolved significantly since its founding. Its history includes an



▲ **Figure 2.** South Africa's chemicals industry has its roots in the nation's abundant coal reserves. Photo courtesy of Richards Bay Coal Terminal.

exit from ammonia and urea production; the sale of its monomers, polymers, chlor-alkali, cyanides, and peroxides interests to Sasol; and international collaborations, such as a joint venture with the U.S.-based Pittsburgh Plate Glass (PPG) Industries to develop the Dulux technical paints business.

The emergence of South African petrochemicals

In South Africa, petrochemicals comprise about 55% of all chemicals produced, and the petrochemicals industry is valued at almost US\$30 billion.

The abundance of coal in South Africa — 92% of the coal consumed on the African continent is produced in South Africa — fostered an economy largely dependent on this fossil fuel (Figure 2). The petrochemicals sector in South Africa is built on coal gasification. Additionally, more than 95% of South Africa's electricity is generated by burning coal.

South Africa's CTL industry dates back to 1895, and the production of synthetic fuels expanded in the early 20th century. Coal chemistry received a boost in 1927 when the government published a white paper advocating the development of gasification and carbonization processes.

In the early 1930s, Anglovaal, a key South African mining company, collaborated with U.K.-based Burmah Oil to mine oil shale near Ermelo. The shale was distilled and refined, mainly for gasoline. Anglovaal's CTL interests were extended when it acquired rights to the German Fischer-Tropsch process. Franz Fischer visited South Africa in 1938 to assist in getting the venture off the ground. However, World War II soon intervened. During the War, Anglovaal maintained its CTL business and explored the prospects of international joint ventures, including one with the U.S.-based M.W. Kellogg Corp., but those efforts were disrupted by the arrival of apartheid in 1948.

Forty percent of the liquid fuels used in South Africa are derived from coal through the Fischer-Tropsch process. Today, the Fischer-Tropsch technology is used in the plants operated by Sasol, which was founded in 1950 (3) and grew into a petrochemicals giant in the 1980s.

Sasol's first CTL plant began production in 1955, in the company's namesake town of Sasolburg, Free State province. Sasol's early production efforts were fraught with technical challenges (3). However, Sasol's chemists and engineers not only kept the plant operating, but also improved its efficiency and widened the product range to include feedstocks for the manufacture of synthetic rubber, fertilizers, and secondary chemicals. In 1971, Sasol collaborated with Total SA and the National Iranian Oil Co. to build a refinery (NATREF) in Sasolburg, which refined imported petroleum to produce ethylene for plastics and supplied pipeline gas to industry.

Before World War II, coal provided more than two-thirds of the world's energy. By 1973, however, oil had replaced coal as industry's dominant fuel. At the same time, the first Middle East oil crisis was threatening the world's oil supplies. In response to those developments, Sasol began construction of a second CTL plant at Secunda. The \$2.8-billion plant, called Sasol Two, was completed in 1980.

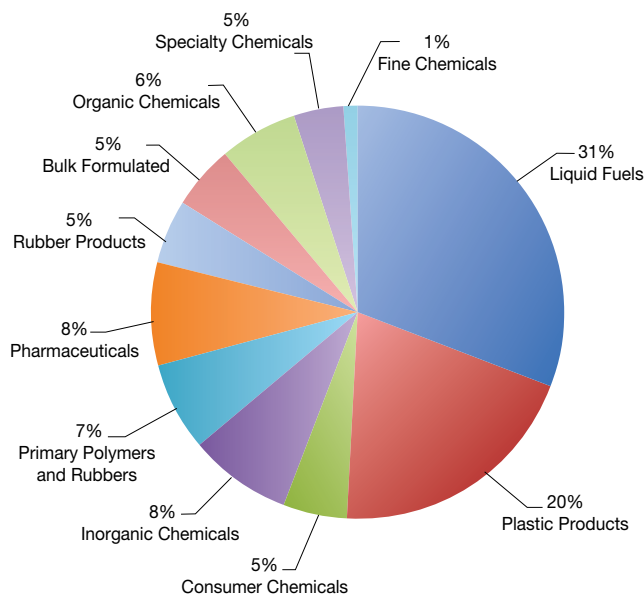
In that era, South Africa had been importing much of its oil from Iran. However, the 1979 overthrow of Iran's Shah, along with the ensuing second Middle East oil shock, prompted Sasol to construct a third CTL plant. Sasol Three was built in 1982 adjacent to Sasol Two.

Since its inception, Sasol has placed a high priority on research and development. The original Sasol plant no longer produces fuels, but instead a wide range of chemicals that includes ethanol, butanol, ethyl acetate, acrylic acid, and butyl acrylate. Chemcity — a new downstream chemical production facility at Sasolburg — started up in 2010 to make use of these Sasol products. Meanwhile, the Fischer-Tropsch process has undergone continuous improvement, first through the Synthol process and, more recently, the Sasol Advanced Synthol (SAS) process.

In 1999, the subsidiaries Sasol Technology and Sasol Synthetic Fuels commissioned seven new SAS reactors at Secunda. Sasol Two and Sasol Three are now producing fuels with greater efficiency, and a variety of petrochemical feedstocks and specialty chemicals are being extracted from the product stream. Also, the Sasol Slurry-Phase Distillate process for making high-quality diesel fuel from natural gas has captured international interest. About 40% of the Secunda site's natural gas feedstock is piped in from neighboring Mozambique.

Today, Sasol produces almost 160,000 bbl/day of liquid fuels (4), serving 40% of the South African market. The company's recent construction of a 34,000-bbl/day gas-to-liquids (GTL) facility in Qatar, a joint venture of Sasol and Qatar's Oryx GTL, and its plans to build an \$8.9-billion, 1.5-million ton/yr ethylene cracker in Louisiana are evidence of Sasol's globalization strategy.

Sasol is not alone in the petrochemicals sector. The



▲ **Figure 3.** South Africa's chemicals industry is highly diversified. This chart shows the key segments of the chemicals manufacturing sector and their share of the country's total production in 2011. Source: (5)

Engen refinery in Durban produces benzene and other aromatics. Propylene is produced at the Sapref refinery in Durban, where a splitter owned by Saffripol is in operation.

South Africa's only state-owned refinery, PetroSA, located in Mossel Bay, Western Cape province, generates mixed-alcohol and ketone streams for export and processes offshore natural gas using a Fischer-Tropsch GTL process.

The specialty chemicals sector

In 1967, three South African companies — National Chemical Products (NCP), Industrial Development Corp. (IDC), and Federale Volksbeleggings (FVB) — pooled their chemical interests into a single entity then known as Sentrachem. Sentrachem's first project was a joint venture with the U.S.-based Uniroyal to produce rubber chemicals. The new venture, called Karbochem, soon absorbed South Africa's Synthetic Rubber Co. (SRC), and eventually diversified into products such as synthetic rubber, water-based lubricants, carbide, acetylene, and carbon black.

Soon after that, Sentrachem embarked on other joint ventures. In 1972, it partnered with Hoechst SA to form Saffripol, a producer of high-density polyethylene and poly-

propylene. Later, Sentrachem collaborated with Olin Corp. to form Aquachlor, which produced chlorine-based water sanitizers. The acquisition of Agricura (renamed Agrihold), a formulator of insecticides and herbicides, launched South Africa's entry into agricultural chemicals.

Sentrachem's international diversification also included the 1995 purchase of the U.S.-based Hampshire Chemicals Corp. Hampshire was selected for takeover because its products, technologies, and markets (specialty organic chemicals used in consumer products, personal care, industrial, agricultural, and pharmaceutical applications) complemented those of companies within the Sentrachem Group.

By the 1990s, however, a variety of factors — including international competition, high interest rates, and South African droughts — had adversely affected Sentrachem's profitability. A concurrent decline in the value of the South African rand left the company in a vulnerable position. In 1997, before restructuring of the Sentrachem Group could be implemented, the Dow Chemical Co. acquired control of the organization. Dow subsequently purchased Hoechst SA's interest in Saffripol and restructured Agrihold and Sanachem into Dow Agrosciences.

In 2001, Dow began selling off some of the businesses in the original Sentrachem portfolio, including those producing alcohols, resins, sorbitol, and amines. By 2006, Dow's South African holdings consisted of two main companies — Dow Agrosciences and Dow Plastics. Dow Plastics has since been re-established under its original name of Saffripol.

South Africa's chemicals industry today

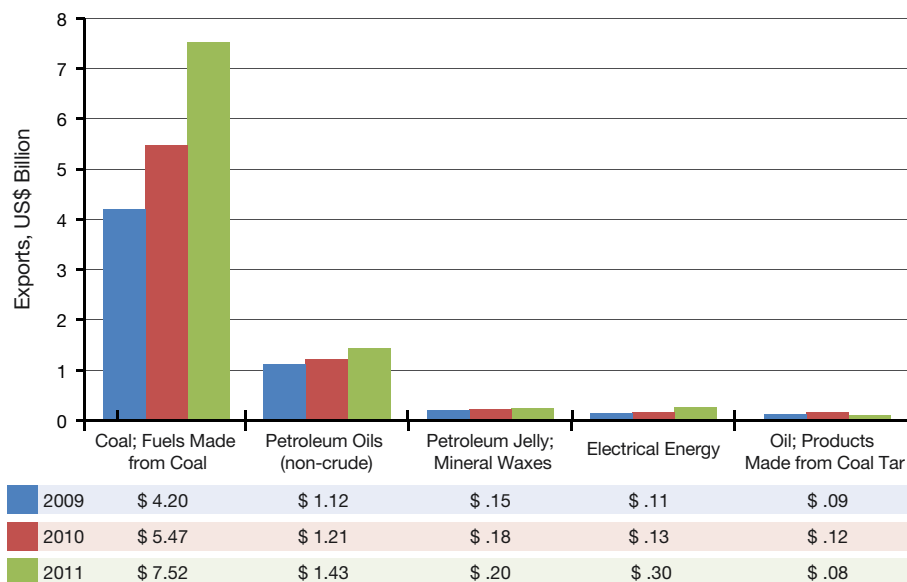
The chemicals sector in South Africa is the largest of its kind in Africa, and it is highly diversified. The sector is broadly divided into 11 subsectors, as shown in Figure 3.

Despite the industry's complexity and recent changes, its foundation is sound, and it is expected to experience growth in the foreseeable future. South Africa continues to have a self-sufficient chemical manufacturing base. However, the country still exports and imports goods as a way of strengthening trade relations with key countries, particularly the U.S., Germany, and China. Table 1 depicts the exports and imports profile of subsectors of South Africa's chemicals manufacturing industry.

The crucial role played by the coal-related industries in

Table 1. South Africa's chemicals imports and exports, value in 2011, US\$ billion. Source: (5)

	Mineral Fuels, Oils, Distillation Products	Plastics	Pharmaceutical Products	Organic Chemicals	Rubber and Related Products	Inorganic Chemicals, Precious Metals, Compound Isotopes	Miscellaneous Chemical Products
Exports	\$9.74	\$1.10	\$0.18	\$1.38	\$0.52	\$1.55	\$0.76
Imports	\$21.24	\$2.41	\$2.20	\$1.71	\$1.50	\$1.31	\$1.43



▲ **Figure 4.** Coal-related industries are a major part of South Africa's chemicals exports profile. Source: (5)

South African exports is worth emphasizing. The top five exports in the mineral fuels, oils, and distillation products sector are coal, petroleum oils, mineral waxes, electricity, and other products distilled from coal tar. Figure 4 summarizes the extent of exports in these subsectors. Coal is the main export revenue generator; more than 25% (almost 70 million ton/yr) of South Africa's mined coal is exported.

South Africa's major coal reserves are located in the provinces of Limpopo, Mpumalanga, Free State, KwaZulu-Natal, and Eastern Cape, with the largest concentration of coal mines near the towns of Witbank, Ermelo, and Secunda (5). Low-grade coal is used mostly for heating, power generation, and gasification. High-quality coal is reserved for export, most of it via the Richards Bay Coal Terminal (Figure 5), Africa's largest coal export facility, located on the KwaZulu-Natal coast of the Indian Ocean.

The future

The chemicals and petrochemicals industry in South Africa is expected to grow by about 2–4% per year during the coming decade (6), and the commodities and specialty chemicals sectors are expected to grow as well (7). While most of this growth will stem from innovation and operational efficiency improvements, the growth in petrochemicals, in particular, is likely to be driven by the demand from end-user industries, such as paints and coatings, automotive, mining, and construction, which procure large amounts of chemicals from domestic refineries and manufacturing plants.

The demand for fuel additives is also expected to increase as South Africa's Clean Fuels II regulation — which mandates fuels with reduced sulfur content of 10 ppm — is expected to take effect in 2017.

A push is underway to implement biofuels requirements set forth by the government's *White Paper on Renewable Energy* (8), which sets a goal of producing 10,000 GW-hr/yr of energy from renewable energy sources — mainly from biomass, wind, solar, and small-scale hydropower. The legislation, which is likely to be implemented within the next two years, would also require all diesel fuels to have a 5% blend of biodiesel, and ethanol to have a bioethanol component between 2% and 10%. The strategy is intended to promote farming and other forms of economic development in areas previously neglected under the apartheid system.

The South African government is also promoting the development of the domestic pharmaceuticals industry, in part to bolster the domestic companies that provide raw materials to this sector.

Alongside its successes and optimism, the South African chemicals industry faces many challenges. Foremost among these is the shortage of engineers in general, and chemical engineers in particular. Currently, the South African population can claim only one engineer for every 2,114 citizens (9), with chemical engineers constituting no more than 10% of all registered professional engineers in the country. Compare this to the workforce in other developing countries, such as India, South Korea, and China, which have one engineer for every 200 people on average, and South Africa's staffing picture looks rather unfavorable.

Another challenge pertains to the fact that much of the chemicals industry still relies on imported raw materials, which are subject to international levies that reduce manufacturers' profit margins. Additionally, the renewed emphasis on green economies implies significant reduction in both gaseous emissions and liquid discharges, which does not bode well for an economy that is largely based on coal. As noted earlier, 40% of the fuel supply in South Africa is derived from coal, and more than 95% of the nation's electricity is generated from coal. However, the recent discovery of shale gas deposits in the country's southern Karoo basin, as well as natural gas reserves discovered in South Saharan Africa (mainly in Mozambique and Angola), are likely to be game changers for the African economy. South Africa, in particular, is in the top ten countries with the largest technically recoverable shale gas resources.

An emerging threat to South Africa and its chemicals

industry relates to another crucial resource: water. South Africa is one of the 30 driest countries in the world, and the need to use water more efficiently has never been more urgent. The heavy reliance on water by several key industries, such as pulp and paper, is a cause for serious concern.

The main threat to the South African chemicals industry remains the fact that it was largely founded under the apartheid philosophy of isolationism and protectionism that shielded it from global competition. Now that South Africa is part of the international community, its chemicals industry must be globally competitive in order to be sustainable. The domestic industries that once served the nation so well can no longer be relied upon solely for future prosperity.

Yet, in the 20 years since the abolishment of apartheid and the transfer of political power to majority rule, South Africa is adapting well to the global scene. Doors have been opened to international import and export markets and opportunities for new collaborations on the world stage. CEP

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▲ **Figure 5.** The Richards Bay Coal Terminal, in KwaZulu-Natal Province on the Indian Ocean, is Africa’s largest coal exporting facility. Ninety-two percent of the coal consumed on the African continent is mined in South Africa. Photo courtesy of Richards Bay Coal Terminal.

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