The Chemical Industry in México: Evolution, Challenges, and Perspectives

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New investments in industry and raw materials, as well as the modernization of infrastructures and industry practices, can help to reverse México's growing trade deficit and restore the health of its chemical industry.

México's chemical industry includes more than 350 companies that operate more than 400 production plants, located mainly in the states of Veracruz and Tamaulipas along the Gulf of México, in the greater metropolitan area of México City, and in the state of Nuevo León in northeastern México along the Texas border. The privately owned petrochemical companies and foreign-owned chemical companies are tightly linked to the state-owned Petróleos Mexicanos (PEMEX), which supplies the industry's main feedstocks and is also a major customer for the industry's products.

In 2010, the chemical industry in México registered imports of $26.3 billion; exports, on the other hand, totaled $9.3 billion — creating a trade deficit of $17 billion. Furthermore, this deficit was 43% deeper than in 2009. The recent economic trends of México's chemical industry are illustrated in the diagram on the next page.

The recent trajectory of the chemical industry in México is evidenced by its contribution to the country's gross domestic product (GDP) — in 1995, the industry accounted for 5.3% of GDP (the world average is 4.6%), but its contribution had fallen to only 1.8% of GDP by 2010. In the capital-intensive chemical industry, annual investments in new facilities or in upgrades of existing facilities recently averaged $900 million. Investments are expected to improve to around $2 billion per year for the period 2012–2016. Investment in R&D is normally 2–3% of sales *(1)*, which compares favorably to investment levels in other world-class economies.

The reasons for the downward trend of Mexico's chemical industry are several. This article offers an analysis of the industry's evolution leading to its current state, and suggests solutions to recover growth.

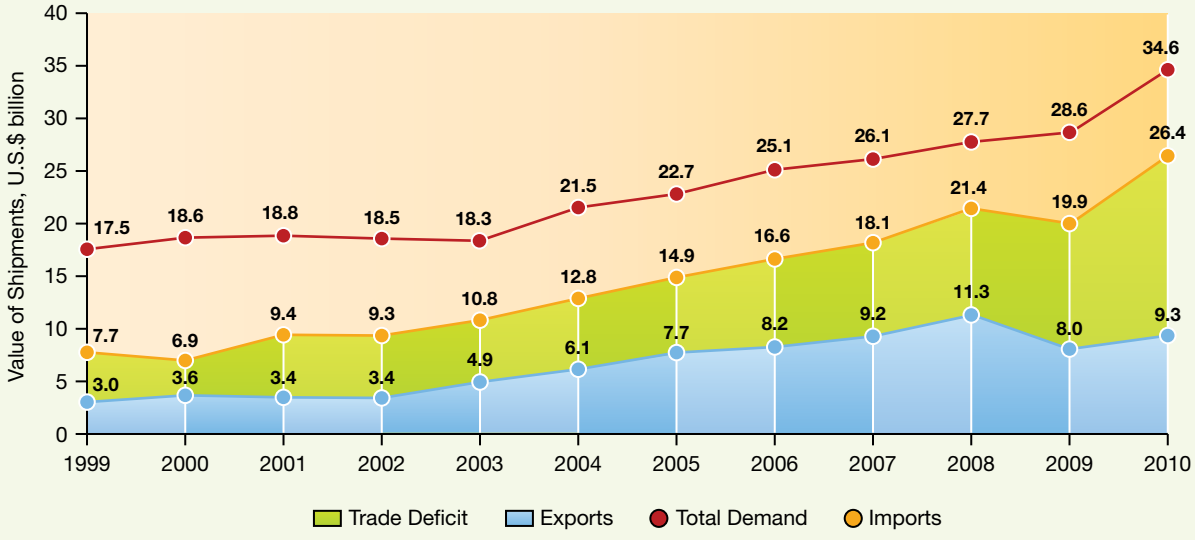
An industry begins *(2)*

In the early 1950s, México's chemical industry was divided into two major segments: basic and intermediate petrochemicals such as benzene, xylenes, and propylene, produced by state-owned companies; and secondary petrochemicals such as glycols, synthetic rubber, and polyvinyl chloride (PVC), produced by private companies.

The first noteworthy modern chemical production plant in México was an ammonia synthesis facility opened in 1950 and operated by the government-owned Guanos y Fertilizantes de México (GUANOMEX), a builder of fertilizer, phosphate, and pesticide plants. In 1957, GUANOMEX and PEMEX collaborated to produce tetraethyl lead in a plant in México City. Other early chemical-industry milestones

The Trade Balance of México's Chemical Industry *(3)*

In México, many of the raw materials used in chemical production are imported, a factor that contributes to the country's significant trade deficit. Notable chemical imports include butadiene (100% imported) and styrene (40% imported). In 2010, 76% of México's consumption of chemical feedstocks was supplied by imports. The commercial balance of the country's chemical industry over the past decade is illustrated in this diagram.



included the production of steel using a nontraditional iron ore hydrogenation process developed in 1957 by Hylsa (a predecessor of ALFA, S.A.), and the revolutionary development of the first hormonal form of birth control pill (using hormones extracted from *Dioscorea mexicana*, an indigenous type of yam plant) that was commercialized by Syntex Laboratories in 1964.

One factor that stimulated early investments in chemical plants was the closing of México's borders to all chemical and petrochemical imports — including pesticides, fertilizers, polymers, and others. The Mexican government also offered tax incentives to domestic chemical producers, as well as to foreign investors, for building plants in México to replace such imports. These factors paved the way for the construction and startup of a titanium dioxide plant by DuPont in 1959. Other international companies entering México at this time included Bayer, Hercules, Montrose, Phillips Petroleum, and Procter & Gamble. Many of these companies co-invested with Mexican partners in order to be allowed to own and operate plants through a petrochemical permit issued by México's Petrochemical Commission, a board composed of representatives from several federal-government entities. The permits provided the protection of a closed border to imports, as well as the capability to fix internal prices, which normally were considerably higher than international competitors' prices. To obtain such a permit, the enterprise could have no more than 40% foreign capital investment.

Although the entry of foreign partners and pro-industry legislation contributed to the rapid industrialization of México's chemical industry, the speed of this growth also promoted inefficiencies and the mediocre quality of products for the domestic market, including plasticizers, pesticides, and polymers such as PVC. Nevertheless, the chemical industry grew at an 8% annual rate during the 1960s and early 1970s.

Case study part 1: The rise of CelMex

A major contributor to the early growth of México's chemical industry — and a good example of how the industry evolved in México — is Celanese Mexicana (CelMex).

During World War II, México was cut off from the synthetic fibers used in textile manufacturing that it had been purchasing from Italy and Japan. Although commercial relations with the United States had soured following the expropriation by México of foreign oil companies in 1938, the Mexican government had little choice but to turn to the U.S. to seek a company to make rayon. It found such a partner in Celanese Corp., which in 1944 became the first large U.S. company to enter México since 1938. Nacional

Financiera, S.A., the government development bank, and Banco Nacional de México (Banamex), the nation's largest private bank, helped finance the venture.

To secure the venture, the Mexican government granted tax concessions extending for as long as ten years, and promised to protect CelMex against competition from imported products in its own field. In 1945, Celanese Mexicana opened its first plant for making acetate fibers. By 1957, the company had seven plants in México, making 29 products and employing 3,500 workers. Subsequent milestones for CelMex included:

• 1967 — the company produced 65% of all synthetic fibers in México

• 1976 — ten plants produced chemicals and plastics, as well as synthetic fibers

• 1982 — a new petrochemicals complex at La Cangrejera, Veracruz, made CelMex the country's leader in secondary chemicals

• 1988 — the company was restructured under its new German owner, Hoechst Celanese AG.

Domestic production replaces imports — The 1960s and 1970s

In the wake of the petrochemical permit legislation of 1959, projects and collaborations were established quickly. These projects covered a wide range of facilities to manufacture critical products needed for agriculture, consumer goods (*e.g.*, detergents), textiles, and gasoline for transportation. In 1961, Montrose Mexicana began the production of dichlorodiphenyltrichloroethane (DDT), chlorinated camphenes, and methyl parathion, which were important pesticides for México's cotton crop. Around the same time, PEMEX started producing dodecylbenzene, ammonia, and tetraethyl lead in partnership with DuPont. Later, DuPont co-invested with several more Mexican companies: with Quimica Fluor to produce fluorine gas; with Pigmentos y Productos Quimicos to make titanium dioxide; with Nylon de México to produce nylon fiber; and with Halocarburos to make chloroflurocarbons. Monsanto established a joint venture with Desarrollo Economico S.A. (DESA) to form Industrias Resistol (IRSA), which produced a wide variety of chemicals and polymers. Other joint ventures and alliances included Allied Chemicals partnering with CYDSA; Rohm & Haas with Polaquimia; Phillips Petroleum Co. with DESA to form Negromex, which produced carbon black and synthetic rubber; and Polysar with PEMEX to form Hules Mexicanos, a producer of styrene butadiene and nitrile butadiene rubber. This dynamic activity gave rise to México's contemporary industrial chemical groups such as ALFA, Desc (now Grupo KUO), IDESA, and Mexichem.

Also during this period, the ascendance of México's chemical industry was promoted by the National Association of the Chemical Industry (Asociación Nacional de la Industria Química; ANIQ). Created in 1959 by a group of private investors, by 1973 ANIQ served more than 300 member companies that accounted for a capital investment of $120 million (in 1973 U.S. dollars) and about 86,000 jobs.

The 1970s also saw the establishment of new legislation, the Petrochemical Law (1971), which superseded the 1959 petrochemicals permit legislation and transferred the responsibilities of the old Petrochemical Commission to a single government entity, the Secretaria del Patrimonio Nacional (SEPANAL), or Dept. of National Patrimony. The new legislation simplified the process of applying for a petrochemical permit, and reduced the time period to obtain such a permit and start the construction of the new facilities.

However, when México went through a national financial and debt crisis in 1976, momentum was broken. Pending projects were delayed, especially those involving basic petrochemicals, although the crisis affected projects related to secondary petrochemicals to a lesser extent.

Modernization brings challenges — 1980s

In 1981, the Mexican government called for the petrochemical industry to increase fertilizer production capacity to 6.3 million ton/yr within two years. To support this mandate, the government invested $93 million, using profits from crude oil exports and international loans. That year, México had 350 chemical and petrochemical plants with an accumulated investment of $930 million, and a total production volume of 13.2 million ton/yr. This was enough to cover 80% of México's domestic demand for such products as vinyl chloride, styrene, xylenes, ethylene oxide, ammonia, nitrogen-derived fertilizers, phosphate pesticides, caprolactam, nylon, and a host of other products. However, the industry's trade deficit remained large — $224 million, 11% of the national trade deficit.

The period from 1982 to 1988 marked México's era of "economic liberalization" and its so-called "industrial reconversion" — characterized by the extensive modernization of industry with automated technologies and energy-efficient processes. Also in this era, México adopted the General Agreement for Tariffs and Trade (GATT — the multilateral agreement regulating international trade, later modified upon the creation of the World Trade Organization).

At the same time, declining crude oil prices and México's economic crisis of 1982 (exacerbated by its trade deficit) promoted a drastic reduction in capital investment by private investors. As a result, many projects were canceled, facilities producing petrochemicals deteriorated due

to poor maintenance, and once-prominent engineering and construction firms folded.

Even with this disruption in momentum, by 1988, México's basic petrochemical industry had grown from three products, three plants, and a production of 66,000 ton/yr in 1960, to 42 products, 146 plants (at 20 petrochemical complexes), and a total production of 14.5 million ton/yr.

Growth stagnates — 1990s to 2000s

Due to the lack of investment by PEMEX in the petrochemical industry and the lack of a development plan for this crucial segment of the Mexican chemical industry, from 1993 to 2003, capital investment in Mexican chemical companies was practically nil. In general, the Mexican chemical industry did not grow, nor did it diversify. This was particularly true of PEMEX Petroquímica (PPQ) — the state-operated petrochemical company that PEMEX created in 1992 to produce and supply the secondary petrochemical industry's entire product chain. From 1995 to 2005, México's total production of petrochemicals fell 20.6%, and their production by PEMEX fell 56.3%. The chemical industry saw a doubling of imports. Remedies to spur investment became a national priority.

In 1996, México's Regulatory Law of Constitutional Article 27 in the Area of Petroleum was reformed to allow private investment in the production of secondary petrochemicals (the government retained the exclusive right to produce basic petrochemicals). These reforms stemmed from the 1980s legislation that allowed private investors to participate in the efforts to resurrect the petrochemical industry.

In 1997, when México sought new private investment for its non-basic petrochemical industry, it created seven subsidiaries of PEMEX Petroquímica, which was the number of state-owned petrochemical complexes. However, as a result of the conditions that México established for co-investing in these subsidiaries, as well as the tight market for petrochemicals, no candidates were interested in investing in the subsidiaries, and today they remain fully owned by PEMEX.

Since 1996, imports have complemented PPQ's products to meet the industry's demand for such important raw materials as butadiene, styrene, propylene, and other monomers. Some chemicals, like ethylene oxide, are not imported due to their risk in transport, and PPQ produces these domestically to satisfy demand.

Case study part 2: CelMex reorganizes

Celanese Mexicana again serves as a good example of the chemical industry's evolution during these years.

With the advent of the North American Free Trade Agreement (NAFTA) in 1994, Hoechst Celanese increased its holding in Celanese Mexicana to a majority stake. That year, CelMex had revenues of $1 billion and was the largest privately owned chemical firm in Latin America. However, due to rising costs and increasing competition, sales had decreased by 6% over the previous year, and profits had fallen by 32%.

CelMex's output at the time included polyester and nylon fibers, oxo alcohols, acetyls, esters, and plasticizers, as well as polyethylene terephthalate (PET) for soft drink

Table 1. A snapshot of PEMEX Petroquímica's (PPQ) active petrochemical complexes and their capacities *(4)*.

Complex	Product/Byproduct	Capacity, kt/yr	Startup Date
Cosoleacaque	Ammonia	960	1981
Escolin	Low-Density Polyethylene (LDPE)	55	1971
Cangrejera	Ethylene	600	1982
	Ethylene Oxide	100	1981
	LDPE	315	1984
	Ethylbenzene	174	1984
	Styrene	150	1984
	Benzene	235	1982
	Toluene	309	1982
	para-Xylene	243	1982
	ortho-Xylene	47	1982
Independencia	Methanol	35	1969
	Methanol	172	1978
Morelos	Ethylene	600	1989
	Ethylene Oxide	200	1988
	Ethylene Glycols	135	1988
	High-Density Polyethylene (HDPE)	100	1989
	Polypropylene/ HDPE	100	1991
	LDPE/HDPE	300	2006
Pajaritos	Vinyl Chloride	405	1982
	Total	**5,235**	

Not shown are a PPQ complex at Tula that is temporarily shut down due to market conditions, and a complex at Camargo that is in the process of shutting down permanently due to poor economies of scale, lack of raw materials, and high production costs.

bottles. The company began exiting noncore businesses and discontinuing uncompetitive products (such as cellophane) to focus on its main polyester fiber and resin, acetyl, and oxo-alcohol operations. In 1995, CelMex sold its thermoset-resins plant, which produced coated resins and unsaturated polyesters, to a Mexican subsidiary of U.S.-based Reichhold Chemicals Inc. Later that year, it sold its nylon plant to Alpek, S.A. de C.V., the petrochemical business of Grupo Industrial ALFA, one of México's biggest companies. CelMex also sold its stake in a caprolactam plant in Salamanca to Alpek. Then, in 1998, the company's fibers division was sold, and the chemicals division became a wholly owned subsidiary of Celanese AG, a company spun off by Hoechst.

Celanese Mexicana then concentrated on producing acetates and polypropylene films. Its complex in Congrejera, Veracruz, produced acetic anhydride, acetone derivatives, acrylic acid, ethyl acetate, methyl acrylate, methylamines, and vinyl acetate monomer. CelMex posted sales of about $550 million in 1998, with exports accounting for 45% of sales. The company's exports rose to 49% of total production in 2000, but overall sales continued to decline — to $444.5 million in 2001. That year, CelMex ranked fourth in México in the production of basic petrochemicals, a significantly lower position than in its golden years of the 1960s to 1990s.

Table 2. Production of petrochemicals by PEMEX, 2007–2010 (kt/yr) *(4)*.

	2007	2008	2009	2010
Total Petrochemicals	15,029	14,857	14,887	15,651
By Class				
Basic	6,411	5,942	6,188	6,801
Secondary	8,619	8,915	8,699	8,850
By Subsidiary				
PEMEX, Gas and Basic Petrochemicals	6,412	5,983	6,151	6,198
PEMEX, Refining	1,121	1,071	1,178	1,120
PPQ	7,495	7,803	7,558	8,333
By Product Chain				
Methane Derivatives	1,859	2,202	1,962	2,282
Ethane Derivatives	2,607	2,604	2,695	2,831
Propylene and Derivatives	47.3	17.5	31.0	84.5
Aromatics and Derivatives	1,338	1,354	1,233	1,042
Others*		8,680	8,966	9,412

*Includes ethane, carbon black, sulfur, propylene, CO_2, and isopropanol

Today, CelMex continues to operate in México with production facilities at La Cangrejera and Ocotlán, near Guadalajara, but with a lower profile than some other chemical companies in the region.

México's chemical industry today

In the 2000s, the Mexican government launched the National Development Plan, 2007–2012, which was devoted to sustainable development and included a national energy strategy. The plan's Energy Sector Program promotes the integration of the privately owned petrochemical industry with the state-led basic petrochemical industry in order to attract complementary investments to this industry and profit from the availability of hydrocarbons in México. Steps in the strategy include:

- modernize PEMEX Petroquímica, emphasizing technology modernization and profitable product chains to reduce production costs, optimize processes, improve integration of downstream stages, and promote environmental protection
- establish mechanisms that promote more complementary investment from the private sector in the petrochemical industry
- provide chemical producers with regulations that assure the validity of long-term contracts, and that guarantee returns on investments made in industrial production
- promote regulatory changes that will allow the petrochemical industry to become more sustainable.

It is within this framework that the first noteworthy new investment in the petrochemical industry was achieved. In 2011, Braskem (Brazil) and IDESA (México) co-invested a total of $3 billion in Ethylene XXI, a cracker to produce 1.0 million ton/yr of ethylene from 66,000 bbl/d of ethane, under a 20-yr contract with PEMEX Petroquímica. This project will allow PPQ to replace $2 billion/yr of polyethylene imports while generating 6,000 to 8,000 jobs during construction and 800 new jobs when the facility is complete.

The installed capacities of PPQ's petrochemical complexes in 2007 are shown in Table 1. (At the end of 2007, 16 plants owned by PPQ were not in operation due to lack of market competitiveness or lack of raw material.)

The total production of petrochemicals by PEMEX in 2007, including basic raw materials, was roughly 15 million tons, with 7.22 million tons coming from PPQ. By 2010, PEMEX's production grew slightly to 15.65 million ton/yr. Table 2 gives details of this production for several PEMEX subsidiaries.

The contribution of the PEMEX subsidiaries to México's total chemical production is significant, accounting for

Table 3. Key private companies with chemical-production plants in México *(5, 6)*.	
Group	**Plant Location and Products**
ALFA (Alpek)	**Altamira:** Purified Terephthalic Acid, Polypropylene, Expanded Polystyrene (EPS), Polyurethane
	Celaya: Caprolactam
	México City: Polyethylene Fibers
Kuo	**Altamira:** Styrene-Butadiene (SB) Elastomers, SB Rubber, Nitrile-Butadiene Rubber, Carbon Black
Mexichem	**Altamira:** Polyvinyl Chloride
IDESA	**Coatzacoalcos:** Glycols, Ethanolamines
	Puebla: Ethylene-Propylene Rubber, Maleic Acid, Phthalic Acid, Anhydrides
	Tlaxcala: EPS, General-Purpose Polystyrene, High-Impact Polysytrene, Dioctyl Phthalate
MG Polymers	**Altamira:** Polyethylene Terephthalate
BASF	**Altamira:** Styrenic Polymers
DuPont	**Altamira:** Titanium Dioxide
	México City: Specialty Polymers
	Pachuca: Refrigerant Gases
Sabic	**Altamira:** Acrylonitrile Butadiene Styrene, Styrene Acrylonitrile
Fertinal	**Lázaro Cárdenas:** Ammonium Phosphate, Ammonium Nitrate, Ammonium Sulfate

57% of total production in 2010, after reaching a high of 67% in 2001. Still, there is room for improvement. In 2007, the production of secondary petrochemicals (including chemical fibers, elastomers, carbon black, synthetic resins, intermediates, nitrogen fertilizers, and specialty chemicals) averaged only 47.7% of capacity, down from a recent high of 54.4% of capacity in 2005. For several of these categories, the installed capacity is considerably higher than production.

A particular case in point is the fertilizers industry, whose capacity utilization has fallen from 67% in 1995 to less than 18% in 2007. Currently, Fertinal is one of the few noteworthy producers of nitrogen-based ferilizers in México.

The products and locations for some of the more prominent private chemical producers are given in Table 3 *(5, 6)*.

Contributing to México's trade deficit, many of the raw materials used in the production of the chemicals shown in Tables 1–3 are imported because of insufficient or nonexistent domestic supply. Notable cases are butadiene (100% imported) and styrene (about 40% imported). In 2010, 76% of México's apparent consumption of chemical feedstocks was supplied by imports.

Prescription for the industry's future

One measure of the current state of México's chemical industry is the number of member companies of the ANIQ, which fell to 220 in 2011, compared to more than 300 companies in the 1970s. Still, these 220 companies accounted for 95% of the chemicals produced in México.

The stagnation in some areas of the chemical industry and the decline in others has been prompted by the lack of domestic supply of raw materials, in addition to disadvantages imposed by underdeveloped energy supplies, environmental regulations, weak foreign trade policies and regulations, insufficient transportation and communication infrastructures, outdated labor laws, and a cumbersome fiscal system. If the chemical industry in México is to regain growth and health in the near future, it is necessary to fix these shortcomings. ANIQ proposed the following recommendations at the end of 2011 *(7)*.

Energy and energetic feedstocks. To guarantee the reliable and long-term availability of energetic feedstocks and petrochemical precursors, and to promote the growth of the chemical industry and the integration of the product chain, it is necessary to:

- find mechanisms to channel government and private investment to the refining, natural gas, and basic- and secondary-petrochemical sectors
- establish a policy of competitive prices for energetic feedstocks and petrochemical precursors
- guarantee a reliable supply of electricity at competitive prices
- guarantee the quality of energetic feedstocks and petrochemical precursors produced by state-owned companies (*e.g.*, PEMEX and the Federal Electricity Commission).

Foreign trade. It is necessary to develop long-term commercial policies to create confidence among current and potential investors; to avoid the unilateral reduction or elimination of tariffs; and to foster the simplification of commerce and the reduction of the costs associated with it.

Logistics and transportation. It is necessary to create regulations that foster a reliable transportation system for dangerous materials and residues. This includes modernizing highways and improving connectivity through the construction of better roads with access to ports and borders. The modernization and proper maintenance of the railroad system and its bridges are needed as well. The construction of facilities for intermodal transport would be a welcome improvement, as would the construction of new seaports and the upgrading of existing ones.

Labor force. The Federal Labor Law needs to be updated in several areas, for example, to allow flexibility in the negotiation of collective bargaining agreements and to address workers' rights, among others.

State actions. The Mexican State must reform its tax code to better support major industry (including PEMEX). This would allow for reinvestment of resources and the creation of facilities to guarantee a competitive supply of raw materials in sufficient amounts to promote growth in the chemical industry. The State must also establish conditions that foster investment and growth in the industry. And, the country's authorities must guarantee the necessary security conditions to allow for the efficient operation of chemical facilities, as well as the sale and distribution of products and the safety and well-being of all industry employees.

If these needs are addressed and satisfied, México's chemical industry can look forward to much better times and a promising future. Otherwise, imports of raw materials will continue to grow, the trade balance will continue to worsen, the industry's contribution to the county's GDP will stagnate at less than 2%, and new investments will remain very low or nearly zero. CEP

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