Spain's Chemical Industry from the 19th Century to the Present

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In the wake of the mid-20th century emergence of the oil-based global chemical industry and the rise of Europe as an international market force, Spain's chemical industry has become modern and competitive.

Spain's chemical industry first coalesced in the 1880s, albeit on a modest scale. During that era, like its European neighbors of Germany, Great Britain, and France, Spain launched its chemical industry by exploiting the potential of hydrocarbons and organic synthesis in order to obtain commodities (such as dyes) that were in demand by the nation's most active industrial sectors (including the textiles industry).

Despite following a similar path to industrialization, Spain's chemical industry in the late 19th century lagged behind those of its European neighbors and the United States. Among the constraints to growth was a lack of capital investment in technology by the Spanish government, which necessitated the industry's licensing of foreign patents. For example, a dynamite factory built in Bilbao, Spain, in 1872 employed a process developed by Alfred Nobel in Germany, and a cement plant opened in Girona, Spain, in 1899 relied on the Portland process developed in the United Kingdom.

Spain's domestic need for some of the products in highest demand, including dyes, could be satisfied only by imports. Moreover, despite imports being an important activity of its chemical business, Spain's import volumes were among the lowest in Europe during the late 19th century *(1)*.

In spite of Spain's isolation from other markets in the late 19th and early 20th centuries, its chemical industry was not insignificant. For instance, the production of synthetic fibers (rayon) promoted the creation of new Spanish companies such as SAFA (Sociedad Anónima de Fibras Artificiales) in Blanes (Barcelona) in 1923, and La Seda de Barcelona in El Prat de Llobregat in 1925.

The true industrialization of Spain's chemical business occurred in the second half of the 20th century, when the industry began to adopt new technologies that grew out of the second industrial revolution of the 1920s to the 1950s. The progressive replacement of coal by oil as the basis of the global chemical industry led to the creation of Spain's first petrochemical companies: the state-owned Compañía Arrendataria del Monopolio del Petróleo (CAMPSA) in 1927, and the privately-owned CEPSA (Compañía Española de Petróleos) in 1929.

Only after this evolution was Spain able to compete in the same technical and commercial arenas with its counterparts in France, Great Britain, Germany, and Switzerland, as well as in the U.S. An example of this progress was the growth of Spain's pharmaceutical sector around mid-century, highlighted by the manufacturing of the first penicillin doses in 1951 in the state factory of Aranjuez (Madrid) *(2)*. Spanish pharmaceutical companies founded during this era included Almirall (1943) and Ferrer Grupo (1959).

By the 1960s, Spain's overall economy was in the midst of a transformation. An economy long dominated by agri-

culture shifted to an industrial economy in a very short time frame *(3–5)*. Whereas agriculture had accounted for 37% of Spain's economy in 1960, its impact had declined to only 19% by 1975. In the same period, Spanish industry, with the help of numerous home-grown chemical companies, increased its impact from only 21% of the overall economy in 1960 to 29% by 1975.

To put this in perspective, despite this growth, the total sales of Spain's chemical industry in 1970 were still lower than the sales of a single international company that year — E. I. duPont de Nemours, which had $3.6 billion in worldwide sales (in 1970 dollars).

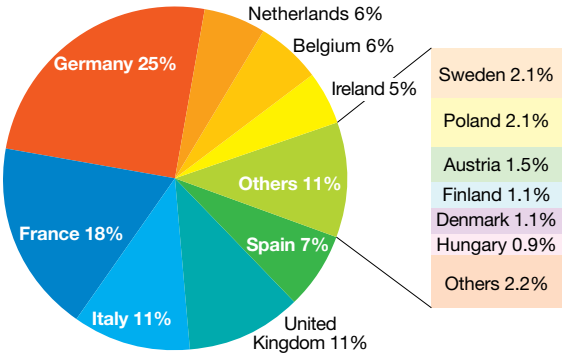
By 1975, however, sales by Spain's chemical industry had soared to $8.4 billion. Factors contributing to this rapid growth included a sharp increase in demand for chemical intermediates and raw materials by domestic industry; rising per capita income, which led to increased demand for new consumer goods; improvements in farming efficiencies, which increased demand for fertilizers; and the growth of Spain's pharmaceutical industry. Thus, between 1960 and 1975, tenfold increases in the sales value of such commodities as fertilizers, organic chemicals, fragrances, rubber, waxes, pesticides, carbohydrates, glues, and pharmaceuticals were recorded. In the same period, sales in Spain's plastics industry grew by more than 1,400%.

Another factor contributing to the growth of Spain's chemical industry in the 1970s was Europe's emergence in the international market at the expense of U.S. companies, which had been more seriously affected by the oil crises. Around 1973, U.S. companies began reducing their investments abroad, while the creation of the European Union Market boosted Europe's overall economy. As examples of this effect, Germany's chemical industry giants BASF and Bayer had established plants in Spain's Tarragona region by the early 1970s.

Thus, the international oil crises of the 1970s, combined with Spain's progressive economic integration with Europe and the decommissioning of coal-based chemical industries, helped to establish the Spanish chemical industry in the form we know today *(6)*.

The Spanish chemical industry in the 21st century

Sales of the worldwide chemical industry in 2007 were more than €2.4 trillion, almost €1 trillion more than in 1997 (€1.5 trillion). For its part, by 2007, the European Union's (EU) chemical industries accounted for some €740 billion in sales. By then, Spain was Europe's fifth largest producer of chemicals (Figure 1), racking up 7% of European chemical business and 2% of chemical business worldwide. Today, the Spanish chemical industry is one of the pillars of the country's economy.



▲ **Figure 1.** In 2007, Spain had the fifth largest chemical industry among European Union nations, accounting for 7% of Europe's chemical business.

Spain's chemical industry today is made up of some 3,300 companies, generating 11.3% of the country's gross domestic product (GDP). Figure 2 depicts the geographic distribution of major chemical industry centers in Spain.

More than 500,000 jobs depend to some extent on the chemical industry, which has become Spain's second largest exporter (behind the automotive industry). Spain's chemical industry exports in 2010 exceeded €26 billion, an increase of about 24% over the previous year. The recent recession particularly affected the Spanish chemical industry. Yet, in spite of the worldwide economic downturn of 2008, and a hard-hit Spanish economy that saw unemployment rates rise to 20% in 2010, Spain's chemical industry has weathered falling employment comparatively well, recording employ-

▲ **Figure 2.** Spain's chemical industry is distributed around the country, with major concentrations of industry near Barcelona, Tarragona, and Huelva.

Table 1. Economic characteristics of Spain's chemical industry.

Year	2000	2005	2008	2009	2010
Companies	N/A	3,649	3,571	3,408	3,311
Jobs	164,500	166,400	191,100	166,800	167,600
Sales*	35,771	44,035	52,585	47,714	53,169
Exports*	11,738	18,476	23,230	21,201	26,367
Imports*	18,147	26,421	32,203	26,837	32,713

* million euros
Source: Federación Española de Industrias Químicas (FEIQUE).

ment losses of only about 4.5% during the downturn.

The trade balance of the Spanish chemical industry (percentage of exports compared to imports) has also been improving over the last decade, from 65% in 2000 to 80% in 2010 — an indication of Spain's improved competitiveness (and interaction) with its European neighbors. Indeed, 71% of Spain's imports come from the European Economic Community market.

Table 1 provides a snapshot of some macroeconomic measures of the Spanish chemical industry since 2000.

Table 2. Top 10 chemical companies in Spain, based on sales in 2009.

Rank	Company	Sales (million euros)	Employees
1	Repsol Química	1,860.2	1,482
2	CEPSA Química	1,630.9	963
3	Puig	983.5	3,593
4	Ercros	606.1	1,819
5	DuPont Ibérica	516.2	1,407
6	Fertiberia	410.2	1,023
7	Sara Lee	257.3	543
8	Bioetanol Galica	244.2	82
9	Coty Astor	232.5	851
10	Praxair España	229.1	357

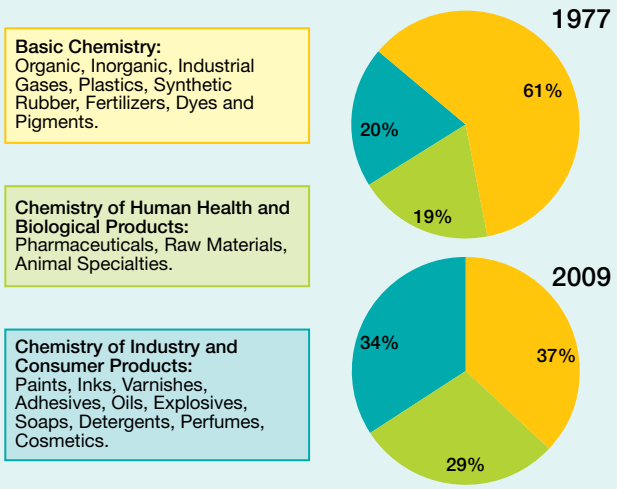
Source: *(9)*.

Another indication of the Spanish chemical industry's integration with the rest of the world can be observed in Table 2, which lists several non-Spanish multinationals,

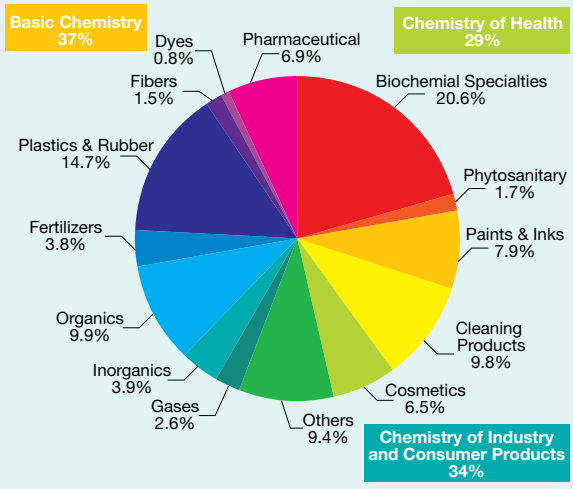
A Realignment of Spain's Chemical Industry Sectors

A major realignment of Spain's chemical industry sectors has occurred since the 1970s. As shown in the figure on the left, basic chemicals represented 61% of Spain's total chemical production in 1977. This proportion had decreased to 37% in 2009. In the same period, the proportion of chemical production devoted to pharmaceuticals and biological products increased from 19% to 29% of total chemical industry production. This is consistent with chemical industry trends around the world, in part a reflection of the emergence of the Middle East and Asia as basic chemicals majors.

The figure on the right shows the distribution of sales for the various sectors of Spain's chemical industry in 2009 *(7)*.



▲ Between 1977 and 2009, Spain's chemical industry shifted from predominantly basic chemicals toward the bio sector.



▲ This diagram presents a breakdown of Spain's key chemical industry sectors as they were in 2009.

including DuPont, Sara Lee, Coty Astor, and Praxair, among Spain's top-selling chemical companies.

It may be surprising to find Bioetanol Galicia, which is involved in biofuel production and is not considered a traditional chemical company, among the top ten Spanish chemical companies, but this reflects the emergence of renewable energy in the chemical engineering arena. This diversification is underscored by the Spanish government's Renewable Energy Plan 2010–2020. The plan's overall objective, dubbed 20-20-20, aims to bring Spain in line with the rest of the European Union's energy objectives by achieving the following by 2020:

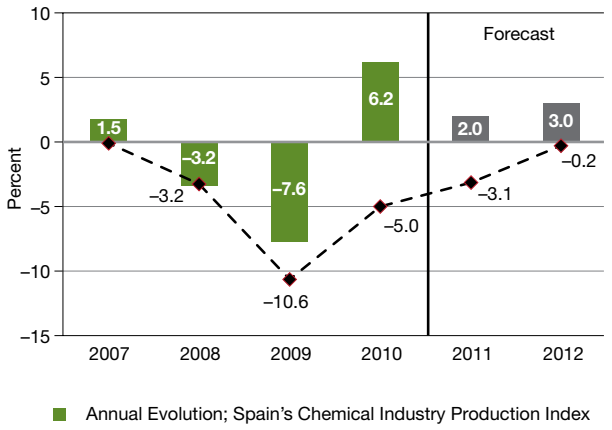
- a 20% reduction in primary energy use
- a 20% reduction in greenhouse gas (GHG) emissions
- a 20% increase in renewable energy consumption, with at least 10% of the energy used by the transportation sector coming from renewable energies (transportation is the main source of CO_2 emissions in Europe).

In Europe, biodiesel accounts for 75% of all biofuels consumed; European biodiesel consumption in 2010 stood at nearly 13 million tons. In 2010, Spain's biodiesel production capacity of 4.6 million tons was second only to Germany's 5.2 million tons *(8)*.

Challenges ahead

Despite the apparent good health of the Spanish chemical industry, several factors can negatively affect the industry's prospects for continued evolution and growth, and must be addressed in the near future.

The average company size. As shown in Table 1, Spain's chemical industry has more than 3,300 companies, of which 85% have fewer than 50 employees. In fact, only 39 Spanish chemical companies have more than 500 employees. This has two implications. On the one hand, smaller-scale, less-well-entrenched firms can be more flexible and mobile in times of reorganization or economic difficulty. On the other hand, smaller companies might suffer when it comes to economies of scale — lacking a substantial enough infrastructure to generate new products that can compete economically in the mature markets of the European Union, where price usually plays a key role.



▲ **Figure 3.** The production index of Spain's chemical industry has recovered since the economic downturn of 2008.

Table 3. Spain's chemical industry sales and exports, 2010–2012.

Year	2010	2011	2012
Sales*	53,169	57,423†	62,705†
Exports*	26,367	28,107†	29,794†

* million euros; † forecasted value
Source: Federación Española de Industrias Químicas (FEIQUE).

Insufficient integration between universities and industry. Over the past 20 years, Spanish universities have reached a high level of academic competitiveness, notably in chemistry and chemical engineering — in part evidenced by a large number of publications in prestigious journals. A new capacity for innovation has also been spurred by a gradual consolidation of a large number of research groups into fewer groups, with more up-to-date resources and equipment, and more extensive experience.

Yet, there is not a great deal of integration or collaboration between technical universities and their related industries. Only 16% of Spain's PhDs (in all fields of knowledge) work in private companies, and only 14% of those companies have collaborated with universities to perform research. These figures lag far behind those of many of the world's most technically progressive nations.

To become truly competitive, Spain should make it a top priority to improve the relationship between industry and the university.

Future prospects for the Spanish chemical industry

After strong chemical industry sales between 2000 and 2006, Spain's production volumes began to decline in 2007, and by 2009 had fallen by 10.6% (Figure 3). Fortunately, this trend has reversed, and it appears that the effects of the recent recession will be neutralized in 2012, with sales and export projections showing a positive trend for 2011 and 2012 (Table 3).

Considering the progress in the chemical market and Spanish industry overall, the competitiveness of Spain's chemical industry will be determined by its ability to maintain production levels. Due in part to declining domestic demand, the basic chemicals sector's contribution to the overall economy is expected to fall from its current 37%

share to 30% or less over the next five years. The industrial supplies and consumer products sector will maintain its share between 32% and 34%. Meanwhile, the best prospects for growth continue to be in the health chemistry sector, where new products and processes related to biotechnology, biomedicine, bioinformatics, and biomolecular design could fuel this sector's growth to more than 37% of total chemical industry sales in Spain by about 2017 *(10)*.

To become more competitive on the world scene, Spain must also devote attention to new environmental technologies, applications in the food industry, energy efficiency, new materials, and particle technology, as well as risk analysis and sustainable development. CEP

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ChE Students Benefit from Reign in Spain

In July, 25 U.S. chemical engineering undergraduates, along with their chaperone professors from Iowa State Univ. and the Univ. of Wisconsin-Madison, completed an intensive unit-operations course in the laboratories and pilot plant of the Univ. of Oviedo, in northwest Spain.

The International Summer Course in Chemical Engineering (ISCChE) is a collaboration between the two U.S. universities and the Univ. of Oviedo that provides students with the equivalent of two semesters of lab work in just five weeks. While the course content is virtually identical to what students would receive in their home labs, participating students benefit from the discipline imposed by the rigorous schedule, and have their perspectives expanded by their immersion in a new culture.

Ken Jolls, Professor Emeritus in Iowa State's Dept. of Chemical and Biological Engineering, says that the ISCChE experience puts a practical face on the unit operations theory that students should have learned in their courses. According to Jolls, in the program, "students do the same unit operations lab work and write the same English-scrutinized reports, but in a totally Spanish environment."

Jolls, who has taught in the Oviedo program since 2002, explains, "Our students, working in pairs, do ten experiments, one every two days, over the five weeks of the course. Individually, they write nine industrial-style lab reports, and present the tenth project orally, with their partner, on the final day of the program."

The schedule also incorporates visits to chemical plants, this year including Bayer Health Care Products, Asturiana de Zinc, and the Mahou-San Miguel brewery. "We visit local chemical industry to underscore the differences with the U.S.," says Jolls. As with the lab work, students are required to write "memo" reports about all these visits. Jolls notes that the discipline acquired from this daily written reporting is a side benefit that many students come to appreciate, as alumni of the ISCChE program have attested.

Students, naturally, also find time for fun and for enjoying the excitement of living, albeit briefly, in Spain.

"We expose students to the culture, including optional Spanish language classes," says Jolls. "But our in-class emphasis is chemical science and engineering — just like the standard unit operations laboratory course required of every BS-level chemical engineer in the world. Students do the normal, intensive, two-semester sequence, and receive four graded credits for the lab, plus pass/fail credits for the trips and cultural events, as well as for a prep course that I teach the spring before we travel."

"Informally, I call the program 'the toughest job the students will ever love,'" he adds.