

Prospects of Taiwan's Chemical Industry

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The chemical industry in Taiwan is characterized by its close interrelationship with other fields such as information, electronics, automobile, and mechanics, etc. Ample petroleum supply since 1960 boosted the petrochemical industry which utilizes petroleum cracking for making the raw materials. The petrochemical industry became the core of chemical industry in Taiwan and the foundation for the prosperity of relevant downstream industries. It also played a substantial role in contemporary economic development.

Transition of the chemical industry in Taiwan

Based on the economic development, the shift of chemical industry in Taiwan evolved in seven stages.

(I) Incubation stage (1913-1943)

The very first stage was during the Japanese occupation period, in which only basic fertilizer and alkaline chlorine sectors emerged.

(II) Substitution of import consumer goods (1944-1952)

After the World War II, Taiwan Alkali Co. was founded in 1946. In the following year Taiwan Fertilizer Co. Ltd took over lead based sulfuric acid plant from Japanese. The Provincial Government then established Kaohsiung Ammonium Sulfate Co. Ltd in 1948, using contact method to produce sulfuric acid. In this period the main objective was to develop the fertilizer industry for agricultural production. Export goods were primarily agricultural products to exchange consumer goods.

(III) Developing stage (1953-1967)

The four-year economic plan entered its third stage in 1953. The plan boosted fundamental chemical industry based on chloro alkali, inorganic acid, and fertilizers; and generated infrastructure for papermaking, monosodium glutamate, sucrose, camphor oil, textile, and dyeing industry. Formosa Petrochemical Corporation started to produce polyvinyl chloride in 1957. In the same year China Manmade Fibers also made rayon filament. They laid solid foundation for future plastic and synthetic fiber industries.

(IV) Export expanding stage (1968-1975)

Chinese Petroleum Corporation (CPC) built its first naphtha cracker plant in 1968, with ethylene capacity of fifty four thousand metric ton per year (MTY). This was the beginning of local made low density polyethylene and dimethyl terephthalate (DMT), a raw material for polyester fiber. Tou-Fen ethane cracker plant was established in 1973, using natural gas as primary source to make ethylene with capacity of fifty four thousand MTY on vinyl chloride monomer and high-density polyvinyl chloride. In 1975 the second naphtha cracker plant in Kaoshung was erected with capacity of two hundred and thirty thousand MTY for ethylene. Meanwhile, synthetic fiber and plastic factories as well as their downstream processing factories were gradually built. They provided a developing infrastructure for synthetic fiber and petrochemical industries. The stable supply from upstream and midstream, plus low labor cost transformed downstream labor-intensive industries, such as textile, plastics and rubber products, from import substitution into export oriented status, consequently generated a comprehensive midstream and downstream petrochemical system.

(V) Maturation stage (1976-1985)

After a comprehensive midstream and downstream petrochemical system was established during the fourth stage for export expanding, the government started to integrate large-scale petrochemical development project. During this fifth stage, a third naphtha cracker plant was built in 1978 with ethylene production of two hundred and thirty thousand MTY and another xylene extraction plant was also built. In 1985, a fourth naphtha cracker plant was built with ethylene production of three hundred and eighty five MTY. This made the total ethylene production of nine hundred and fifty three thousand MTY, placing Taiwan's petrochemical industry on top 12 worldwide. The establishment of factories for intermediate raw materials further facilitated the development of relevant industries in petrochemical, electronics, and information. It was obvious that the petrochemical industry played a major role in the speedy economic development in Taiwan.

(VI) Transition stage (1986-1993)

The industry entered a transition stage in 1989. During this period, the awareness of environmental protection, rising labor cost, plus labor shortage and weak government authority created obstacles for fifth and sixth naphtha cracker projects. It was after numerous negotiations and warranties on pollution mitigation did fifth naphtha cracker plant finally start operation on September 1990 with production capacity of four hundred thousand MTY of ethylene. At this time, the first naphtha cracking plant was closed and the raw material supply for domestic petrochemical industry was in shortage, as a result, a low quantity but high valued special chemical and engineering plastic industry emerged. In order to breakthrough the obstacles of such transition effectively, and upgrade the industry to a higher level, it is necessary to transform the petrochemical industry from a labor- and capital-intensive, simple-processing one into a high-value-added, advanced-technology, low-pollution, and automated level one.

(VII) Regeneration (1994-current)

Taiwan's petrochemical industry entered a regeneration stage since 1994. During this period, CPC established its fifth naphtha cracking plant in 1995 and started production. Formosa Plastic's sixth naphtha cracking plant also started its construction in 1997, and started manufacturing in 2000. On top of those, Tuntex's seventh naphtha cracker and CPC's eighth naphtha cracker plants were proposed. Both government (Ministry of Economic Affairs) and private sectors were eager to break the obstacles of such transition, and move toward the high value-added, advanced-technology, low-pollution, and fully-automated direction. Meanwhile, quite a few downstream processing factories invested and moved to mainland China or South East Asia for production.

Contemporary chemical industry status

The productivity of chemical industry in Taiwan reached USD 61 billion and accounted for 24% of national manufacturing output in 2002. A broad definition of chemical industry included upstream base chemical raw materials, petroleum and kerosene products; midstream fertilizer, intermediate petrochemicals, polymers, specialty chemicals, medical chemicals, paper and printing chemicals, and downstream sub-industries such as synthetic fiber, rubber products, and plastic products as listed on table 1.

As part of the trend of industrial transition, downstream processing products such as umbrella and plastic shoes once topped the global market and drove the growth of domestic chemical industry. Like many other downstream industries, most of them moved to mainland China. Midstream chemical materials and upstream chemical raw materials also grew stably and proportionally with the export growth. Chronicle data of the output value of domestic chemical industry is shown in table 2. The value doubled from 1990 to 2002. The majority of the growth was in petroleum and kerosene products, intermediate petrochemicals, polymers, while fertilizer and plastic products had slightly negative growth. When comparing the ratio of each sub-industry from 1990 to 2002 (Figure 1), one can see the pattern of this variation, in which, the value of plastic products slightly decreased, however, its proportion significantly reduced from 29.3% down to 14.8%.

Figure 2 depicted respective output values in 1990, 1997, and 2002. An obvious trend here shows that only three major items recorded significant growth, other categories had moderate growth include basic chemical raw materials, special chemicals, and medical chemicals. On the other hand, the categories with negative growth included fertilizer, paper printing chemicals, manmade fibers and plastic products.

Table 1: Representative products of major chemical sectors

sector	Representative products
Base chemical materials	oxygen, hydrogen, nitrogen, sulfuric acid, nitric acid, phosphoric acid, sodium hydroxide
Fertilizers	calcium ammonium nitrate, potassium sulfate, urea, ammonium sulfate, calcium super phosphate
Petroleum and kerosene products	gasoline, kerosene, diesel oil, fuel oil, lubricant, asphalt
Petrochemical Intermediates	styrene, vinyl chloride, ethylene, AN, CPL, PTA
Polymers	polyethylene, polyvinyl chloride(PVC), polyester, polystyrene, polypropylene, ABS resin
Specialty chemicals	synthetic resin, adhesives, dyes and pigment, surfactants, plastic additives
Medical chemicals	generic drug, medical intermediates
Paper and printing chemicals	pulp preparation chemicals, wet end chemicals, coating additives, varnish, glue
Synthetic fibers	polyester filament/fiber, nylon filament/fiber, acrylic fiber, rayon filament/fiber, carbon fiber
Rubber products	tire, rubber shoes, rubber pipe, adhesive tapes, rubber gloves
Plastic products	plastic sheets, pipes and tubes, plastic bags, plastic house ware, plastic shoes, PET bottle

Table 2: Output values of the major sectors of Taiwan's chemical industry

Unit: US\$ million

Sector \ Year	1990	1997	1998	1999	2000	2001	2002
Base chemical materials	848	1367	1368	1368	1554	1590	1525
Fertilizers	203	246	235	221	209	185	176
Petroleum and kerosene products	4349	7970	8002	8698	12388	12927	13472
Petrochemical Intermediates	2909	5381	4672	5443	7669	8465	9726
Polymers	3276	7746	7683	7891	9228	8983	9485

Specialty chemicals	2370	3942	3903	4166	4635	4002	4373
Medical chemicals	904	1318	1376	1442	1498	1482	1503
Paper and printing chemicals	5043	6343	6213	6324	6856	5899	6004
Synthetic fibers	2472	3936	3574	3317	3766	3480	3663
Rubber products	1835	1947	1944	1923	1942	1798	1994
Plastic products	10047	10259	9555	9773	9522	8466	9053
Total value in chemical industry	34256	50455	48524	50567	59266	57278	60970
Total value in manufacturing	136572	220552	226361	233910	265288	234489	251989
Chemical industry/ manufacturing	25.08%	22.88%	21.44%	21.62%	22.34%	24.43%	24.20%

Source: the Industrial Economics & Knowledge Center of the Industrial Technology Research Institute in Taiwan.

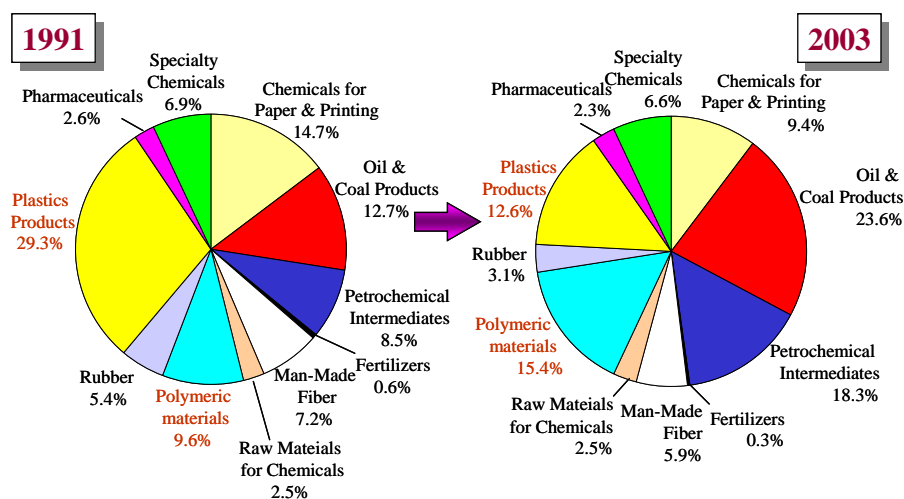
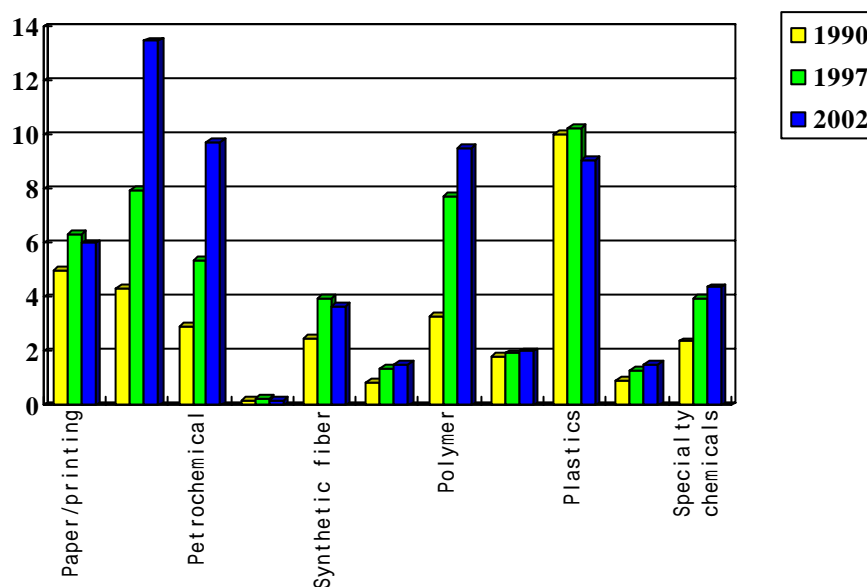


Figure 1: Annual output of the major sectors of Taiwan's chemical industry

Figure 2 Annual output of the major sectors of Taiwan's chemical industry



Opportunities of chemical industry

The long and narrow geographic layout of the island constrained the development of chemical industry in Taiwan. Taiwan lost its competitiveness due to the changing investment environment, decreasing competitiveness in labor-intensive or high-polluting industries. Factories started to relocate to mainland China or South-East Asia. Facing such challenge, the government's core strategy was to assist conventional industry in advancing their technology, upgrading product competitiveness, and aggressively promoting new industry with high added value. In terms of products, high market potential and high added value items were intermediate petrochemicals, specialty chemicals, medical, fiber and engineering plastics. The opportunities of Taiwan chemical industry can be summarized as follows:

1. It is important to utilize excessive amount of base petrochemical raw materials in the future to develop key intermediate petrochemicals to meet the need of midstream and downstream industries and then export to other areas.
2. In order for domestic textile industry to maintain international competitiveness, it is necessary to move toward high value added areas such as functional fibers, innovative composite fibers, and non-woven fibers to drive the industry into a higher level.
3. Chemicals for semiconductor and IC-packaging materials based on the prosperous development of industries such as information, electronics, communication, and optoelectronics, have huge market niche.
4. Medicine, biotech and advanced materials are listed as major developing fields to meet Taiwan's goal of becoming the manufacturing center in Asia Pacific. As a result, it is expected that the emerging fields of engineering plastics, specialty

chemicals, electronic chemicals and medical chemicals will have significant growth.

5. Unique development niche is in the areas of construction materials, medical and healthcare goods, engineering due to the demand in public construction and social welfare.
6. Future direction should focus on developing raw materials for engineering plastics and utilize Metallocene catalytic technology to gain competitive advantage owing to the severe competition of plastic products in global market, plus insufficient supply of domestic market and higher price.
7. Medical chemistry, chemical raw materials, vascular medicine and psychological medicine are areas worthwhile for further investigation. In terms of reagents, long-sustained release drugs and targeted delivery drugs are future trends. For new drugs, future demand would be medicine for senior citizens and chronicle diseases. In response to environmental consciousness, cleaner production should be adopted into manufacturing process. As a result, products of low pollution should be the mainstream of new product development, such as water-borne resins.
8. CEFIC has officially advocated REACH (registration, evaluation and authorization of chemicals) since 2002. The implementation of REACH can be both a crisis and an opportunity for local industry. Local manufactures have better access to identify foreign transferable technologies.

Future Perspectives

Overall, chemical industry in Taiwan has already paved a substantial foundation. Future development directions for chemical industry should focus on:

- 1.(a) Transforming the conventional industry into a high value-added one; (b) actively utilizing the chemical technology to enhance hi-tech technologies; (c) focusing on tremendous market potentials in the fields of information, electronics, communication, and opto-electronics; and (d) integrating upstream, midstream, and downstream research and development capabilities.
- 2.(a) Developing green production process and green products to cope with global environmental awareness; (b) applying the concepts of minimum raw material, low energy consumption, and low waste generation; (c) looking forward to a sustainable management and development in chemical industry.
- 3.(a) Promoting “Alliance for Industrial Research and Development”; (b) providing resources and technologies for research institutes; (c) facilitating the establishment of a platform for shared technology to upgrade the technology for midstream and downstream industries.
- 4.(a) Developing innovative products with high function and high added values to compete with products from low cost and labor intensive areas; (b) using supply chains and brand image to penetrate the global market.