The Chemical and Pharmaceutical Industry in China
The Chemical and Pharmaceutical Industry in China

Opportunities and Threats for Foreign Companies

With 29 Figures and 81 Tables
Preface

“Don’t miss out on China!” and “What are you doing about China?” Catch phrases like these are spreading among managers all over the world. Just take a brief look at the business class occupancy of flights from Europe, North America or Japan to major Chinese cities: This gives you a glimpse of how business people are attracted by steady growth rates of 6 percent to 10 percent. It also indicates how much attention is given to a market featuring 1.3 billion potential consumers and a government committed to rapidly changing the country from an agriculture-dominated developing country into one of the world’s economic powerhouses. Most of the global industrial players have had economic ties with China for decades already, but they were further strengthened after the country’s opening to the world in the early 1980s. Furthermore, China’s accession to the World Trade Organization is expected to catapult this already surging economy into another sphere of development.

The Chinese market is of increasing significance to the global chemical and pharmaceutical industry. This book analyzes and illustrates the current situation from different viewpoints. It is structured in three parts: the first two parts focus on a characterization of the chemical and pharmaceutical industries in China, outlining the economic and political situation in China with its strategic and operational implications for Western companies, complemented with strategy-in-action cases of BASF, Degussa, Merck and Novartis. The third part of the book comprises case studies describing how Western companies like BASF, Bayer, Bicoll, Ciba, Degussa, and DSM are managing the market entry and investments for further growth in China. These are more than mere testimonials: these case studies are rich compendiums of good and best practices of launching new businesses in China. Based on thorough analysis the authors disclose and provide new strategies, approaches and tools to deal with sometimes not obvious challenges in China. The book also analyzes the threat to Western companies in their home markets from Chinese competitors.

We are honored to have a long list of distinguished experts contributing as authors to this book. We would like to thank the authors for their time, effort and commitment in formulating their insights and putting them down in writing. We are also grateful to Gerhard Sichelstiel, Martin Jung, Joachim Luithle and Elaine Britton, whose invaluable contributions to this unique compilation have made this book a reality. Last but not least, we would like to thank Martina Bihn of Springer Verlag for her support and editorial guidance.

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Part I: The Chemical Industry in China
1 The Global Chemical Industry

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This chapter describes the global chemical industry as well as major trends like the ongoing transformation of the industry and industrial biotechnology which will have a big impact, especially in emerging economies like China.

1.1 Some Basic Facts About the Chemical Industry

The chemical industry today is one of the largest and most diversified industries in the world with an impressive history (Arora/Landau/Rosenberg 1998). More than 1,000 large and medium-sized companies manufacture over 70,000 different product lines, and the total value of chemicals produced in 2002 was EUR 1,841 billion (including pharmaceuticals). The chemical industry accounts for 3 to 4 percent of global gross domestic product (GDP), which probably makes it the largest manufacturing industry in the world. The European Union is the largest market with 29 percent, followed by the United States with 26 percent, Japan with 10 percent and China with 6 percent (Fig. 1.1). Within the European Union, Germany is the largest national market with sales of EUR 133 billion in 2002 and EUR 136 billion in 2003.

Fig. 1.1. Global chemical market (including pharmaceuticals) by region, 2002 (percent) (Source: CEFIC)
In emerging economies, and particularly in those of China and South Korea, the consumption of chemical products accounts for about 10 percent of GDP and there is significant potential for further growth in these countries. In mature economies such as Germany and the United States, however, future growth rates of chemical consumption are falling below those of GDP.

Chemical companies serve almost every single industrial sector – from food processing to construction and electronics. The automotive industry, for example, relies on many chemical products in the production of tires, seats, dashboards and coatings. Industries like electronics and pharmaceuticals are also important customers in which innovation is often driven by chemicals such as new materials for electronic devices or new active substances for pharmaceuticals.

The chemical industry has a distinctly multiregional character in the sense that there are limited trade flows between the three main manufacturing regions of North America, Europe and Asia. Only about 10 percent of total output is shipped between these three regions. Not surprisingly, interregional trade is particularly limited for volume products which are relatively expensive to transport. The limited interregional trade has not, however, decoupled prices and industry cycles in the different regions. The prices of commodity plastics, for example, moved in remarkably close harmony in all three regions. Unlike interregional trade, trade within the regions is very strong. In Europe, for instance, 46 percent of total chemical industry output in 2002 was exported within the European Union itself. 29 percent was exported outside the European Union and only 25 percent was consumed in the country of manufacture.

1.2 Transformation of the Chemical Industry

The chemical industry consists of three groups of companies (Fig. 1.2). The first group is focused on commodity chemicals such as basic chemicals or plastics and accounts for a little over one third of total sales. These companies are often the chemical subsidiaries of the big oil companies like BP, ExxonMobil and Shell.

The second group of companies like Ciba Specialties, Clariant and Rohm & Haas is focused on specialties and accounts for just one quarter of all sales. The third group, the integrated conglomerates, dominates the chemical industry and contributes almost 40 percent of overall sales. This conglomerate structure was characteristic for the chemical industry. Nearly every industrialized country has the residue of its own nationally developed chemicals industry in which every company traditionally tried to produce the whole range of chemical products. Especially during the 1970s and 1980s these companies grew to considerable size and still have a large number of different businesses, ranging from upstream basic chemicals, specialty chemicals, agrochemicals and in some cases also pharmaceuticals (examples are Akzo Nobel and Bayer).
Due to their large and diversified portfolios, it is increasingly difficult for the conglomerates to provide all the resources necessary to run them. Synergies between chemical and other businesses seem to be either non-existent or difficult to capture so that specialized players generally perform better than non-specialized players. Therefore, investors are more interested in focused companies with less complicated and more transparent structures. But the conventional wisdom used to be that specialties are better than commodities, and that less cyclical businesses are better than more cyclical ones is in the longer term not true. The top quartile of commodity firms and specialty firms outperform by far all categories in the lower quartiles. The key factor, it seems, is operational excellence, regardless of the nature of the business. That means that excellent commodity firms are better value creators than average specialty players.

Many of the diversified conglomerates began radical changes during the 1990s, kicking off a global industry restructuring and M&A wave in an attempt to exit and divest those businesses without leading positions (Festel 2003a, 2003b). In that sense a lot of major transactions have taken place in the last ten years. BASF sold its chemical trading activities, magnetic tapes business and pharmaceuticals operations (Knoll). DOW also divested its pharmaceuticals business. DSM sold its petrochemical business and strengthened its life science business by buying Gist Brocades’s and Roche’s vitamins divisions. The most spectacular transaction was the break-up of Hoechst: after divesting its specialty chemicals business to Clariant, Hoechst spun-off its basic chemicals businesses (now Celanese) and merged its life science divisions (pharmaceuticals, animal health, crop science) with Rhône-Poulenc to found the new company Aventis. Aventis (which was recently bought by Sanofi) has since sold its crop science business to Bayer which last
year started a major transformation process by separating its chemicals operations and parts of its polymers business as an independent new company with the name Lanxess.

![Diagram](image_url)

**Fig. 1.3.** Trend from conglomerates with many sub-critical businesses to focused companies with globally leading businesses

![Diagram](image_url)

**Fig. 1.4.** Structure of the chemical industry tomorrow

At the end of this transformation process, there will be more pure players producing bulk chemicals in the upstream (e.g. ExxonMobil Chemical, Shell Chemicals) or downstream (e.g. Basell, Borealis) commodity value chain. On the specialties side, focused players will start to form around segments like coatings, water treatment or fine chemicals. Infrastructure is no longer the core business of these focused companies and was divested during recent years so that a new class of independent infrastructure companies (e.g. Infraserv Höchst) appeared (*Fig. 1.4*).
1.3 Impact of Industrial Biotechnology

Scientific breakthroughs in the life sciences are fascinating and will change the structure of the industry (Enriquez/Goldberg 2000). Biotechnology has already demonstrated that it can accelerate innovation in pharmaceuticals, where its application is most advanced. Over the past ten years, most of the truly innovative drugs (those that address an unmet medical need) have come from the application of biotechnology. Many more biotech-based products are currently in the pipeline and are expected on the market soon. But what are the implications of biotechnology for the chemical industry and how will they change the industrial landscape?

The market for biotech-based products, excluding ethanol and starch derivatives which have traditionally been produced by fermentation, accounts today for only 3 percent of the total chemical market (about US$ 30 billion). Examples include biocatalysis and biomolecules in fine chemicals, biopolymers as substitutes for synthetic polymers, enzymes and modified additives in specialties, and the production of basic and intermediate organic chemicals using fermentation. The share of biotech-based chemicals will increase dramatically within the next years. In 5 to 10 years (2010+) nearly 20 percent of chemical products with a sales volume of approximately US$ 300 billion will be produced by biotechnological processes (Fig. 1.5).

**Fig. 1.5.** Importance of biotechnological production processes in 2001 and 2010+

Fine chemicals offer the greatest potential (60 percent) using biotech routes for the production of enantiomerically pure complex chiral molecules (Festel/Kö nell/Götz/Zinke 2004). More than 50 percent of the top 100 drugs are based upon enantiomerically pure molecules and such drugs today already post sales exceeding
US$ 100 billion. In addition, 60 percent of the new active pharmaceutical ingredients in drug development phases II and III are chiral and 90 percent of the new chiral substances are enantiomerically pure. Also, specialty chemicals (20 percent) will be increasingly produced using biotech processes with many potential applications in the food, cosmetics, textile and leather industries. Within polymers (share of 10 percent) as well as basic chemicals and intermediates (share of 15 percent), a key focus will be on using renewable raw materials and new products which are not available by chemical synthesis.

The most important biotechnological production processes in the coming years will be the fermentation of microorganisms and biotransformation. Fermentation with animal/plant cell cultures is especially suitable for the synthesis of complex biomolecules such as sugar- and lipid-modified molecules and proteins which are not accessible by chemical synthesis routes. Although fermentation requires high dilution, it is a single step process that leads to the desired product.

In contrast, biotransformation can work at concentrations up to 50 percent but a single enzymatic step does not necessarily lead to the desired product, so the reaction may need to be performed in multiple steps. However, technical development has progressed rapidly and will further boost the application potential of biotransformation. Increasing knowledge of enzyme reactions in non-aqueous solutions will lead to a broader spectrum of processes and a greater number of potential substrates. Process efficiency will be improved due to new developments in reactor and process design. The versatile application of extremophiles will enable more robust processes, increasing the diversity of process conditions and reducing reaction times. Additionally, the use of directed evolution processes can lead to the development of tailor-made and high-performance enzymes. Genetic engineering of microorganisms will result in the discovery of new enzymes and reactions and reduce unwanted side reactions in cell-bound biotransformation processes. As a result of this technical progress cell-free biotransformation (enzyme catalysis) will widely replace fermentation in the next ten years.

Restrictions in the use of biotechnological production processes are primarily seen on the economic side, e.g. operating costs, R&D costs and investment. The synthesis of existing products by chemical processes is frequently so inexpensive that the development of a biotechnological production process is often not cost-efficient, especially if production facilities for chemical routes already exist. This is a big hurdle for the further establishment of biotech processes in mature economies. However, this hurdle is much lower in emerging economies like China where new capacities have to be built to meet strong market growth. In these cases, biotech processes could provide clear cost advantages as they often have substantially lower capital and manufacturing costs and allow greater flexibility due to lower minimum economies of scale. Additionally, biotechnology is more eco-friendly with less waste produced and less energy consumed. Therefore, biotech will have a bright future in chemicals production – especially in China.
2 The Petrochemical Industry in China

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2.1 Major Players in the Chinese Chemical Industry

The development of China's petroleum and petrochemical industry can be roughly phased into three stages. The first stage started with the discovery of the famous Daqing Oil Field in northern Heilongjiang province and ended in 1978. During this stage several large-scale oil fields were developed and the capacities of some oil refining enterprises in the provinces of Gansu, Liaoning and Shandong were expanded. Yanshan Petrochemical Company in Beijing became China’s first enterprise to boast ethylene production facilities with an annual capacity of 300,000 tons. This was the starting point of the petrochemical industry in China.

The second stage from 1978 to 1998 saw the establishment of a series of large-scale petrochemical industrial bases in the country. They are in Daqing, Yangzi (Jiangsu), Qilu (Shandong), Shanghai, Jilin and Maoming (Guangdong).

The period since 1998 is viewed as the third stage. In that year the government divided the assets. The northern region with the larger oil reserves went to China National Petroleum Corp. (CNPC), whereas the southern region with less resources yet the large coastal market went to China Petroleum and Chemical Industry Corp. (Sinopec) (see Fig. 2.1). China National Offshore and Oil Corp. (CNOOC) was kept offshore. The three local giants in the industry, namely CNPC, Sinopec and CNOOC were successfully listed on the stock exchanges in London, New York and Hong Kong in 2000, and their listed companies are called PetroChina, Sinopec Corp. and CNOOC Ltd. respectively.

Two of the three corporations (CNPC and Sinopec) have formed a complete business system ranging from oil and gas exploitation to sales of finished products. Sinopec and CNPC dominate production of ethylene, petrochemical intermediates and downstream products in China, with their combined capacity accounting for over 90 percent of the country’s total. Of the 18 ethylene plants in China, 16 are owned by the two giants. The future presence of CNOOC in the sector with the joint construction with Shell of an ethylene plant producing 800,000 tons a year at Nanhai, Guangdong province will alter the current pattern of capacity distribution.

Local medium-sized (e.g. Huayi Corporation in Shanghai) and small state enterprises and a large number of township and private enterprises are mainly active in downstream petrochemical segments, while foreign investment focuses on plastics and synthetic fibers that are in short supply in China and highly dependent on imported raw materials. For domestic synthetic resin production, Sinopec and CNPC contribute the vast majority of polyethylene (PE), polypropylene (PP) and synthetic rubber, but only 10 percent of polyvinyl chloride (PVC) for which pro-
duction quotas were historically allocated to local state chemical enterprises (e.g. Shide in Dalian, Liaoning Province) and dependent on imported raw materials from various sources. Sinopec and CNPC supply the majority of synthetic fiber intermediates such as purified terephthalic acid (PTA), ethylene glycol (EG), acrylonitrile (AN) and caprolactam (CPL), while local state companies and non-state enterprises produce synthetic fibers including polyester, acrylic, polyamide and polypropylene fibers. Foreign joint ventures (e.g. BASF, LG Chemical, ChiMei) manufacture most of the country’s polystyrene (PS) and ABS.

Fig. 2.1. Geographical division of business operations of CNPC and Sinopec (Source: CNPC and Sinopec)

2.2 Underpinning Economic Growth and the Energy Bottleneck

The Chinese economy grew strongly following the start of reforms in 1978 and the opening in the early 1980s. Although there have been several ups and downs, the average growth rate of more than 8 percent is unprecedented for an economy of this size and complexity (source: China’s State Statistical Bureau). The outlook of 6 to 7 percent growth in GDP until 2015 is based on models provided by BASF (Fig. 2.2).
This rapid economic growth has led and will lead to an increasing demand for energy. The outlook for China through 2010 broken down by fuel type including “other”, (i.e. primarily hydroelectric and nuclear) is based on many assumptions to project the fuel mix. In particular, the pace of natural gas development and the mix of fuels for power generation are difficult to predict (Fig. 2.3). Coal will remain the dominant fuel throughout the period. However, the energy mix will change because the growth of oil and gas is greater than that of coal. Oil demand is growing at a rate of 4 to 5 percent compared with 2 percent for coal during this decade. This leads to an analysis of the oil supply/demand, which is important for the feedstock analysis for the chemical industry (Fig. 2.4).

There will be a growing dependency on imports. The lower line on the chart shows the outlook for domestic Chinese oil production. It is relatively flat across the period. The shaded area shows the likely range of uncertainty. It is relatively
narrow since, given the long development lead times, any substantial volumes that could be brought to market in this time frame have mostly been discovered and are under development. Even this relatively flat profile represents considerable effort in offsetting the decline in mature domestic fields. There is more uncertainty on the demand side of the equation, as shown by the upper lines. This is fundamentally driven by economic growth, and the range of uncertainty reflects differing assumptions made by various forecasters regarding the drivers that influence the demand for oil.

Fig. 2.4. Growing oil imports likely (Source: ExxonMobil Data 2000, Stephen F. Goldmann)

China’s import dependency will continue to grow from around 40 percent today (2003: 91 million tons (MT) of oil, 1.8 million barrels a day (MBD)) to between 43 and 58 percent in 2010.

According to various forecasts, China’s oil demand in 2010 is estimated to be:

- 300 MT or 6 MBD by Chinese government assessment
- 346 MT or 7 MBD by the IEA (International Energy Agency)
- 358 MT or 7.2 MBD by CERA (Source: CERA, Cambridge Energy Research Associates 2002)

This translates into imports of between 130 million tons per year (MTY) (2.6 MBD, import dependency 43 percent) according to the Chinese government forecast, or 208 MTY (4.2 MBD, import dependency 58 percent) according to CERA.

China’s economic growth has outstripped its own energy resources. When it comes to consumption China is an energy superpower second only to the United States. Meeting its energy needs is one of the most difficult challenges China will face. Anything above 130 MTY (2.6 MBD) is a large number. Nevertheless, compared with Western Europe’s oil demand of about 700 MTY in 2002 and imports of 400 MTY it might not seem particularly large in absolute numbers. However, the market would be concerned about that additional amount in a tight oil market but can accommodate it in terms of availability. It is a matter of setting up new
commercial relationships without conflict. The International Energy Agency (IEA) believes China will become a far more influential player in the global oil market, specifically in the oil-rich Middle East. A most significant result of this in terms of facility planning is that the average crude slate will become heavier and higher in sulfur content, that is, more sour.

What is the outlook with respect to the supply and demand of petroleum products and the implications in terms of refining capacity and the subsequent feedstock situation for the chemical industry?

### 2.3 Outlook for Feedstock Supply

*Fig. 2.5* shows refinery supply and demand, with the tops of the columns representing total product demand consistent with the outlook discussed earlier.

![Fig. 2.5. Growing petroleum product shortfall (Source: ExxonMobil Data 2000, Stephen F. Goldmann)](image)

It can be seen that demand is met from three components. The first is the existing capacity, which increases over time with the assumption that capacity utilization will increase from the present level of 70 percent to about 90 percent by 2010, consistent with best practices in other parts of the world. There will also be some debottlenecking and expansions. The balance will be met by product imports, which would be in excess of 45 MTY or 1 MBD depending on how much demand increases. The need for additional refining capacity to process increasing volumes of heavier, high sulfur crude will require significant investments and lead times for facility planning. The average scale of China’s refineries is much lower than the world average. Yet there are notable exceptions such as the Sinopec Zhenhai Refinery with a capacity of 16 MTY. The structure of refining equipment is biased towards fluid catalytic crackers, which account for 35 percent of total refining equipment as compared to the global average of 17 percent. It is also biased to-
Towards oil with a low sulfur content, so the capacity for processing sulfur oil is insufficient.

Within China it is mainly the east and southeast that will continue to be short of refining capacity while the northeast and northwest will remain product exporters to the high-demand sectors, even after allowing for some planned shutdown of small and inefficient capacities. The greatest requirement for capacity additions is in the rapidly growing provinces of the south and southeast. Overall, China will have a refining capacity shortfall by 2010 even after allowing for a dramatic improvement in capacity utilization and some expansions and debottlenecking. China’s naphtha demand is expected to surge by 67 percent by 2005 to 34.5 million tons, spurred by strong demand from the petrochemical manufacturing sector, especially along the coastline. And demand is likely to rise further to 53 million tons by 2010 and 90 million tons by 2020. China currently produces about 21 million tons of naphtha a year, which basically meets local demand. But with production capacities for ethylene (a naphtha product) set to increase, domestic naphtha production will be unable to meet demand for much longer, according to official sources. The feedstock naphtha for crackers has to be imported from Korea, Taiwan and other Asian countries.

### 2.4 Cracker Capacity Development

The main customers of the refining industry are the crackers. *Fig. 2.6* illustrates the very dramatic growth in olefin demand in China since the mid-1980s.

![Fig. 2.6](image-url) Growing olefin derivatives imports in China (Source: ExxonMobil Data 2000, Stephen F. Goldmann)

This is very consistent with the growth observed in other rapidly developing economies around the world. Demand in 2010 is projected to be about ten times the demand in 1985. In spite of very rapid growth in domestic supplies, China will
remain about 50 percent import-dependent for olefins in 2010. This outlook assumes that all of the six major grassroots steam cracker projects currently under construction and discussion will be in operation by 2010. These are BASF Yangzi Corporation in Nanjing, BP Sinopec Caojing (SECCO), Shell CNOOC Nanhai, and possible domestic crackers operated by Sinopec in Tianjin, Zhenhai and Caojing No.2.

Even with the planned debottlenecking of existing smaller crackers and possibly six new grassroots additions, China remains largely import-dependent (see Fig. 2.7). This conclusion remains even if more conservative assumptions are made about GDP growth. Even if GDP increases at the unlikely low figure of only 5 percent annually for the next decade, China will still need to import about 30 percent of its ethylene demand. There are major crackers coming on stream in the Middle East over the next three years, and China is their main target market. If China eventually tries to achieve self-sufficiency, this could cause world market prices to erode.

![Fig. 2.7. Possible scenario of ethylene capacity development (2010 vs. 2000) (Source: China Petroleum & Chemical Industry Association (CPCIA), BASF)](image)

### 2.5 Consumption of Ethylene and Its Derivatives

From 1995 to 2003, China’s demand for ethylene increased at an average annual rate of more than 12.5 percent. China’s national ethylene production capacity reached 6.12 million tons in 2003, but domestic demand climbed to 15.4 million tons. As locally made ethylene and downstream products are in short supply, petrochemical imports to China have increased by an average 32 percent since the 1990s. Foreign raw materials and products have accounted for more than 50 percent of domestic demand for synthetic resins and of total consumption of ethylene equivalent petrochemicals. The figure exceeds 80 percent for polystyrene and ABS consumption (Source China’s State Statistical Bureau (Beijing)).

Another feature of ethylene and downstream products is that their production and consumption is growing faster than GDP. The average GDP growth rate in
China for the period 1990 to 2003 was about 9 percent while the consumption of the five main synthetic resins grew from 2.27 million tons to 16.60 million tons, yielding average annual growth of 22 percent. The demand for synthetic rubber leaped from 320,000 tons to 940,000 tons at an average rate of 13 percent. Synthetic rubber consumption increased from 1.65 million tons to 6.62 million tons, with an annual growth rate of 17 percent.

2.5.1 Forecast of Market Demand for Ethylene in China

Due to the comparatively mature marketing mechanisms in the Western countries, it is easier to make predictions in the United States or Europe. Companies there only have to consider four factors: historical inertia, ultimate purpose, new applications and substitute products. The elastic coefficient is usually set at between 1 and 1.2. In China, the market for petrochemical products is still growing rapidly and less predictably. The country’s ethylene consumption grew at an annual rate of 12.5 percent during the period from 1995 to 2003, while its GDP increased at a rate of less than 10 percent. The calculated annual elastic efficiency ratio between the growth rate of ethylene demand and GDP for the period of 1995 to 1997 was 2.1, 2.4 and 1.9 respectively. The forecast predicted that this efficiency ratio should be 1.0 for the period from 2000 to 2005 and 0.8 for 2005 to 2010.

The demand for ethylene in China is mainly driven by high demand for plastics. This has always been very closely linked to general economic activity. As a general rule of thumb, the growth in demand for plastics is a multiple of the GDP growth of the country. For developing countries such as China, demand elasticity has often been around 1.5 to 2.5 times that of the country’s real GDP growth while in a more mature country such as the United States, elasticity is often lower at 0.6 to 0.8 times.

Therefore, 60 percent of the ethylene produced in China is used to make polyethylene, and the proportion is slightly higher than the world average of 56 percent. 13 percent are used to manufacture glycol, 10 percent for PVC, 3 percent for glacial acetic acid and 18 percent for other products. Actual ethylene demand in China in 2003 was 15.4 million tons. The country is likely to need 18.5 million tons of ethylene in 2005 and 28.5 million tons in 2010.

2.5.2 Forecast of Market Demand for Ethylene Derivatives in China

The demand for ethylene translates to a development in demand for three main categories of synthetic materials: synthetic resins, synthetic rubber and synthetic fibers.

Synthetic Resins

Polyethylene, polypropylene, polystyrene, PVC and ABS the most widely used, and their consumption accounts for over 80 percent of total synthetic resin con-
consumption in China. Polymethylmethacrylate (PMMA) and polyformaldehyde (POM) are used to a much lesser extent. To predict the market for plastic products in China, the following development trends are important.

- Farm-use plastic products still enjoy a vast market but the growth rate is declining.
- Demand for resins for construction applications will climb quickly.
- Demand for resin for packaging applications will continue to grow at a high rate.
- Demand for utensil resins will decline.
- Demand for synthetic materials for electronic products, wiring and household appliances will see higher growth.
- Plastics used in automotive applications will experience stable market growth.
- Demand for resin materials for the production of disposable meal boxes and trays will see declining growth rates.
- Demand for resins for larger household appliances will grow at a slower rate.

**Synthetic Rubber**

Synthetic rubber products mainly include styrene butadiene rubber (SBR), cis-1,4-polybutadiene rubber (BR), neoprene (CR), Buna-N rubber (NBR), ethylene propylene rubber (EPR), butyl rubber and isoprene. The first two types of rubber account for 83 percent of the country’s total synthetic rubber production capacity.

China has very limited natural rubber resources, with output stabilized at 500,000 to 600,000 tons a year. However, the country’s annual consumption of such materials is 1.5 to 1.6 million tons. In 2003, China produced 188 million tires, of which approximately 25 percent were exported.

In predicting the market for synthetic rubber, the following forecast can be made:

- Major consumption comes from the tire production sector.
- Radial ply tires are taking a larger share in total tire production, which will cut demand for synthetic rubber.
- Half of the existing rubber-processing enterprises are Sino-overseas joint ventures which require rubber of higher quality. Most of these producers rely on imported rubber materials.

**Synthetic Fibers**

China is currently the world’s largest producer and consumer of polyester fibers (for textiles). According to government statistics, China’s 2003 consumption of purified terephthalic acid (PTA) - the primary raw material used in the manufacture of polyester fibers for textiles - and polyethylene terephthalate (PET) for bottles, textiles, packaging and film products exceeded 8 million tons. However, of
that amount, only 30 percent was supplied from domestic production. Fibers are mainly used for civilian purposes with little volume going to industrial sectors. Synthetic fibers include polyester, acrylic, polypropylene, polyamide and vinylon fibers. Over 60 percent of polyester fibers are used in the production of outerwear, 20 percent for decorative fabrics and 15 percent for industrial textiles. Acrylic fibers are used in the production of wool blend yarns and carpets. Polyamide fibers are used to make flat chafer fabrics and lining fabrics for clothes. Polypropylene and vinylon are used in industrial applications. China’s fiber-processing volume has increased in the last few years and reached 13.7 million tons in 2003, the largest in the world. The current production of synthetic fibers in China has reached 11.8 million tons, making the country number one in the world.

The market for synthetic fibers is following the development trends described below:

- Most of the synthetic fibers are used for clothing and the change in fashion as well as purchasing power will determine the growth in demand for such fibers. As the standard of living improves, demand for personalized and functional fibers for clothing will grow at the cost of low-quality products.
- Due to the limited of natural fibers, synthetic fibers will play the leading role. In China, natural and synthetic fibers share the market equally. However, the output of natural fibers has stabilized at five million tons and will not increase noticeably in the coming years.
- Acrylic fiber products are now at a mature stage of the market cycle and demand for these will slow. New applications for polyester and polyamide fibers will post growth in the coming years.

Table 2.1 shows the predictions made by experts for the demand for ethylene and related products in the coming ten years.

Table 2.1. Predicted demand for ethylene and related products (million tons) (Source: BASF)

<table>
<thead>
<tr>
<th>Product</th>
<th>2005</th>
<th>2010</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethylene</td>
<td>18.5</td>
<td>28.5</td>
<td>&gt;30</td>
</tr>
<tr>
<td>Five categories of synthetic resins</td>
<td>21.6</td>
<td>28.6</td>
<td>37</td>
</tr>
<tr>
<td>Synthetic rubbers</td>
<td>1.1</td>
<td>1.4</td>
<td>1.7</td>
</tr>
<tr>
<td>Synthetic fibers</td>
<td>8.2</td>
<td>9.8</td>
<td>11</td>
</tr>
</tbody>
</table>

2.6 WTO Entry and Its Impact on China’s Petrochemical Industry

The situation in China since entering the WTO is that with less policy protection from state authorities, multinational companies are going to compete with their local counterparts on the basis of their significant advantages in funding,
technological R&D, human resources, service, distribution skills and brands. How soon Chinese petrochemical producers can enhance their competitiveness will be vital for them to survive the challenges. China’s duty on crude oil imports has been eliminated and the duty tariffs on the following downstream products are listed in Table 2.2.

Table 2.2. Import tariff development according to China’s WTO 2001 accession commitment (Source: US-PRC WTO Agreement, websites)

<table>
<thead>
<tr>
<th>Product</th>
<th>2000 tariff (%)</th>
<th>WTO agreed terms</th>
<th>Effective year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude oil RMB16 per ton</td>
<td>0</td>
<td>0</td>
<td>2000</td>
</tr>
<tr>
<td>Naphtha</td>
<td>6</td>
<td>6</td>
<td>2000</td>
</tr>
<tr>
<td>PE</td>
<td>18</td>
<td>6.5</td>
<td>2008</td>
</tr>
<tr>
<td>PP</td>
<td>16</td>
<td>6.5</td>
<td>2008</td>
</tr>
<tr>
<td>PS</td>
<td>16</td>
<td>6.5</td>
<td>2008</td>
</tr>
<tr>
<td>Styrene</td>
<td>9</td>
<td>2</td>
<td>2005</td>
</tr>
<tr>
<td>ABS</td>
<td>16</td>
<td>6.5</td>
<td>2008</td>
</tr>
<tr>
<td>Ethylene</td>
<td>5</td>
<td>2</td>
<td>2003</td>
</tr>
<tr>
<td>Ethylene glycol</td>
<td>14</td>
<td>7</td>
<td>2003</td>
</tr>
<tr>
<td>Acrylic esters</td>
<td>9</td>
<td>6.5</td>
<td>2001</td>
</tr>
<tr>
<td>Acrylic acid</td>
<td>9</td>
<td>6.5</td>
<td>2001</td>
</tr>
<tr>
<td>Methyl amines</td>
<td>9</td>
<td>6.5</td>
<td>2001</td>
</tr>
<tr>
<td>C4-oxo alcohols</td>
<td>8</td>
<td>5.5</td>
<td>2001</td>
</tr>
<tr>
<td>Formic acid</td>
<td>9</td>
<td>6.5</td>
<td>2001</td>
</tr>
<tr>
<td>Propionic acid</td>
<td>6</td>
<td>5.5</td>
<td>2000</td>
</tr>
<tr>
<td>DMF</td>
<td>8</td>
<td>6.5</td>
<td>2001</td>
</tr>
<tr>
<td>Isocyanates</td>
<td>10</td>
<td>6.5</td>
<td>2003</td>
</tr>
<tr>
<td>Nylon-66</td>
<td>16</td>
<td>6.5</td>
<td>2005</td>
</tr>
<tr>
<td>Polyester</td>
<td>19</td>
<td>5</td>
<td>2005</td>
</tr>
</tbody>
</table>

2.7 Competitive Environment in the Chinese Market

China’s market for petrochemical and chemical products is served by the large petrochemical producers (PetroChina, Sinopec, CNOOC), by imports brought in by many local fragmented companies and by some multinationals. The individual market shares differ at the individual levels of the value chains (see Fig. 2.8).

The Chinese petrochemical and chemical industry is still dominated by Sinopec (chemical business worth RMB 92 billion in 2003), PetroChina (chemical business worth RMB 39 billion in 2003) and CNOOC (at this stage virtually no chemical business). They are the big three in China. Yet other companies are getting stronger either by means of M&A (e.g. ChinaChem) or organic growth. These Chinese companies might become very strong competitors in their respective fields (see Table 2.3).

Roughly one third of China’s oil products are imported. Around 75 percent of imports come from neighboring counties like Singapore and the Republic of Korea (ROK). For example, the ROK, Japan and Taiwan Province together account
for 66 percent of general-purpose resin imports to China every year. Japan, ROK, Singapore, Malaysia and Taiwan Province also contribute 80 percent of China’s polyester imports. About 90 percent of China’s styrene butadiene rubber imports came from Japan, ROK, Russia and Taiwan Province.

![Fig. 2.8. Structure of the petrochemical and chemical market in China (Source: BASF estimate based on different analysts’ reports and Chinese statistics)](image)

Table 2.3. Top 10 chemical companies in China (Source: China Petroleum and Chemical Industry Association (CPCIA); 2003 annual reports of PetroChina, Sinopec Corp. and CNOOC Co. Ltd.)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Company</th>
<th>Turnover in 2003 (in RMB million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PetroChina (listed part of CNPC)</td>
<td>455,133</td>
</tr>
<tr>
<td>2</td>
<td>Sinopec Corp. (listed part of Sinopec Group)</td>
<td>443,136</td>
</tr>
<tr>
<td>3</td>
<td>CNOOC Co. Ltd. (listed part of CNOOC Group)</td>
<td>40,950</td>
</tr>
<tr>
<td>4</td>
<td>Shandong Binghua Group Co. Ltd.</td>
<td>7,795</td>
</tr>
<tr>
<td>5</td>
<td>China National Chemical Industry Corp.* (ChemChina)</td>
<td>6,900</td>
</tr>
<tr>
<td>6</td>
<td>Liaoning Huajing Chemical (Group) Co. Ltd.</td>
<td>3,505</td>
</tr>
<tr>
<td>7</td>
<td>Jiangsu Lingguang Group</td>
<td>3,503</td>
</tr>
<tr>
<td>8</td>
<td>Juhua Chemical Group</td>
<td>2,850</td>
</tr>
<tr>
<td>9</td>
<td>Jiangsu Chemicals and Pesticides Group Company</td>
<td>2,035</td>
</tr>
<tr>
<td>10</td>
<td>Yantai Wanhua Polyurethanes Co. Ltd.</td>
<td>2,008</td>
</tr>
</tbody>
</table>

* Rubber processors, chemical fertilizer and chloro-alkali producers are excluded from the list.
** Annual sales based on Bluestar + Haohua

Most European and American companies compete for China’s market by establishing joint ventures. The local players will have to cope with higher pressure mainly from overseas companies in the foreseeable future. This is difficult as do-
mestic facilities are mostly sub-scale, e.g. of 18 ethylene plants, only seven produce more than 300,000 tons per year, compared with the world average of 750,000 tons per year.

During the coming years the competitive environment in China will change. The country’s petrochemical industry is currently in a phase of restructuring, mainly driven by administrative and state enterprise reforms that started in 1998 and focus on separating administrative functions (government functions) from actual operations (business management functions). In the past, government organizations were deeply involved in such aspects as personnel matters, investment decisions and asset disposal of the state-owned enterprises. Due to this influence, especially small-scale investments were sometimes made irrespective of economic efficiency or market demand. In some projects, vast funds were borrowed and promotions were not always based on merit, subsequently leading to inefficient management. This is changing for the better. In China about 54,000 chemical sites are said to be in place. These companies are either collectively owned (provincial or municipal ownership) or, increasingly, privately owned. Some of the collectively owned enterprises are spin-offs from Sinopec and PetroChina following their restructuring in 1998.

Management is an obvious weakness of Chinese enterprises. Reform efforts with the introduction of corporate governance have just begun. It will take time to catch up with international standards in this regard. Redundancy remains serious despite massive lay-offs. The number of employees is still at least five times larger than the world average.

Estimates show that compared with the average prices of ethylene products from neighboring countries like Japan and ROK, domestic prices are 20 to 30 percent higher. This difference includes 8 to 12 points in manufacturing costs, 3 to 5 points in financial costs, 1 to 2 points in management costs and 3 to 8 points in tax costs. China can no longer afford small ethylene units.

The overall conclusion is that China will need to invest in substantial refining and petrochemical plant capacity in the coming decade. It will be critical for China’s long term competitiveness in the global marketplace to ensure that these new plants are world-scale and world-class, and capable of competing with the best facilities anywhere. China has decided to:

- close small and inefficient plants;
- cut operating costs;
- reduce redundancy;
- restructure institutions;
- upgrade technologies and equipment;
- integrate refineries and petrochemical plants with sales and distribution companies;
- expand the sales network;
- strengthen international cooperation.

The bottom line is that the continuing strong growth of the Chinese economy will spur imports of crude oil, petroleum products and petrochemicals, despite massive
and ambitious investment plans within China. Imported crude oil will become increasingly heavy and sour, requiring new refining configurations and modification of existing plants. The product shortfall will grow over time and will be concentrated in the south and southeast. As for chemicals, there will be a substantial continuing dependence on imports, despite an aggressive debottlenecking and grassroots construction program.

The investment implications of this outlook are quite challenging, with the petroleum and petrochemical industry in China facing a huge task. The question is not whether these investments are needed, but rather whether the technical, managerial and financial capabilities can be marshaled to safely and efficiently develop competitive world-class facilities.

2.8 Summary and Outlook

The development of China's petroleum and petrochemical industry has gone through massive changes, as it was struggling to stay in sync with the fast growing Chinese economy.

This capital and know how intensive sector has developed from a small sized regionally diverse industry into an increasingly globally competitive industry, partly also due to the heavy engagement of multinational companies. China's raw material needs especially for oil make China internationally more interdependent, and the secure supply of oil determines the industries future. Refineries are debottlenecked, new capacities come on the market. The fast growing economy with China being the future production center of the world requires a competitive and reliable chemical industry, and China focuses on new crackers and the expansion of existing facilities, to serve as an industry of the industry. China has the fastest growing chemical market in the world, and the focus is on synthetic resins, synthetic rubber and synthetic fibers. China's entry into WTO has altered the economic and legal landscape, opened up new possibilities for investors as well as importers. The competitive pressure in this market is very high, and only the respective market leaders with world scale facilities will prevail.

Given the fact that China is already the second largest economy in purchasing power parity terms (in 2004 7th largest economy in real GDP terms) and about to grow its economy by 6-7% over the next decade, this determines the growth pattern of China's petroleum and petrochemical industry. China will have the world’s largest automobile industry in 2030; half of its population by then will be a middle class with a consumption pattern that reflects that of Southern Europe, and its energy needs and chemical demand will reshape the global markets. Not only will China consume more and more oil, gas, steel, iron ore and copper, but will have to develop a sustainable economy to avoid the environment and the international commodity markets to collapse. Modern technologies in the chemical sector will help China to grow without outgrowing the system. The 21st century looks set to become the Asian Pacific century, and the European companies are already in China to become part of this unprecedented growth story.