

A Comparative Analysis of Petrochemical Industry Development in China and The United States.

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Abstract. Concurrently, the petrochemical industry serves as a catalyst for scientific and technological innovation, propelling the frontiers of knowledge while spearheading societal progress. This symbiotic relationship between industry and innovation has been pivotal in shaping the trajectory of scientific development, technological advancement, and the broader societal landscape. This discourse endeavors to undertake a comparative analysis of the petrochemical landscapes in both China and the United States. Through such an examination, the aim is to galvanize mutual progress in technological innovation, enhance competitiveness, facilitate resource synergy, and foster bilateral cooperation. By emulating sustainable practices from both nations, the petrochemical sector can chart a course toward harmonious and ecologically-conscious growth. The ramifications of this collaboration hold the potential to catalyze growth within the petrochemical industry of both countries. Not only will it serve to bolster their economic development, but it will also be instrumental in underpinning their strides towards sustainable development. Ultimately, this harmonized approach stands to amplify the progress of the petrochemical domain, acting as a catalyst for economic growth while championing a sustainable and balanced future.

Keywords: Petrochemical industry; technological advancement; keywords covered; economy.

1. Introduction

The petrochemical industry plays a crucial role in the global economy, serving as a key driver of industrial development and providing essential raw materials for various sectors. China and the United States, as two major players in the global petrochemical market, have witnessed significant growth and transformation in their respective industries over the years. This paper aims to provide a comparative analysis of the development of the petrochemical industry in China and the United States, exploring similarities, differences, and potential areas of collaboration. China, with the rapid growth of economy and the expansion of industrial base has emerged as a leading consumer and producer of petrochemical products. The country's strategic initiatives, such as the "Made in China 2025" plan and the Belt and Road Initiative, have further propelled the growth of its petrochemical industry. On the other hand, the United States, with its abundant natural resources and advanced technological capabilities, has long been a dominant player in the global petrochemical market. The shale gas revolution and favorable investment climate have contributed to the resurgence of the U.S. petrochemical sector. This paper will examine various aspects of the petrochemical industry in both countries, including policies, technology development, industrial competitiveness and relevance to other industries. By comparing these factors, we can gain insights into the strengths, weaknesses, and opportunities for improvement in each country's petrochemical industry. Furthermore, identifying areas of convergence and potential cooperation between China and the United States will be crucial in fostering sustainable growth and development in the global petrochemical market. In conclusion, this comparative analysis will contribute to a deeper understanding of the petrochemical industry's development in China and the United States. By identifying similarities, differences, and potential areas of collaboration, policymakers, industry stakeholders, and researchers can gain valuable insights into fostering sustainable and mutually beneficial growth in the global petrochemical market.

2. Policies

2.1. Chinese Policy

As a pillar industry related to the national economy and people's livelihood, the petrochemical industry has been paid more and more attention by various countries. The Chinese government has introduced a number of policies in 2021 to promote the industrial upgrading and efficient and low-carbon development of China's petrochemical industry, and some policies have already been implemented. The importance of the Chinese government to the petrochemical industry can be seen from the policy aspect. Here are the key petrochemical policies in China from 2021 to 2022: February 2022: "Some Policies on Promoting Steady Growth of Industrial Economy." The policy focuses on new infrastructure and the cultivation of industrial clusters. It proposes supporting major engineering projects and industrial investment projects, promoting technological transformation in traditional industries, and stimulating the market potential of petrochemical enterprises. This policy provides a starting point and practical measures for creating new drivers of industry growth [1]. December 2021: "Some Opinions on Promoting Healthy and Sustainable Development of Platform Economy Norms." The policy aims to build a clean, low-carbon, safe, and efficient energy system. It emphasizes controlling the total amount of fossil energy, improving energy efficiency, diversifying and expanding sources of oil imports, consolidating the domestic production base, and enhancing the oil reserve system [2]. November 2021: "14th Five-Year Plan for Promoting Cleaner Production Nationwide." This plan involves carrying out comprehensive reviews, evaluations, and certifications of cleaner production. It promotes green transformation and upgrading in key industries such as petrochemicals and chemical raw materials, focusing on energy conservation, water conservation, material conservation, pollution reduction, and damage prevention [3]. November 2021: "Guidelines on Strengthening Cooperation between Industry and Finance to Promote Green Industrial Development." The policy accelerates efforts to transform industries such as petrochemicals and chemicals into greener industries. It encourages financial institutions to develop financial products that target the green transformation of key industries, such as steel and petrochemicals, green building materials, new energy vehicles, electrification of old ships, and promotion of green products [4]. October 2021: "Action Plan for Energy Conservation and Carbon Reduction in Key Petrochemical and Chemical Industries under Strict Energy Efficiency Constraints." This plan aims to significantly improve the overall energy efficiency level, reduce emissions, and enhance the capacity for green and low-carbon development in the industry through energy conservation and carbon reduction actions by 2025 [5]. May 2021: "Notice on the Action Plan for Deepening the Reform of the Price Mechanism during the 14th Five-Year Plan Period." This policy focuses on studying and improving the pricing mechanism of refined oil products in response to changes in domestic and foreign energy markets and the reform process of domestic institutional mechanisms. It aims to steadily advance the reform of oil prices [6]. From the above policies, it can be seen that the policy support of the Chinese government is mainly reflected in expanding oil reserves, strengthening the structural reform of the petrochemical industry, and strengthening the infrastructure construction of the petrochemical industry.

2.2. The US policy

In 1911, the US government published the Anti-trust Act, which means the breakup of the Standard Oil Company. Until the 2030s, the government started to allocate production quotas according to market demand and limit oil production. Then in 1959, the Oil Import Restriction Program (MOIP) caused disagreements between the large producers and individual producers, but later the Oil Export Organization (OPEC) were established to oppose the MOIP. The Department of energy and the Strategic Petroleum Reserve System (SPR) was established in 1977. The petroleum resource in the US is now owned by the government, but the government doesn't have the right to control and determine the price of the oil. All the private oil companies have the right to produce the oil, which cannot be intervened by the government. The landowners have the right to exploit the oil underground,

which is called the landowner system. As a result, the price of the oil is determined by the market demand and supply, and the oil companies are all run by individual investment. In addition, if the oil price fluctuates significantly for a long time, the government will try to adjust and intervene the market., the US government also published the Strategic Petroleum Reserve System (SPR), which is mainly used for commercial and strategic reserves. Problems such as oil embargoes and oil supply disruptions can be solved effectively. It is widely known that the petroleum resource is rich in the US, but for the reason that more and more lands have already been exploited, it costs much more to produce the oil nowadays. The US government implemented quite a lot of measures in order to cooperate with individual companies and achieve more effective research on oil. According to the report, due to the improvements on the technology of exploiting oil, the cost of producing oil has been reduced from \$20 per barrel to only \$5 [7]. The government also implemented discounts on taxes. Except for cooperating with domestic companies, the US government also encourages all the oil companies invest overseas. In order to get more profit, they tried to make good use of all the international resources. For example, the US government take part in the international competition by offering subsidies and technical assistance to domestic enterprises.

3. Technology Development

3.1. Chinese Technology Development

Under the guidance of the policy, China's petrochemical industry has achieved rapid and stable development in the past few decades, becoming an important pillar of the Chinese economy. At the same time, China is committed to transformation and upgrading, promoting green and sustainable development to address environmental challenges and promote sustainable development of the industry. China is the world's largest crude oil importer and fourth largest crude oil producer. China produces more than 100 million tons of crude oil a year, while consumption is as high as 500 million tons. This has made China an important player in the global oil market. China has a large number of oil refineries, refining capacity in the world. In 2022, China's refining capacity will exceed 900 million tons per year, which can meet domestic demand and export to other countries. China has a wide range of refined products, including gasoline, diesel, aviation fuel, lubricants, etc. At present, China's petrochemical industry has mastered many advanced technologies such as deep-water oil and gas exploration and development technology, intelligent oilfield technology, etc. These technologies have helped China's petrochemical industry accelerate its development in recent years and become one of the pillar industries in China.

3.2. The US Technology Development

The origin of the US oil industry Can be dated back to the early 19th century. The oil resources were widely exploited from the middle of 19th century to the beginning of the 20th century. During this period, the US oil industry has experienced rapid growth and prosperity. However, due to the demand of oil in the US having decreased and the competition abroad became more and more serious, the oil industry faced a serious challenge in the middle of the 20th century. The two oil shocks made the oil industry hard to survive. As a result, the government encouraged technological innovation in the whole country. Then America became the biggest country to produce oil, and also provided power to promote the American economy. For example, the development of hydraulic fracturing technology has made the exploitation of oil faster. Before 2003, the US mainly adopts the vertical well technology. By 2021, horizontal well drilling has been widely used. The initial production speed, controlled reserves and final recoverable reserves of horizontal wells can reach 3 to 4 times that of vertical wells [8]. In addition, the improvements in drilling technology have also contributed to the growth of the US oil industry: As the traditional surface drilling cannot meet the demand for deeper and more oil resources, rotation drilling and deep-water drilling have been explored nowadays. These technologies have lied a solid foundation for the American oil industry.

4. Industrial Competitiveness

4.1. Chinese Industrial Competitiveness

China has made significant strides in developing and adopting advanced technologies in the petrochemical industry. Through research and development efforts, the country has successfully improved process efficiency, reduced energy consumption, and enhanced product quality. Additionally, China's focus on innovation and intellectual property protection has fostered the development of cutting-edge technologies, positioning Chinese petrochemical companies at the forefront of technological advancements, thereby bolstering their industrial competitiveness. The Chinese government has implemented various policies and initiatives to foster the growth of the petrochemical industry. The "Made in China 2025" plan, for instance, aims to transform China into a global manufacturing powerhouse by promoting technological innovation, upgrading industrial infrastructure, and encouraging domestic consumption. Additionally, the government offers financial incentives, tax benefits, and streamlined regulatory processes to attract both domestic and foreign investments. These supportive measures have contributed to the competitiveness of the Chinese petrochemical industry. China's access to abundant and diverse resources has played a crucial role in its industrial competitiveness. The country has significant reserves of oil, coal, natural gas, and other raw materials required for petrochemical production. This resource advantage has not only ensured a stable supply of feedstocks but also allowed Chinese companies to explore diverse product portfolios, catering to various market demands. Moreover, the integration of upstream and downstream sectors within petrochemical complexes has enhanced efficiency, reducing logistical costs and strengthening overall competitiveness. China's domestic market presents immense opportunities for its petrochemical industry. The country's rapid urbanization, rising middle class, and increasing consumption patterns have fueled the demand for petrochemical products, ranging from plastics and fibers to fertilizers and specialty chemicals. Chinese petrochemical companies have capitalized on this demand by establishing localized manufacturing facilities, tailoring their products to meet specific market needs. The ability to adapt quickly and cater to diverse customer requirements has given them a competitive edge in both domestic and international markets. In conclusion, Chinese industrial competitiveness in the petrochemical sector is driven by factors such as growing production capacity, technological advancements, government support, resource availability, and market demand. As China continues to invest in research and development, streamline regulations, and promote sustainable growth, its petrochemical industry is expected to further strengthen its global position and contribute significantly to the country's economic development.

4.2. Competitiveness in the US Industry

America has a geographical advantage in the petrochemical field, and its oil reserves are extremely rich. This is the basis for the development of the petrochemical industry in the United States. The US also owns the world's largest oil companies. The Chevron Corporation was founded in 1879 in California, and has become the second largest company in 2022, which now has operations in more than 180 countries. For instance, in 2022, the Chevron Corporation has 3 million barrels of net oil-equivalent daily production, and the total assets has already reached 257.7 billion [9]. Its business includes all aspects of the oil industry: exploration, production, refining, marketing, transportation, petrochemicals, power generation, etc. Over the past 140 years, Exxon Mobil has evolved from a regional marketer of kerosene in the U.S. to one of the largest publicly traded petroleum and petrochemical enterprises in the world, which witnessed the development of the world's oil industry [10]. American oil companies monopolize the market and solidify their position in the global energy market by establishing these oil companies and making foreign investments and cooperations.

5. Relevance to Other Industries

5.1. Chinese Petrochemical Industry's Relevance to Other Industries

The rapid rise of China's petrochemical industry in domestic and international markets has had a profound impact on other related industries. The petrochemical industry in China is closely linked to the energy sector [11], providing abundant raw materials for industries such as automotive manufacturing, construction, electronics, pharmaceuticals, and daily consumer goods. Furthermore, the development of the petrochemical industry has also stimulated the growth of related industries such as petrochemical equipment manufacturing, logistics, transportation, and packaging promoting employment and improving the industrial chain. The development of China's petrochemical industry plays a crucial role in driving the development and upgrading of the domestic market. The demand for plastic products has driven the growth of the plastics processing industry, while the production of fertilizers and pesticides supports agricultural modernization and increased agricultural productivity. Additionally, the innovation and development of chemical products have provided new growth opportunities for the Chinese economy, Enhanced the international competitiveness of products. There is a close relationship between China's petrochemical industry and the environmental protection industry. Petrochemical enterprises are transitioning towards low-carbon, green and sustainable development. By adopting advanced environmental protection technologies and measures, these enterprises not only reduce the risks of environmental pollution but also create new market demands for the environmental protection industry. In areas such as waste treatment and recycling, the petrochemical industry and the environmental protection industry have formed a synergistic effect, promoting the development of circular economy. China's petrochemical industry is closely connected to technological innovation. To enhance product quality, Technological competitiveness and value-added products, Chinese petrochemical companies actively introduce and innovate advanced production technologies and management practices. This technological innovation not only drives the development of the petrochemical industry but also promotes the upgrading and technological progress of related industries. Collaboration between Chinese petrochemical companies, universities, research institutions, and other industries is strengthening, injecting vitality into industrial innovation. In conclusion, the petrochemical industry in China has a close relationship with other industries. Its rapid development provides abundant raw materials and market demand for other related industries, driving the development and upgrading of the domestic market. The transformation and innovation of the petrochemical industry positively impact the environmental protection industry and technological innovation. As China's petrochemical industry continues to gain prominence on the global stage, it will continue to play a significant role in driving and leading sustainable development in the Chinese economy.

5.2. The US Petrochemical Industry's Relevance to Other Industries

With the rapid development of the US oil industry, in fact, it is also affecting the economy. Firstly, oil plays an important role in industry, transportation and agriculture, which improves the social and technical development. If the price of oil falls, it will lead to a decline in the profits of the entire oil industry, which will affect economic growth. The COVID-19 caused the fact that global oil demand has been hit hard. It is mainly because of the two problems of oversupply and insufficient storage space: fuel demand has fallen sharply because aviation, transportation and industrial engineering have largely halted. As a result, the global oil production fell by an average of 500,000 barrels a day since March [12]. In addition, fluctuations in oil prices also affect demand for other energy sources such as nuclear energy and renewable energy. As these industries can substitute each other in some areas, people will always choose the one with the lower price. As a result, the prices in oil industry affects the other competitive industries.

6. Conclusion

The petrochemical industry really plays an important role in the energy resources area. In this paper, it is clear to see that the United States is still the world's leading oil import and export, with the largest and most advanced oil corporations, a long history of development, and continuous breakthroughs in scientific and technological innovation. The US has many policies in the field of oil, mainly including the government encourages the continuous innovation and development of oil corporations and provides funds and subsidies. At the same time, constantly adjust the market to ensure a balanced and stable market. Cooperating with private enterprises to facilitate domestic oil demand. At the same time, it conducts overseas investment and cooperation to achieve mutual benefits and win-win results. To sum up, the United States dominates the world's oil resources and has unprecedented influence in the oil market.

On the other hand, China is catching up in its own way, and the technology in the petrochemical industry has improved significantly over the years. As the largest developing country, China ranks first in terms of oil consumption and is an important participant in the world oil market. Meanwhile, China ranks fourth in the world in terms of oil production, which shows that China has developed very fast in recent decades. Nowadays, China has already aimed at shifting towards green and sustainable development in order to reduce pollutant emissions.

In the future, China will continue to pursue green and sustainable development and achieve technological innovation, trying to catch up. While the US has already developed technologies such as rotation drilling and deepwater drilling, and it will make good use of these technologies.

Authors Contribution

All the authors contributed equally, and their names were listed in alphabetical order.

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