After the establishment of the People’s Republic of China, the country’s petrochemical industry started from scratch but developed fast. Due to dramatic growth, particularly in the two decades since opening to the outside world, China has become one of the major petrochemical producers.

By the end of 2004, China’s primary crude distillation capacity had reached 315 million metric tons per year (mmtpa) (second worldwide), ethylene production had reached 6.085 mmtpa (third worldwide), synthetic resin 19.50 mmtpa (second worldwide), synthetic fibre 13.10 mmtpa (first worldwide), and synthetic rubber 1.39 mmtpa (fourth worldwide). In 2004, China’s refining throughput totaled 270 million tonnes, with 160 million tonnes of gasoline, diesel, and kerosene products, meeting domestic demand both in volume and in quality. Ethylene production in 2004 was 6.27 million tonnes, satisfying 38.5 percent of direct and indirect needs for ethylene.

The reform and restructuring of the Chinese economy initiated in 1998 led to the establishment of several dominant state-owned enterprises in different sectors of the petrochemical industry, thus creating an interim system and mechanism for a future market economy. SINOPEC and China National Petroleum Corporation (CNPC), ranked 31st and 46th respectively in Fortune 500 for 2004, are a testimony to the increasing competitive power of state-owned enterprises.

In recent years, restructuring and technology advances have intensified in China’s petrochemical industry, with improved industry layout and expanded scale. The construction of world-scale refineries with integrated refining and chemical operations has been accelerated, with eight refineries reaching ten-million-tonne capacity, including Zhenhai, Dalian, and Maoming. A number of refining and chemical complexes have been developed, such as Yanshan Petrochemical, Shanghai Petrochemical, Yangzi Petrochemical, and Daqing Petrochemical. The completion of joint ventures with YPC-BASF, SECCO, and CNOOC-SHELL for ethylene production will further optimize the industry layout and product mix, gradually increasing industry concentration. Through increasing investment and technology revamping, China has been able to improve the quality of its refined oil products, narrowing the gap between domestic and international standards. On 1 July 2005 China implemented a nationwide automotive gasoline standard equivalent to Euro II. In addition, Beijing has started to apply the Euro III-equivalent standard for auto-use gasoline and diesel.

Years of unremitting research and development efforts have enabled China to develop its own technology leading to intellectual property rights in a number of core technologies. A series of unique refining technologies, including heavy oil cattracking, hydrocracking, hydrofining, residue hydrotreating, and hydro-upgrading, have been successfully developed and deployed. In chemical production, improvements have been developed and commercialized in ethylene cracking; in the production of acrylonitrile, ethylene/propylene, SSBR [Solution Styrene Butadiene Rubber], and SBS [Styrene Butadiene Styrene]; in toluene disproportionation and transalkylation, aromatics extraction, and C5 extraction. Some of these improved technologies have also been licensed overseas. China is now 85 percent self-sufficient in manufacturing and supplying catalysts for refining and chemicals.

Petrochemical Technology—The Current Situation in China

China has made remarkable progress in petrochemical technology along with its industrial development. For more than 50 years, especially since the establishment of the former China Petrochemical Corporation in 1983, a technology R&D system has existed that inte-

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grates research institutes, colleges and universities, and industrial enterprises. Guided by the motto “Prosper the Petrochemical Industry, Science and Technology Take the Lead,” technological innovation was promoted based on licensed foreign technologies and a large number of patented technologies subsequently developed in China. This drive toward innovation has strongly bolstered China’s petrochemical industry and is constantly driving it forward.

Through R&D and innovation, China has developed unique processes and catalyst technologies for clean fuels production, heavy and sour crude processing, and integration of refining and chemical production. China is also capable of building refineries with ten-million-tonne capacities with the self-developed technologies and equipment.

In clean fuels production, China has improved not only the conventional hydrocracking and hydrotreating technologies, but also a series of desulfurization and olefin reduction technologies for catalytic gasoline. These include medium-pressure hydro-upgrading and hydrotreating for diesel fuel; catalysts for diesel hydrotreating; new technologies for FCC [fluid catalytic cracking] gasoline desulfurization, such as FCC gasoline selective HDS [hydro desulfurization], FCC gasoline HDS, and olefin removal; flexible FCC gasoline olefin removal technologies and a supplemental reactor for upgrading and olefin removal; and a series of catalysts and co-catalysts that reduce the olefin content in FCC gasoline for the production of cleaner burning fuels. These technologies are helping to meet the goal of providing high-quality clean fuels for the 2008 Beijing Olympics and 2010 Shanghai World Expo.

In residue processing, improved technologies include residue catcracking, hydrotreating, and decoking. The self-developed Daqing vacuum residue FCC encompasses several leading technologies, lifting the ratio of vacuum residue in FCC feed to as high as 85 percent, or even 100 percent in some cases. This achievement allows China to process heavy crude and to utilize the residue resources. In addition, the patented fix-bed residue hydrotreating technology and relevant catalysts can effectively remove sulfur, nitrogen, and metals in the residue and fully convert sulfur-containing residue. Its successful commercialization marks a breakthrough in China’s sour-crude processing technology, enabling China to process imported high-sulfur crude. Self-developed processes and catalysts for residue hydrotreating account for more than 90 percent of the market share in China.

In refining and chemical integration, a series of technologies for maximum chemical feedstock production have been developed, such as DCC (catcracking for maximum propylene production), maximum gasoline and LPG production, maximum iso-olefin production, maximum iso-paraffin production, hydrocracking to produce high-quality feedstock for reforming and cracking, and low-pressure combination-bed catalytic reforming for aromatics.

Improvements to other refining technologies, such as isomerization, hydrogenation, sulfur recovery, and technologies for high-class lubricants and asphalt have been developed. The Great Wall premium-quality lubricant was used in China’s Shenzhou V Spaceship, and Donghai high-class asphalt was used in the Shanghai International Circuit’s Formula-1 race track.

Through intensified technology transfer and innovation, China has developed and commercialized many patented chemical technologies, some of which have been licensed to overseas market.

With respect to basic organic feedstock, ethylene, butadiene, toluene disproportionation and transalkylation, and ethyl benzene/styrene technologies have been developed. The self-developed ethylene cracker, which is widely commercialized in China, achieves world-leading marks on technical and economic indices. The jointly-developed 100 kta cracker with ABB Lummus has been widely applied. The self-devel-
Developed complete ethylene technology proved successful in revamping and expanding Tianjin and Zhongyuan ethylene facilities, demonstrating that China is able to build large-scale ethylene facilities independently with its own technologies.

With respect to other organic feedstock, acrylonitrile, purified terephthalic acid, cumene, caprolactam, ethylene glycol, and C5 extraction technologies have been developed. For caprolactam, China has developed and commercialized cyclohexane biomimetic catalytic oxidation, cyclohexanone oximation, and a magnetic stabilized fluid bed caprolactam purification process. This is the only brand new caprolactam process in the world.

In synthetic materials, loop-process polypropylene (PP), SBS/SSBR technologies have been developed and N catalyst for PP and SBS technology have been transferred overseas. N catalysts and NG catalysts for PP have been applied to large-, medium-, and small-scale PP facilities in China, delivering international-level performance.

China has developed a number of technologies for catalyst manufacturing. Catalyst technologies for catcracking, hydrofining, hydrocracking, residue hydrotreating, catalytic reforming, PP, polyethylene, ethylene oxide/ethylene glycol, AN, toluene disproportionation, and transalkylation have reached world-leading levels. Presently, 85 percent of the catalysts, solvents, and agents used in refining and chemical enterprises are domestically manufactured and supplied, with some exported as well.

Prospects for China’s Petrochemical Technology

China has clearly developed a blueprint for constructing a moderately prosperous society in the first two decades of this century. Guided by this blueprint, China’s goal is to sustain its healthy and fast economic growth, which should translate into sustained demand growth and huge potential for petrochemicals and other energy-related raw materials. This in turn will encourage the development of core and proprietary petrochemical technologies in the following areas.

1. China should further develop deep processing through innovation, such as hydrocracking, to increase product yield, to efficiently utilize this valuable crude resource, and convert it into transport fuels and chemical feedstock to the maximum extent possible. Clean-fuels production technologies should be developed to make it possible to meet the clean-fuels production requirements while using increasing amounts of low-cost feedstock. The target is to implement Euro III equivalent auto-use gasoline and diesel standards in China in 2010.

2. China should develop maximum low-carbon olefin and aromatics production technologies, utilizing the synergy of integrated refining and chemical operation. The refining industry should be restructured to revamp existing enterprises and increase their scale and integration. China should increase the number of ten-million-tonne capacity refineries and mega-tonne ethylene crackers in the Yangtze River Delta, Pearl River Delta, and Bohai Bay area, tapping the synergy of integration and optimization and improving competitive power.

3. The target for petrochemical technology development should be to address the needs of economic development. Therefore, ethylene and polyolefin technologies and other core and proprietary technologies should be intensely developed to reach world-leading levels, enabling the construction of large ethylene sites and major chemical complexes. New product development and product mix restructuring should be market oriented. While increasing production volume, the industry should also develop new products, upgrade product quality, increase the proportion of high-end products such as performance compounds of synthetic resins, and differential synthetic fibers, so as to sharpen its competitive edge in the marketplace.
China’s Petrochemical Technologies

4. China should comprehensively improve the industry’s automation, optimize facilities in real time, and widely promote network technology. Petrochemical enterprises should implement enterprise resource planning and other IT construction measures, thus integrating human resources, operation management, and technology and optimizing information flow, materials flow, and cash flow. In this way, IT can strongly support the enterprise's operations and decision-making processes and facilitate the intelligence and modernization of the enterprise.

5. China should develop and promote efficient technologies and low pollution emissions. The industry should limit the generation of pollution at the source, increase production of clean fuels and green petrochemicals, and strengthen the control and recycling of pollutants.

Only with constant innovation can we succeed in developing new petrochemical technologies and meeting the changing and ever-higher requirements of the world economy and international community. As China’s petrochemical enterprises pursue innovation, they seek to enhance the exchange and collaboration with international peers. We are committed to the harmonized development of the human society and our globe. 🌍

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