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Chinese Petroleum Refinery Modernization: Depending on Western Technology

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An Intelligence Assessment

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September 1987

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Chinese Petroleum Refinery Modernization: Depending on Western Technology [redacted] 25X1

An Intelligence Assessment

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Chinese Petroleum Refinery Modernization: Depending on Western Technology 25X1

Key Judgments

Information available as of 1 June 1987 was used in this report.

China is relying heavily on Western technology to expand its oil refining capability. In the long term, the Chinese seek to meet the energy requirements of an ambitious modernization program. More immediately, however, they seek to earn foreign currency by exporting petroleum products to the West. 25X1

Expanding energy supplies will be critical for the success of China's national modernization effort. We judge, however, that the Chinese may not meet their refining needs by using indigenous technology. China is looking to Western suppliers to build the more sophisticated processing units that can convert China's unusually heavy crude oils into valuable and exportable products. 25X1

The refinery expansion and upgrading now under way is enabling China to substantially increase its output of gasoline and other valuable light products. By 1990, China will have doubled its 1978 capacity for light products through a program of construction and equipment acquisition that would cost $3-4 billion in the United States. This program has already resulted in increased gasoline production and enhanced feedstocks to China's chemical industry, and will probably be successful in keeping pace with China's production and import of motor vehicles. 25X1

The heavy, waxy quality of Chinese crude is posing problems for refiners. The Chinese lack the best technology for the secondary refining steps that crack the heavy constituents of crude. As a result, a large portion of their refinery output remains as heavy fuel oil. To increase future production of lighter products, such as gasoline and aviation fuel, China has chosen not to copy existing refineries and process a greater volume of crude—which would leave less crude available for direct sales. Rather, China has chosen to build more secondary refining facilities to refine each barrel of crude more completely. 25X1

Complicating their refining problem further, the quality of crude oil entering China's refineries is declining. Falling output of heavy oil from the Daqing oilfield is being offset by increasing production of even heavier crude from the Shengli oilfield. China must therefore improve or expand its refineries simply to maintain its current production level of light products. 25X1

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The Chinese will need Western help in two forms to meet their refining requirements. First, China needs secondary processing units—catalytic crackers, alkylation units, hydrocrackers, and hydrotreaters. These units will allow refiners to convert the heavy components of crude oil into light products. China's copies of US technology from the 1950s are no longer adequate. China is also purchasing technology for making high-octane gasoline for domestic use and lead-free gasoline for export to the United States. Second, the Chinese will require process control technology and operational know-how. Better process control will be especially critical for making exportable products that meet foreign product specifications. Better operational know-how may not be essential but would significantly improve reliability and overall efficiency in China's refineries. 25X1

Reliance on Western assistance will continue as China modernizes its refining industry, at least through the mid-1990s. Because of the central role of energy in China's national modernization effort and the importance of oil for export, this dependence will probably remain among the important elements of China's overall technology acquisitions. 25X1

The impact on US interests of China's efforts to upgrade its refineries will be primarily commercial. Orders for process equipment and technology represent income for Western firms in the near term, and Chinese exports of refined products and, eventually, process equipment represent likely economic competition in the late 1990s and beyond. Indirectly, the progress of China's refinery expansion program will also have political and military implications, for it fundamentally affects China's basic industrial growth and war-fighting capability. 25X1

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Chinese Petroleum Refinery Modernization: Depending on Western Technology [redacted] 25X1

Introduction

China intends to become a modern industrialized state with commensurate economic, military, and diplomatic strength. Because of its size and extensive resources, China can potentially become a major global power, but the obstacles to industrialization are formidable. The problems range from inadequate education and transportation to party politics. Energy production is essential for China's industrialization. For example, higher production of motor vehicles is planned both as a driver of broad industrial development and as a critical element in improving transportation. For these plans to succeed, China will need energy for new industrial plants and fuel for a fleet of motor vehicles that the Chinese hope to double between 1986 and 1990 and double again by the end of the century. Petroleum refining capacity must be expanded to meet these requirements. Figure 1 shows the locations of China's major refineries and their capacities in 1985. China's goal for the Seventh Five-Year Plan is to expand refining capacity 30 percent, to about 130 million metric tons per year, by 1990. In the course of this expansion, China hopes to rectify the large disparity between the locations of its refineries and the major consumer centers. [redacted]

In addition to satisfying future domestic energy requirements, energy resources are one of China's most important exportable commodities. Crude oil and refined products are exported to earn the foreign currency essential for buying the high-technology imports that are needed throughout Chinese industries. In 1984, China's petroleum exports earned nearly $5 billion—a fifth of its total export earnings. Exports of crude oil to the United States increased from 1.1 million metric tons in 1984 to 3.9 million metric tons in 1985. Exports of Chinese gasoline to the United States, on the other hand, fell from about 1.3 to 1.1 million metric tons per year in the same period—the result of decreasing US demand for China's leaded fuel. Because of China's hard currency requirements, plans for the future expansion of energy supplies will have to include trade-offs between satisfying domestic needs and exporting to earn foreign currency. We see evidence of the pressure to export in China's efforts to produce unleaded gasoline, which is aimed at sales to the United States. The Chinese realize that they can earn more foreign currency by exporting refined products rather than unrefined crude oil. [redacted] 25X1

This paper assesses the changes occurring in Chinese petroleum refining and gauges the importance to China of technology acquired from the West. [redacted] 25X1

Refining Technologies

At least 75 percent of China's crude oil distillation capacity is based on 1950s US technology copied from a 34,000-barrel-per-day (b/d), Esso-designed unit at the Nico Lopez refinery in Cuba. The Chinese have scaled up the distillation units to a standard capacity of 50,000 b/d. They construct large refineries or expand existing refineries by building more standard units. China has not yet achieved the economic benefits of scaling further to larger (100,000 to 200,000 b/d) crude oil distillation units. We do not know what hinders the Chinese in this area, but their present distillation technology seems adequate for their needs. China's key shortfalls are in the technologies for converting heavy streams from the distillation process into useful products. Figure 2 shows the processes involved in the conversion of crude oil into useful products. The first step, distillation, separates the crude oil into streams of naturally occurring gasoline, kerosene, and diesel fuel and into large streams of heavier oils that are the feedstocks for the secondary processing units of the refinery. These secondary refining technologies are discussed in the following section. [redacted] 25X1

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Secondary Processes

Fluidized-Bed Catalytic Cracking. Before 1970, many Chinese refineries were fractionation-only installations, separating the crude oil into small quantities of naturally occurring light fuels and a preponderance of less useful, heavy fuel oil. [redacted] most of the older refineries have since installed fluidized-bed catalytic cracking (FCC) units, now the most common secondary processing unit in Chinese petroleum refineries. All of the FCC units constructed in China appear to be copies of an Esso-designed unit using 1950s US technology. The standard Chinese versions of these units have a feed capacity of 12,000 b/d, but units with capacities of 24,000 b/d have also been constructed. [redacted]

In six of their 32 known FCC units, the Chinese have tried to use riser-cracking technology—a modification that exploits the more active properties of synthetic zeolite catalysts. The switchover to riser cracking occurred in the West about 1970. [redacted]

The Chinese produce all the catalysts used in their FCC units. Contrary to Chinese claims in open literature, we do not believe that they are satisfied with these catalysts. Between 1980 and 1982, the Chinese conducted long negotiations to obtain the rights to produce a Western cracking catalyst. The negotiations failed [redacted]

In 1985, China for the first time turned to the West for direct purchase of catalytic cracking technology. In October 1985, the Chinese contracted with a US firm for a new FCC process that accepts as feed the heaviest portion of the crude oil—literally that at the bottom of the barrel. The US firm developed this process because of the worldwide trend toward less direct burning of heavy oil and the corresponding need to refine it further. The technology is very new; only two or three US refineries employ it. [redacted]

The Chinese will rebuild two FCC units, at the Zhenhai and Wuhan refineries, to accept the US process. The units will probably be operational by the fall of 1987. Three new FCC units will be built, at the Guangzhou, Changling, and Nanjing refineries, and are scheduled to come on line in the summer of 1988. [redacted] 25X1

[redacted] in November 1986, the Chinese also concluded a contract for eight riser-cracking FCC units of French design. The units will each have a capacity of 24,000 b/d and will reportedly use a Chinese-made zeolite catalyst. The French firm Total will provide the process technology and the basic engineering design, and the Chinese will do the detailed engineering and construction. [redacted] 25X1

Hydrocracking and Hydrotreating. Hydrocracking is catalytic cracking in the presence of hydrogen gas. Hydrocracking units can process a wide variety of heavy feedstocks and are attractive to refiners because adjustments in the feedstock and operating conditions (such as temperature and pressure of the unit) can change the relative amounts of gasoline, kerosene, or diesel fuel produced. Because of this versatility, hydrocrackers are the best units for altering the product mix of a refinery. Hydrocrackers are unique in that they upgrade all feedstocks into more valuable, lighter products without depositing much carbon on the catalyst or producing heavy streams. This process is of special interest to the Chinese because it can substantially upgrade their abundant heavy feedstocks. [redacted] 25X1

China has purchased four US-designed hydrocrackers, but construction and startup delays have hampered completion of these units. As of January 1986, only the hydrocracker in the Maoming refinery was operating at full capacity. The delays have been due to the shortage of funds to pay foreign contractors, poor Chinese construction capabilities, and even a shortage of feedstock. Such delays would be highly unusual in US refineries. A unit at the Nanjing refinery was purchased in 1979 but was mothballed in 1981. The Chinese claim that it was started up in October 1984, but whether it operates at design capacity is unknown. [redacted] 25X1

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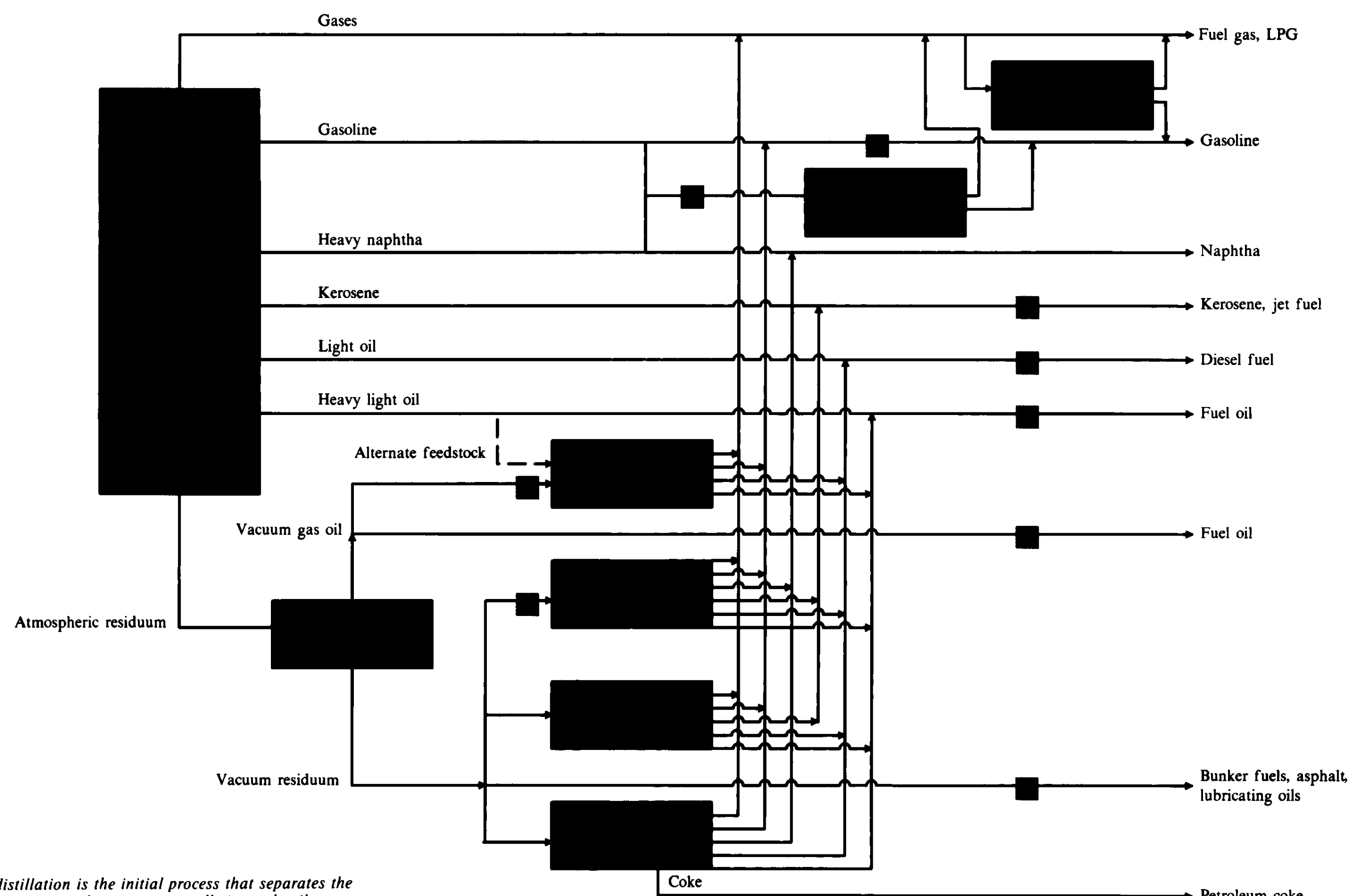
Figure 2
Processes Involved in Converting Crude Oil Into Useful Products

■ Hydrotreater ■ Isomerization



Crude oil distillation is the initial process that separates the desirable components that occur naturally in crude oil. Secondary processes follow, mainly to break up, or "crack," the remaining heavy molecules into useful products. Other secondary units (catalytic reformers and alkylation units) act to improve the octane quality of the gasoline.

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A similar process, but on a smaller scale than hydrocracking, is an operation known as hydrotreating. Hydrotreaters are small units that remove nitrogen, sulfur, and metals from refinery streams by mild hydrogenation. Hydrotreaters also stabilize refined products to prevent gum formation. We judge that Chinese hopes for meeting foreign product specifications will lead them to purchase more of these units for new or upgraded refineries. [redacted]

The Chinese claim to have developed hydrocracking and hydrotreating catalysts, but we judge that they have had little experience in this area and will probably be dependent on the West for replenishment. Before their purchase of the US-designed hydrocrackers, only one Chinese refinery had a hydrocracker of native design. [redacted]

A major obstacle to the Chinese purchase of more hydrocrackers is that hydrocrackers consume large amounts of hydrogen. China's refineries do not have a large catalytic reforming capacity (discussed in the section entitled Catalytic Reforming), which yields hydrogen as a byproduct. Therefore, dedicated hydrogen production plants must accompany each Chinese hydrocracker purchased. We believe that the associated large capital expense has discouraged the Chinese from buying more hydrocracker units. [redacted]

Delayed Cokers and Other Thermal Processes. Delayed cokers process heavy oil streams into solid coke, lighter liquids, and gaseous products. The feedstocks to the coker are too heavy to be processed by an FCC unit or hydrocracker. The alternate uses for these feedstocks are direct burning as a heavy fuel oil or conversion to asphalt. The virtue of delayed coking is that about 45 percent of the feedstock becomes valuable lighter products or feed streams suitable for the FCC unit or hydrocracker. Because of China's abundance of heavy crude oil, delayed coking plays a larger role in Chinese refineries than in US refineries. [redacted]

The Chinese have their own delayed coking technology, although antiquated by US standards. [redacted] the Chinese have begun to seek US coker technology, negotiating in November 1985 for a new plant having a capacity of 90 million metric tons per year at the Shanghai Gaoqiao petrochemical complex. The program for Gaoqiao calls for spending $75 million and includes ancillary plants for processing byproducts of the coker operation. [redacted] 25X1

The Chinese also process their heavy oil streams in other ways. Thermal cracking and visbreaking are two other processes that crack heavy feedstocks in high-temperature furnaces. These thermal processes are inferior to catalytic cracking because the quality of products from thermal processes is poorer. These processes have become obsolete in the United States, but we believe that they still play important roles in China because of the surplus of heavy fuel oil compared with the catalytic cracking capacity. [redacted] 25X1 25X1

Catalytic Reforming. Catalytic reformers are secondary processing units that restructure hydrocarbons in some streams from the crude distillation unit to produce motor gasoline and aromatic hydrocarbons (for example, benzene, toluene, and xylene). The aromatics can be important as high-octane components in the motor gasoline, but in China they are removed and serve as feedstocks to petrochemical plants. [redacted] 25X1 25X1

China's first two catalytic reforming units—a 3,000-b/d Soviet-type unit and a 6,000-b/d unit imported from Western Europe—were built in the 1960s. The Chinese have modified these designs to produce standard-sized 3,000-b/d reformers and have developed their own reforming catalysts. The Chinese may be departing from this pattern of self-reliance, however, in favor of better performance from newer Western equipment. In 1985, China completed construction of an 8,000-b/d continuous catalytic reformer of US design at a Shanghai petrochemical plant. This reformer is the largest in China and may indicate a Chinese decision to install large units of US design. 25X1

[redacted] 25X1 25X1

All of China's catalytic reformers are accompanied by aromatic separation equipment that provides feedstocks to petrochemical plants. The Chinese plan to double their polyester fiber production by the end of 25X1 25X1

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the 1980s, which will require expanded production of aromatics as feedstock. Any increase in Chinese reformer capacity, therefore, will probably be directed toward satisfying petrochemical feedstock requirements rather than producing gasoline additives. China will try to meet gasoline octane requirements by using alkylation and other processes. [redacted] 25X1

Alkylation and Other Octane Enhancement Processes. Alkylation units are designed to recombine light molecules created in the cracking process to produce larger molecules that fall within the gasoline boiling range. The resulting alkylation products are added to gasoline to raise the octane. [redacted] 25X1

The Chinese produce leaded gasoline with octane ratings of 70 and 85. The latter is required for the automobiles China has imported from the West and is only available in large urban areas. We believe that the Chinese also seek to produce an 87 octane, lead-free gasoline for export to the United States. Increasing the number of alkylation plants will allow China to increase gasoline exports and keep pace with increasing domestic requirements for high-octane gasoline. [redacted] 25X1

Before 1980, the alkylation units in China were small and few in number, replicas of Soviet-designed units that used sulfuric acid as the catalyst. The Chinese have since purchased 10 large alkylation units of US design that use hydrofluoric acid. The table lists the locations, capacities, and construction status or completion date of the alkylation units ordered. The hydrofluoric acid used as a catalyst in the US process is highly toxic, but the process design includes measures for self-contained acid regeneration. [redacted] 25X1

[redacted] 25X1

In 1983, [redacted] the Chinese planned to have six or seven new alkylation units operating by 1985 and were interested in eventually equipping all 30 of their major refineries with alkylation units. The Chinese have fallen behind their original plans but remain committed to the expansion of their alkylation capacity because of the need for higher octane gasoline. [redacted] 25X1

Chinese Alkylation Units of US Design

	Capacity (*thousand metric tons/year*)	Status [a]
Beijing	50	C81
Tianjin	60	U?
Taiyuan [b]	60	U86
Shanghai (Gaoqiao)	60	U87
Anqing	60	E88
Dalian	100	E88
Fushun 2	60	E86
Liaoyang	100	E89
Nanjing	60	E88
Zhenhai	60	E87

[a] Status: C—completed, U—under construction, E—in engineering. Dates are estimated times of completion.
[b] Refinery unlocated.

[redacted] 25X1

The Chinese are also looking at other ways to meet their octane goals. As environmental concerns force US refiners to lower the lead levels in leaded gasoline, US industry is switching to oxygenated additives with good octane-enhancing properties. The Chinese would like to produce these same additives and have recently purchased a 40,000-metric-tons-per-year plant to produce methyl tertiary butyl ether (MTBE) as a gasoline additive. The facility uses French technology and is slated for completion in August 1987. The Chinese have also contracted for two 20,000-metric-tons-per-year MTBE plants to be completed in 1988 and 1989. They have also expressed interest in purchasing isomerization units. These units slightly raise the octane rating of hydrocarbon streams from the crude oil distillation unit before the streams are blended into gasoline. We believe that the Chinese are depending on the West for the technology to meet their octane requirements for indigenous and exported gasoline. [redacted] 25X1

Lubricant Production. Lubricating oils will play an important role in the expansion and modernization of Chinese industry, defense, and transportation. These oils are produced by processing material from a vacuum distillation column, usually in three or four processing units. [redacted] Chinese lubricating oil technology is based largely on Soviet units built in the mid-to-late 1950s. [redacted]

China has major lubrication problems in motor vehicle engines. Their lubricating oils were developed for low compression, Soviet-designed truck engines of the 1950s. In about 1975, the Chinese began producing higher compression engines but have not adjusted their motor oils for this harsher service. Their lubricants are prone to break down at high temperatures, which means faster wear and shorter engine life for all Chinese motor vehicles. The Chinese are aware of this problem; they seek to develop their own lubrication industry and stop importing the additives needed to improve the performance of their lubricants. The Research Institute of Petroleum Processing in Beijing has a large group active in additive research, theoretically competent but without production experience. In late 1984, Qinghua University received $16 million from the central government to develop lubrication research capabilities. [redacted]

The highly paraffinic quality of Chinese crude oils is the major cause of their lubricant problems. The conventional methods of lubricating oil processing involve crystallization of the waxes by adding a chilled solvent, followed by filtration. [redacted] the Chinese seek to improve their lubricating oils by following this process with hydrotreaters modified to do mild hydrocracking of any residual paraffin waxes. [redacted]

The Chinese have also been seeking Western lubrication plants. According to open-source publications, in August 1984, a US oil firm formed a joint venture with the Chinese Petrochemical Corporation (Sinopec) to build a 50,000-metric-tons-per-year blending and packaging plant in Shenzhen. At the same time, an 80,000-metric-tons-per-year lubricating oil plant was being considered for the same location. [redacted]

Chinese Design and Construction Capabilities

To modernize their refining industry, the Chinese will need more than straightforward purchases of Western equipment. The Chinese have teamed up with US firms to improve the design and construction of their refineries, and they are improving the efficiency of their refining operations. Further help is needed in process control and operations. [redacted] 25X1 25X1

The Chinese already have some established capabilities for refinery design and construction and have demonstrated an ability to modify foreign process designs for their own purposes. Nevertheless, the Chinese have sought Western help in this area. Open-source reports state that in November 1984 and May 1985, the Chinese formed two joint ventures with US design and construction firms. [redacted] 25X1 the Chinese hope to learn construction methods from the US firms as they work together on Chinese construction projects. Other joint ventures have been formed between US and Chinese firms to coproduce process instruments and equipment. [redacted] 25X1 25X1

We do not believe that the financial posture of the Chinese will permit them to continually buy foreign plants and equipment to expand their refining industry. 25X1 They are entering joint ventures to acquire technical expertise from the West. While their near-term goal in joint ventures is to modernize their own refineries inexpensively, they ultimately seek to earn foreign currency by constructing refineries and chemical plants worldwide. [redacted] 25X1 25X1

When licensing Western technology, the Chinese seek to conserve their hard currency by providing much of the equipment, engineering, and construction themselves. 25X1 Whereas the cost of a turnkey facility installed by a foreign firm might be $200 million, the process license agreement costs only $5 million. The Chinese are eager to save this foreign currency and occasionally overchallenge their abilities. One Sinopec official privately admitted that the PRC Government was going too fast in its do-it-yourself campaign. His

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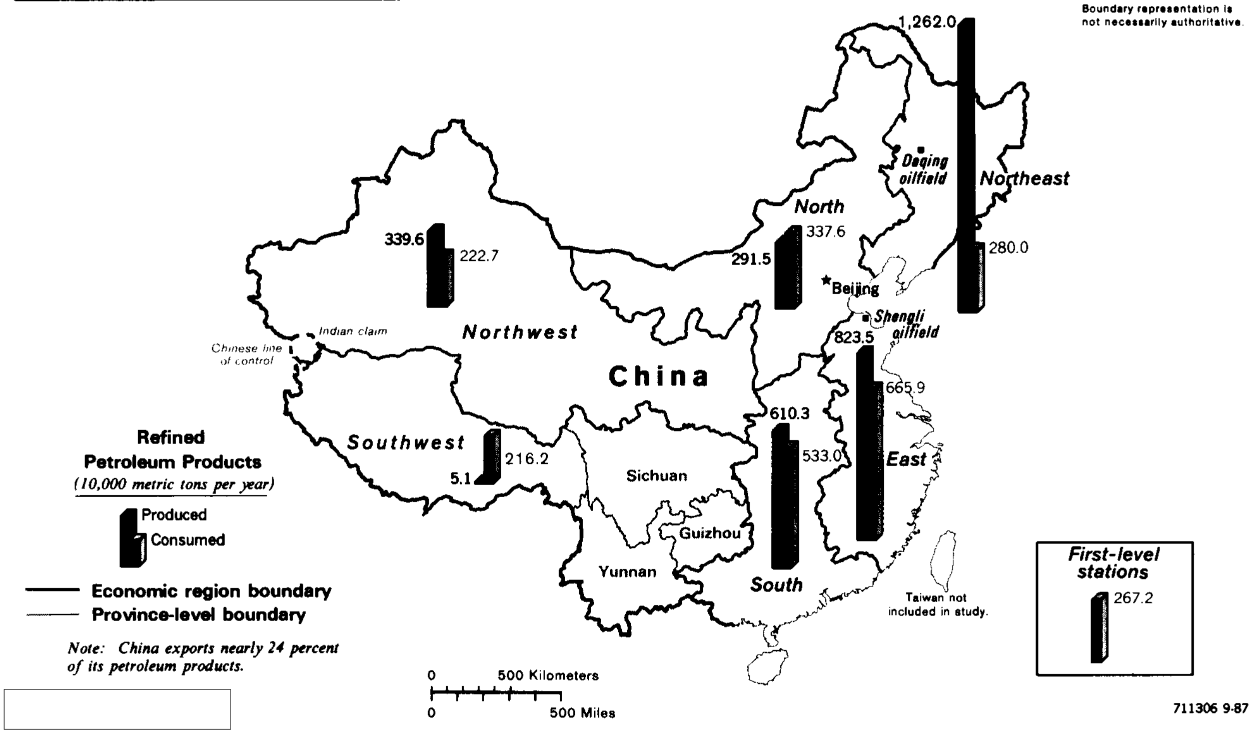
Mislocation of Chinese Refineries



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Compounding the problem of insufficient secondary processing units for China's heavy crude oils is the mislocation of Chinese refineries. They were constructed near the oilfields and along coastal regions, and their products were shipped by rail and barge to the populated centers. The Daqing oilfield, in northeast China, was the first major discovery, and its legacy is a disproportionately large refining capacity nearby. The movement of refined products consequently requires a great deal of rail-shipping capacity because of a shortage of product pipelines.

The map includes a comparison based on 1982 data of the relative levels of production and consumption of refined products in the six regions of China. Note the insert labeled "first-level stations." Having no refining capacity, this consumption figure probably represents the products consumed by priority users, perhaps the military or high-level party cadres. Because these figures have been based on Chinese open literature, they should be considered approximate.

The disparity between refining and consumption is most apparent in northeast and southwest China. In the northeast, over four times as much was refined as was consumed. A particular example of this disparity is China's Dong Fang Hong (East is Red) Refinery in Beijing. This refinery, China's largest, produces more petroleum products than the Beijing region requires. Not only is crude oil shipped into Beijing to feed this refinery, but most of the refined products are shipped out of Beijing—a double burden on the rail system. Yunnan, Guizhou, and Sichuan, in southwest China, have a dearth of refining capacity and are candidate locations for new refineries. 25X1

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The refining industry has called for locational readjustment of China's crude oil processing capacities. Areas of deficiency are to receive new refineries, and areas of surplus are to have their refineries modernized, permitting the export of quality petroleum products. In both cases, Western refining technology will be needed. 225X1 comments were prompted by a recently licensed process that called for vessels of special alloys beyond current Chinese metallurgical and manufacturing capabilities. By insisting on self-reliance and continually challenging their capabilities, the Chinese will eventually acquire the ability to do most of the expansion of their petroleum refineries and be able to offer construction and engineering services for refineries abroad. [redacted]

Improving Refinery Efficiency

In addition to modernizing their refining process and lightening their product mix, the Chinese will need to continue to improve the efficiency of their refineries. Efficient refining involves directing appropriate feed streams to the proper process units and selecting the best operational parameters to maximize the value of products from the refineries. In mid-1985, the Chinese used their own linear programing models on personal computers to guide their refinery operations. The guidance obtained may be incorrect because operation of the model requires the calculated prices for products and intermediate streams. These prices, in China's planned economy, tend to be unrealistic. The Chinese are replacing their linear programing models with better models from the West. We believe that these new Western techniques will improve the understanding of the value of intermediate streams and lead to better refinery operations. [redacted]

The Chinese have also been gradually improving the energy efficiency of their refineries. They have had an aggressive program of energy conservation in their plants since 1979. In 1983, the Chinese claimed in an open-source publication to have reduced energy consumption by nearly one quarter to a level where 80 kilograms of fuel oil were required to refine each metric ton of crude. This level is comparable to the energy consumption levels of US refineries in 1981. Their claims for reduced oil leakage and flaring have been confirmed [redacted]. Although putting the formerly flared material into the refinery's fuel system may save the energy content, there are more economical uses for these light hydrocarbons in the alkylation process. The Chinese know this and plan to expand their alkylation capacity, as discussed above, to recombine light hydrocarbons from their catalytic crackers. [redacted] 25X1

A more dramatic example of energy savings in Chinese refineries is the widespread construction of boilers connected to their catalytic cracking units. [redacted] 25X1 25X1 25X1

[redacted] In this new configuration common in Chinese refineries, the effluent from the regenerator is piped to the adjacent boiler, where the combustion is completed and the heat content of the regenerator effluent generates useful steam. [redacted] 25X1 25X1

Other techniques now being explored by the Chinese to save additional energy were implemented in the US petroleum industry nearly a decade ago. Conversations with Chinese refinery personnel indicated their awareness of these techniques, but actual implementation has never been tried. [redacted] 25X1

Improving Refinery Reliability 25X1

Crude oil contains many inorganic substances that become corrosive at various points in the refining process. [redacted] Chinese personnel from one refinery revealed a lack of understanding of the corrosion problems in critical areas such as the crude tower overhead system. Corrosion control in Chinese refineries lags developments in the West and is another area where the Chinese might come to the West for expertise. [redacted] 25X1 25X1

The Chinese can improve operations by making selective purchases of refinery components that are critical to process reliability. In June 1986, for example, a Chinese delegation came to the United States seeking slide valves for fluidized-bed catalytic cracking units of US design. The five valves, costing approximately 25X1 25X1 25X1

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$5 million, are critical for the control of the continuous circulation of catalyst. This is harsh service because the fluidized catalyst is abrasive. The short life of FCC slide valves often dictates when a refinery must be shut down for repairs. Shutdowns occur every two and a half years in US refineries, but Chinese refineries are shut down yearly. This frequency of scheduled shutdowns may be driven by other factors, in addition to FCC valve wear. The yearly shutdowns underscore China's need for critical equipment and the poor state of process reliability in their refineries.

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Process Control Technology

The process control instrumentation used in Chinese refineries is obsolete but satisfactory for meeting most needs. Tougher product specifications will have to be met, however, if the Chinese wish to sell more refined products abroad. 25X1

most Chinese refineries have separate, independently operated control houses for each process unit in the plant instead 25X1

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of centralized control centers that are common in Western refineries 25X1 The dispersal of processing units along mountain valleys for security purposes introduces numerous control problems. This practice puts greater reliance on people than on process control technology and results in suboptimal control of plant operations. We believe that the process control equipment in China's refineries will have to be modernized if export products are to meet foreign specifications. Process control instrumentation accounts for 10 percent of the cost of a new facility. The Chinese know the economic benefits from installing advanced process control systems. 25X1 the Chinese have therefore decided to equip all new facilities with Western state-of-the-art computerized process control systems. As the Chinese modernize older refineries, therefore, large sums will be spent for Western control equipment. 25X1

Implications

The trends in Chinese petroleum refining suggest that China is diverting scarce resources from other projects in the near term to expand refining capabilities

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Organization of China's Petroleum Industry

The Chinese eliminated the confused fragmentation of their petroleum industry by centralizing it in 1983. The Chinese Petrochemical Corporation (Sinopec), a ministry-level organization, was established to plan and control petroleum refining, new design and construction, research and development, and all internal trade in petroleum products. Sinopec's purpose was to eliminate the inefficiencies of having several ministries active in the two areas of petrochemicals and refining. Sinopec now controls nearly 95 percent of China's refining capacity.

Sinopec has the authority to buy foreign products, to license foreign technology, and to engage in joint production ventures. In export matters, the lines of responsibility are unclear. Export sales of refined products and crude oil are conducted by the Chinese Chemicals Import-Export Corporation (Sinochem), a trading corporation under the Ministry of Foreign Economic Relations and Trade (MOFERT).

The consolidation of China's refining industry could revert to the pre-1983 fragmented condition. The creation of Sinopec in 1983 was not without friction: the Ministry of Chemical Industry lost control of China's petrochemical plants and the Ministry of Petroleum (MoP) lost control of most of China's refineries. That the MoP's authority may be on the rise is reflected in the Seventh Five-Year Plan, which designates that all new refineries be under MoP control. Sinopec will only be expanding its existing refineries. It is likely that China will increase its refining capacity by about 30 million metric tons per year by 1990. About 15 million metric tons per year will result from new refinery construction under direct control by the MoP, and about 15 million metric tons per year will result from the expanded capacity of Sinopec's existing refineries.

quickly. Beijing knows that purchases of more sophisticated refining processes from the West are necessary to promote their industrial modernization. China may not be able to satisfy internal demands for fuel in the future or expand petroleum exports without this infusion of Western equipment and know-how. Even if hard currency constraints persist, China will probably continue its investment in refinery technology because of the potential to export products not consumed internally. 25X1

Until China can copy the newly acquired processes or develop its own, the dependence on foreign technology may be an incentive for maintaining good commercial 25X1 ties to the West. The duration of this dependence is uncertain, but at least 10 years seems likely. In that time, China will be completing several refinery improvements and major equipment replacements. Through several joint ventures with Western firms, the Chinese will learn construction management techniques and coproduce process valves, pumps, and other equipment. Although the purchase agreements for Western processes call for importing of fresh 25X1 catalysts, the Chinese continue to develop their own. Chinese researchers are also very active in obtaining synthetic fuels from coal and shale oil. While we do not expect the Chinese to immediately reverse-engineer Western processes, the accumulated effect of their indigenous research and commercial interactions will make process copying and independence from the West possible in the future. 25X1

For the United States, the most direct impact of China's effort to upgrade its refineries will probably be commercial, with both positive and negative results. In the near term, China's need for Western technology represents potential sales of equipment and services worth several hundred million dollars. In the longer term, China's ability to build modern process equipment will probably lead to competition with Western firms for sales to Third World countries. 25X1 We believe China intends to export both facilities and services. Competition with Western refineries

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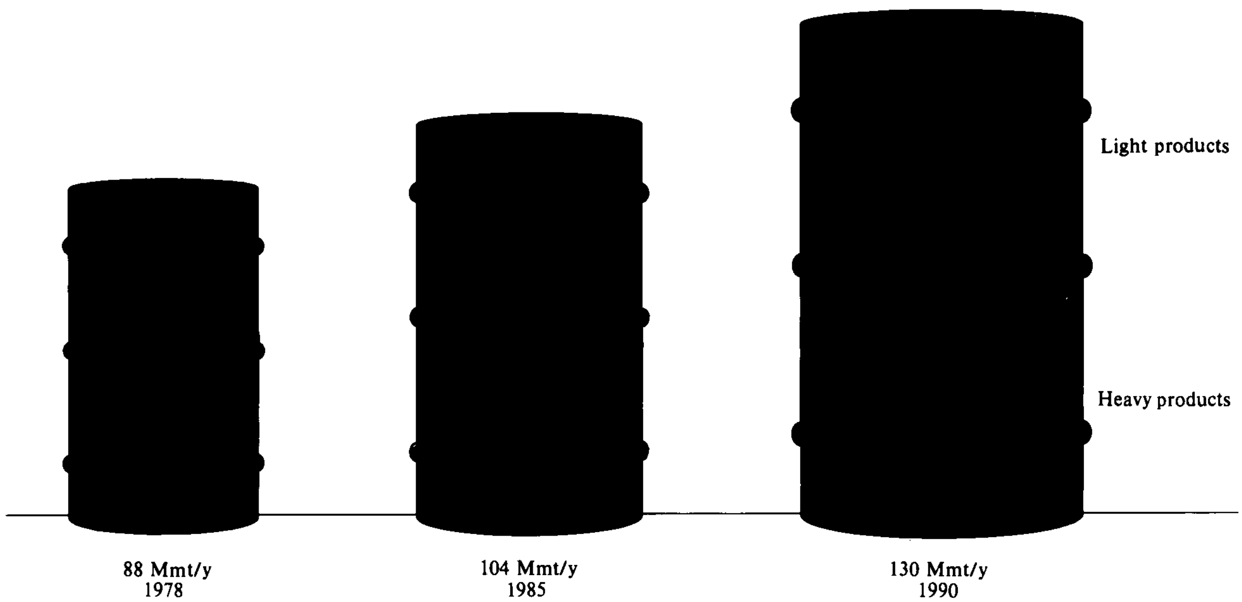
Figure 7
Increased Output of Light Petroleum Products

Million metric tons per year (Mmt/y)



China is making two efforts to expand the production of petroleum products. The Chinese are increasing their refinery capacity to process more barrels of crude oil per year. They are also acquiring more advanced technology from the West to process each barrel of crude more completely into light products such as gasoline and diesel fuel. Shown here is the increase in refining capacity achieved in recent years and China's projection for refining capacity in 1990, which will probably be achievable. Chinese progress in refining their oil more completely points to a 60-percent conversion to light products by 1990—approaching today's European refining operations. The United States converts more than 70 percent.

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may also increase as China begins to export more of its petroleum as refined products rather than as crude. In the past, however, Chinese sales of gasoline to the United States—its major customer—represented, at most, only 5 percent of US gasoline imports. We believe internal demand may keep China from becoming a major supplier of refined products. [redacted]

China's refinery expansion will promote basic economic growth and industrialization. Its general strategic and political implications for the United States go beyond the scope of this assessment. The payoff for China is considerable. With continued access to Western technology, we believe that by 1990 China will be able to extract 30 percent more of the valuable, light products from each barrel of crude oil than was possible in 1978. And as China's refineries are expanded to process more barrels of crude per day, the multiplicative effect will be a doubling of the output of light products (see figure 7). Regardless of changes in leadership, China may see the current progress of its petroleum refining industry as a benefit from maintaining close commercial ties to the West. [redacted] 25X1

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