



Questions to be responded to by the firm submitting the application Why do you think this project should receive an award? How does it demonstrate:

innovation, quality, and professional excellence

transparency and integrity in the management and project implementation

sustainability and respect for the environment

The project is located in Daya Bay Petrochemical Industrial Park in Huizhou City, Guangdong Province, P. R. China. The feasibility study was completed in 2002, and the construction was started in December 2006. In June 2009, the project started commissioning and all the units were successfully started up on the first try. In 2010, the project was put into commercial operation.

CNOOC Huizhou Refinery processes 100% high TAN heavy crude oil with a design acid number of 3.57mgKOH/g and an API gravity of 21.9. It consists of 16 main production units including a 12.0Mt/a CDU/VDU, the supporting utilities, auxiliary facilities and offsites. The project is designed to have an overhaul period of 4 years, and all the units are single-train ones. The overall objective of this project is to build a world-class refinery with the characteristics of differentiation, cleaner production, informatization and high value. The project used the world's most advanced process technologies and took the lead in using low-value high TAN heavy crude oil to produce clean and high-quality gasoline, kerosene and diesel oil products, provide high-quality cracking materials for downstream ethylene projects, and produce high-value-added aromatics products such as para-xylene, so as to balance the production of oils, chemicals and fibers. While processing heavy crude oil, the refinery-wide light oil yield reached 82.98%. The quality of gasoline and diesel oil products of this refinery meets the Euro V standards.

Since the project was put into operation in 2010, high-quality products have been produced. Gasoline and diesel oil products meet the Euro V standards. The comprehensive commodity rate is 96.45%, the light oil yield rate is 82.98%, the processing loss rate is 0.35%, and the comprehensive energy consumption is 59.04kgEo/t. 100% of the treated oily wastewater can be reused, and all the treated saline wastewater meets the discharge standards. Its main technical and economic indicators reached the industry-leading level.

I. Recognized by Industry Experts at Home and Abroad

This project achieved the highest status of Award Winner in Award Category Project Excellence Award in Mega-sized Projects at the 24th IPMA World Congress in November 2010. It is the first oil refinery project in the world which has been granted this honor.

According to the overall evaluation carried out by Solomon (USA), this project is in the leading position both in the Asia-Pacific region and in the world. As one of the largest refineries in the Asia-Pacific region with an EDC of 4.807 million barrels per day and a structure coefficient of 20.6, it is highly complicated in configuration. Its operating cost (non energy consumption part) is US\$ 24.3/EDC, being among the lowest in the world, and its cash operating expense is US\$ 0.34/UEDC, ranking No.9 among the 75 refineries in the Asia-Pacific region. Its energy use intensity index is 64.6, among the top 5% of refineries in the Asia-Pacific region and the top 3% in the world. Both its net cash profit (US\$ 21.24 per barrel) and return on investment (45.5%) rank No.1 in the Asia-Pacific and Indian Ocean region.

FIDIC SECRETARIAT

PO Box 311, 1215 Geneva 15, Switzerland

Tel: +41 (22) 799 49 00 - Fax: +41 (22) 799 49 01 - E-mail: fidic@fidic.org



Lummus made a preliminary comparison of the process flow of this project and those of the existing refineries in USA. The results show that the overall process flow of this project is up to date. Its Nelson complexity index is 12.5, comparable with all the refineries in China and Southeast Asia. The project won the Second Award of 2014 National Science and Technology Progress Award. The experts believe that this project is the first refinery project worldwide capable of processing 100% high TAN heavy crude oil. It adopted the complete sets of high TAN heavy crude oil processing technology independently developed at home, achieved integrated innovation of the overall process flow for high TAN heavy crude oil processing, and innovatively developed a scientific anti-corrosion system and the complete sets of high acid wastewater treatment technology.

In July 2011, China Petroleum and Chemical Industry Federation organized experts to assess the scientific and technological achievements of the project. The appraisal committee agreed that this project carried out an in-depth study on the chemical composition and properties of high TAN heavy crude oil, adopted over 10 world leading patent technologies at home and abroad, achieved the integrated innovation of the overall process flow for high TAN crude oil processing, innovatively developed a scientific anti-corrosion system and the complete sets of high acid wastewater treatment technology, built the 12 MTA world-class refinery capable of processing 100% high TAN heavy crude oil with the characteristics of “differentiation, cleaner production, informatization and high value”, solved the difficulties in processing large quantities of 100% high TAN heavy crude oil, and developed the complete sets of high TAN heavy crude oil processing technology. It reached the world advanced level in high TAN crude oil processing, and some of the technical indicators reached the world leading level.

II. Excellent and Innovative Technologies

1. Integrated Innovation of Overall Process Flow

High TAN heavy crude oil is difficult to process due to its high acid number, high density, high viscosity, high gum content, high nitrogen content, high salt content, high heavy metal content, high water content and low light oil yield. To solve this problem, the integrated innovation of the overall process flow for high TAN heavy crude oil processing was achieved. A technological route of crude distillation – hydrocracking – catalytic cracking – delayed coking – hydrogen production from gas + catalytic reforming – PX was selected, and gas turbine and boiler cogeneration facilities, which take natural gas as raw materials, were provided for steam generation and power generation. To solve the problem of off-spec cetane number of diesel and off-spec smoke point of aviation kerosene when using hydrofinishing technology to process straight-run kerosene and diesel distillates, the team innovatively selected medium pressure hydrocracking technology to ensure the direct production of high quality aviation kerosene and diesel oil meeting the Euro V standards. Taking the processing benefits and the refinery-chemical integration requirements into full consideration, the team optimized the configuration selection of different gas oil processing technologies, and developed a unique configuration scheme of “large-scale hydrocracking and small-scale FCC”. Its hydrotreating capacity reached 87% of the primary crude oil processing capacity.

The design philosophy of this project is to determine the processing scheme depending on the applicability of the feedstock. High-quality hydrocracked naphtha is used as feedstock for aromatics production, and the unconverted oil from hydrocracker and the coker naphtha are sent to the nearby ethylene plant as cracking material. An optimal processing scheme with low-value feedstock and minimal material and energy consumption came into shape by optimizing the overall process flow, integrating and combining advanced technologies, optimizing the overall plot plan, configuration structure of utilities, energy utilization and product structure. In this way, the resource utilization and benefits were maximized. As to the refinery-chemical integration, the multi-plant and



multi-period PIMS model was adopted. Using this model to guide and predict the integration scheme, the utilization of the value of refining and chemical products and materials was maximized. And the overall process flow for 100% high TAN crude oil processing with Chinese characteristics and strong competitiveness came into being.

2. Innovative Anti-corrosion System for High TAN Crude Oil Processing

This project has developed the *Material Selection Guidelines for the Design of Equipment and Piping in Units Processing High TAN Crude Oils*, which passed the appraisal by experts from the oil refining and petrochemical industries. The anti-corrosion system introduces the concept of active anti-corrosion and draws the corrosion flowchart of the key parts in each unit of the refinery. Corrosion and protection handbook for high TAN crude oil processing has been developed. It systematically explains the corrosion mechanism and monitoring programs of the key corroded parts in each unit as well as the anti-corrosion strategies for equipment and processes. Closed-loop circulation is formed and whole process control is achieved through the automatic analysis and distinguishing of the management software in corrosion monitoring system, providing a scientific solution to the corrosion problem in the industrial processing of such crude oil. No corrosion has ever occurred since the refinery was put into operation, and the technical difficulties in processing large quantities of 100% high TAN heavy crude oil were solved.

3. Development of Combined Technology for Saline Wastewater Treatment in High TAN Crude Oil Processing

Due to the high acid number of the high TAN crude oil, the saline wastewater in this refinery is quite different from other refineries, as shown below:

- 1) The saline wastewater is seriously polluted: After oil removal, the COD reaches 3000~5000mg/L, 3~5 times that of conventional refineries;
- 2) The saline wastewater has high salt content: The chloride concentration in wastewater reaches more than 1500mg/L, and the total salt content reaches more than 4000mg/L.

The project innovatively carried out the following researches according to the characteristics of the wastewater in high TAN crude oil processing:

- 1) Analysis of the composition characteristics and evolvement rule of the pollutants in the whole process of wastewater treatment in high TAN crude oil processing;
- 2) Development of catalytic ozonation technology for wastewater in high TAN crude oil processing;
- 3) Development of pretreatment technology for high-acidity and high-salinity wastewater;
- 4) Optimization of the technical scheme for odor gas treatment and the harmless disposal and resource utilization of oily sludge in wastewater treatment plant;
- 5) Optimization of the combined technology for wastewater treatment in high TAN crude oil processing to find the optimal process parameters;
- 6) Development of zero emission technology for saline wastewater.

The combined technology for wastewater treatment in high TAN crude oil processing was successfully developed based on the above-mentioned researches. In actual operation, 100% of the treated oily wastewater can be reused, and all the treated saline wastewater meets the discharge standards, achieving up-to-standard discharge of wastewater and wastewater reuse in high TAN crude oil processing.

This project has applied for 11 Chinese patents, 9 of which have been granted. Among them, 8 patents are patents for invention. One set of technical regulations and one specification have been developed. And the complete sets of high TAN heavy crude oil processing technology has been developed, filling the technology gap in high TAN heavy

crude oil processing in China. The comparison of main technical indicators of this project and the world leading indicators are shown below:

Indicator	Item	World Leading Level	World Advanced Level	Huizhou Refinery project
Profitability	Net cash profit	1 st group	1 st / 2 nd group	1 st group
	Cash Operating cost	1 st group	1 st group	1 st group
	Return on capital employed	1 st group	1 st / 2 nd group	1 st group
Operation	Energy consumption (EII)	<70	<78	64.6
	Processing loss rate	<0.40	<0.45	0.39
	Operation cycle of main units	≥4 years	≥4 years	4 years
Quality	Vehicle gasoline	Euro V standards	Euro IV / V standards	Euro V standards
	Vehicle diesel	Euro V standards	Euro IV / V standards	Euro V standards
Environmental Protection	Waste gas emission, SO ₂ / (mg/m ³)	<200	<400	<150
	Wastewater discharge, COD / (mg/L)	<60	<60	<60

III. Cleaner Startup and Cleaner Production

During project construction, environmental supervision was introduced. Specialized environmental supervision agencies were employed to effectively control the ecological environmental impact and environmental pollution during construction. As a result, outstanding performance of no major accident, no fatalities and zero injury rate was achieved, and the targeted HSE control objectives were achieved.

During the startup, the “OIP idea” which is the concept of non-defective startup was carried out to research and monitor the entire process. Measures covering the study on the overall process flow, the design coordination, the research and optimization of startup organization and startup scheme, the use of “item elimination” method as operating rules and so forth were taken to ensure the successful commissioning of all the units on the first try. And the refinery achieved zero emission during the startup.

The project actively implemented the measures for ecological protection and pollution prevention which were proposed in the environmental assessment and approval stage, and the occupational safety and health facilities were designed, constructed and put into operation simultaneously with the main project. The project, after completion, passed the acceptance check on environmental protection carried out by the Ministry of Environmental Protection of China.

The quality of gasoline and diesel oil products reached the Euro V standards, and the production process was safe and clean with low emission, making CNOOC Huizhou Refinery an environment-friendly and resource-saving refinery.

IV. Implementing Principles of Transparency and Integrity throughout the Project

FIDIC concepts of contract management, risk management and sustainable development were practiced throughout this project. An integrity management mechanism was established by introducing FIDIC integrity management system and integrating FIDIC ideas such as social responsibility, quality service, objectivity and impartiality, integrity, combating corruption and ethnic competitive edge. By adopting FIDIC project



management methods, integrity control was emphasized together with schedule control, quality control, investment control, HSE control and contract control, so as to ensure a high-quality project and excellent staff. During the 8 years from feasibility study to operation, this project strictly followed FIDIC standards and Chinese laws and regulations, and implemented transparent and standardized bidding system. There were no serious violations of disciplines and laws.

This project achieved a total sales revenue of RMB 224.93302 billion, total profit of RMB 4.78861 billion and total tax of RMB 38.08494 billion during the three-year period from 2010 to 2012. It is an important part in building a world-class petrochemical industry base in Daya Bay in Huizhou City of Guangdong Province. After the completion and commissioning of the project, the energy supply in the southeast coastal areas has been further guaranteed, and the contribution of tax to the state and local government revenue has been over RMB 10 billion each year. This has effectively boosted the development of downstream industries and played an important role in promoting the economic development in Guangdong Province and the Pan-Pearl River Delta region and in facilitating the development of China's oil refining and petrochemical industries.

What services did the member firm provide to the project? Please describe briefly.

SINOPEC Engineering Incorporation (SEI) and China International Engineering Consulting Corporation (CIECC) provided consulting services. As the main engineering contractor, SEI provided most of the engineering design. The consulting team carried out in-depth studies on the characteristics of heavy marine crude oil with high acid number and defined the risk identification in heavy oil processing, the processing difficulties and countermeasures, and the technological challenges and solutions. The team has adhered to the principles of "differentiation, cleaner production, informatization and high value". By providing consulting services for the integrated innovation of several leading technologies, the team developed the processing scheme and technology roadmap for high TAN heavy crude oil.

Please use additional pages as needed. Maximum 5 pages per project.