Gas Separation Plant

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What is gas separation?

Gas separation is a process of separating various hydrocarbon components in natural gas to be used at its fullest value.

Gas separation plant in Thailand

The construction of gas separation plants in Thailand followed the utilization of natural gas as fuel in replace of imported crude oil. PTT which is responsible for national energy constructed the pipeline from the production fields in the Gulf of Thailand to come ashore at Mab Ta Phut, Amphur Muang, Rayong Province. The pipeline was laid further to Bangpakong and South Bangkok Power Plants of Electricity Generating Authority of Thailand to bring gas to be used as fuel for power generation.

However, the gas from the Gulf of Thailand consists of various valuable hydrocarbon components which can be extracted into many products instead of using as fuel only. The gases can be separated before sent to the power plants which play a key role in industry development in the Eastern Seaboard and along the pipeline route especially the petrochemical industry as well as other related industries.

PTT requested for endorsement from the Cabinet to construct two units of gas separation plants at Mab Ta Phut, Amphur Muang, Rayong Province. Initially, PTT constructed the first unit which required a budget of 7,360 million baht. The first gas separation plant has a processing capacity of 350 million cubic feet per day (MMscfd). The construction began in 1982 and completed in 1984. Coming on stream in 1985, the plant was graciously presided over by His Majesty the King in the opening ceremony on April 18, 1985.

Later, the demand for liquefied petroleum gas or LPG increased sharply, the Cabinet thus approved PTT to construct the second unit in the compound of the first one. The second unit has a processing capacity of 250 MMscfd and required a budget of 2,507 million baht. It was in 1991 that the plant completed.
As the demand of LPG continued to grow, the Cabinet then approved PTT to construct the third unit with a processing capacity of 350 MMscfd to be located in Rayong province and in the same compound of the first and second unit. The fourth unit of the Gas Separation Plant with a processing capacity of 230 MMscfd is located in Nakhon Sri Thammarat Province. Both units began operation in 1996. They were aimed to satisfy the rising demand of LPG which has to be imported and help strengthen security of petrochemical industry in the Eastern Seaboard.

In spite of having four units of gas separation plant, the country is still under supply, especially for the demand of petrochemical feedstock which is still on a rise. Therefore in 1999, PTT’s Board of Director resolved PTT to construct the fifth unit with a processing capacity of 530 MMscfd to be located in Mab Ta Phut Industrial Estate, Amphur Mueng, Rayong Province. First commercializing in August 2005, it is the largest separation plant in Thailand.
**The objective of Gas Separation Plant**

- **The Gas Separation Plant Unit I**
  Main objective: To produce feedstock for petrochemical industry and liquefied petroleum gas (LPG) or cooking gas for household use.

- **The Gas Separation Plant Unit II, III and IV**
  Main objective: To satisfy the rising demand of liquefied petroleum gas (LPG) or cooking gas.

- **The Gas Separation Plant Unit V**
  Main objective: To cope with expansion of petrochemical industries which require more ethane, propane, and liquefied petroleum gas (LPG) or cooking gas as feedstock as well as to strengthen energy supply security and export of products.

**Size and processing capacity of the plants**

<table>
<thead>
<tr>
<th>Plant capacity</th>
<th>Methane (MMscfd)</th>
<th>Ethane (ton/year)</th>
<th>Propane (ton/year)</th>
<th>LPG (ton/year)</th>
<th>Natural gasoline (ton/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit 1 390 MMscfd</td>
<td>250</td>
<td>330,000</td>
<td>191,000</td>
<td>243,000</td>
<td>76,000</td>
</tr>
<tr>
<td>Unit 2 290 MMscfd</td>
<td>230</td>
<td>76,000</td>
<td>108,000</td>
<td>205,000</td>
<td>36,000</td>
</tr>
<tr>
<td>Unit 3 390 MMscfd</td>
<td>315</td>
<td>111,000</td>
<td>201,000</td>
<td>250,000</td>
<td>47,000</td>
</tr>
<tr>
<td>Unit 4 230 MMscfd</td>
<td>215</td>
<td>-</td>
<td>-</td>
<td>205,000</td>
<td>34,000</td>
</tr>
<tr>
<td>Unit 5 530 MMscfd</td>
<td>337</td>
<td>520,000</td>
<td>151,000</td>
<td>495,000</td>
<td>177,000</td>
</tr>
</tbody>
</table>
Apart from PTT’s gas separation plants in Rayong and Nakhon Sri Thammarat province, Thai Shell Exploration and Production Inc built the Phalang Petch Gas Separation Plant at the production site of Sirikit Oil Field, Kampaengpetch province which came on stream in March, 1990 in a bid to increase the value of the gas produced from the Oil field. PTT purchases LPG from this plant to distribute to the customers. The rest of natural gas is also delivered as fuel for power generation at Lan Krabue power plant of Electricity Generating Authority of Thailand.
Products from Gas Separation Plants

As the natural gas consists of various valuable composition, it can be processed at the plant for various valuable products as follows:

**Methane**

**Usage**
- A fuel for power generation and heat for industries
- A fuel for vehicles
- A feedstock for fertilization production

**Transportation**: Through pipeline to the customers in Rayong, Chonburi, Samutprakarn, Chacherngsao, Bangkok, Phathumthani, Ayuthhaya and Saraburi.

**Ethane**

**Usage**
- A feedstock to produce ethylene, a starting material for plastic pellet-polyethylene (PE) which produces plastic bag, toothpaste tube, plastic container for shampoo, and plastic fibers

**Transportation**: Through product pipeline to Mab Ta Phut Industrial Estate to be used in industrial plants e.g. Petrochemical Public Company Limited.

**Propane**

**Usage**
- A feedstock to produce propylene, a starting material in petrochemical industry to produce polypropylene plastic pellets (PP) for automotive parts such as combustion chamber, battery, glue and lubrication additive.
- A fuel for industries

**Transportation**: To industrial plants by truck and via production pipeline to Mab Ta Phut Industrial Estate

**Butane**

**Usage**
- A raw material for petrochemical industries
- Mix with propane for liquefied petroleum gas (cooking gas)
Liquefied Petroleum Gas (LPG)

Usage
- A fuel as cooking gas for household and vehicles.
- A fuel to provide heat to industries.
- A raw material in petrochemical industry like ethane and propane.

Transportation
Through network management to the customers covering nationwide e.g. Lampang Petroleum Terminal, Khon Kean Petroleum Terminal, Nakorn Sawan Petroleum Terminal, Suratthani Petroleum Terminal, Songkla Petroleum Terminal, Bangchak Petroleum Terminal, Khao Bo Ya LPG Depot, and Ban Rong Po LPG Depot.

From Rayong Gas Separation Plant
Transporting product through the pipeline to customers in Mab Ta Phut Industrial Estate and Khao Bo Ya and Ban Rong Po LPG Depots to distribute to both domestic and overseas customers.

From Khanom Gas Separation Plant
Transporting product via ship to Suratthani and Songkhla Petroleum Terminals to market the products in the south.

Natural Gasoline (NGL)

Usage
- A raw material for solvent industries.
- Blend with oil to produce gasoline.
- A feedstock for petrochemical industries.

Transportation

From Rayong Gas Separation Plant
- Through product pipeline for customers in Mab Ta Phut Industrial Estate.
- Through product pipeline to Khao Bo Ya LPG Depot for export.
- By truck at the Gas Separation Plant.

From Khanom Gas Separation Plant
- Via vessel to the customers.

Carbon dioxide (CO$_2$)

Usage
- Used in steel casting, food preservation, and beverage.
- A raw material for fire extinguisher, artificial rain and others.

Transportation
Through pipeline from the Gas Separation Plant to the producers of liquid carbon dioxide and dry ice.
Gas separation process

**The Gas Separation Unit I, II, III in Rayong province**

### Process to separate non-hydrocarbon components (Gas separation process for Non-hydrocarbon components)

Generally, natural gas also contains contaminants or non-hydrocarbon components such as carbon dioxide, water (H2O) and mercury (Hg). Particularly, the content of carbon dioxide in the natural gas from the Gulf of Thailand is as high as 14-20%. In processing, it is necessary to use low temperature (around -100°C), however under such temperature water and carbon dioxide will be frozen and clog the pipe. Therefore, they must be removed from the natural gas by applying the following methods:

- **Benfield Unit**: Using potassium carbonate (K2CO3) as solution to absorb CO2 from the natural gas. (By increasing temperature and depressurizing, the saturated potassium carbonate by CO2, the CO2 can be extracted for selling accordingly.) The potassium carbonate solution can be reused again.

- **Dehydration Unit**: As adsorption is a method, molecular sieve will be used to absorb water from natural gas.

- **Mercury Removal Unit**: As the natural gas from the Gulf of Thailand contains mercury, it must be removed to prevent any problems with the equipment of the separation plant and danger to the customers.

### Process to separate hydrocarbon components

The gas separation process applies the same principles as refining process. The gas will be converted into liquid. The temperature of each liquid is adjusted to be at the boiling point of desired hydrocarbon which can be done by two processes:

- **Ethane Recovery Unit**: After removing carbon dioxide and water, it will be sent to the turbo expander to decrease pressure and temperature which will convert the gas to be liquid. Next, the liquid will be sent to a demethanizer where methane is extracted from the natural gas. The extracted gas is called sale gas.

- **Fractionation Unit**: The unit using fractional distillation method to extract the gas to be a pure substance. The fractional unit is comprised of a deethanizer to extract ethane (C2) and a depropanizer to extract propane (C3), liquefied petroleum gas (C3+C4) and gasoline (C5+).
Utility Equipment

The equipment are designed to generate power and cooling to be used in processing the gas. For instance, the equipments are the steam producing unit, waste heat recovery unit and etc.

The IV Gas Separation Unit in Nakhon Sri Thammarat Province

Khanom Gas Separation Plant adopts expander process in its production. In a process, a turbo expander is used to reduce pressure. As the pressure steps down, the temperature of natural gas is also decreased to become liquid which will be sent to a distillation column where various products can be extracted. At different boiling points The main process and equipments are as follows:

**A process of extracting non-hydrocarbon components**

- **Mercury Removal Unit**: The unit extracts mercury which contaminates the natural gas.
- **Dehydration Unit**: Applying adsorption method, the unit uses molecular sieve to absorb water from the natural gas

**A process of extracting hydrocarbon**

- **The Units to extract ethane, methane and carbon dioxide** These units consist of two joining columns: a recontactor column and a deethanizer column. The gas which has been removed water vapor will be decompressed and reduced temperature and sent to a recontactor column where increases the efficiency of gas extraction methane and ethane for more purification. The methane and ethane will be extracted at the tower head and sent it to Khanom Power Plant to be used as fuel for power generation. The gas from the tower bottom will be fed into the deethanizer column to extract methane and ethane from other gases. The gas from tower head will also be fed back to a recontactor column to extract methane and ethane. Then the temperature of the gas from the tower bottom will be increased before sending to the units where liquefied petroleum gas and natural gasoline are extracted.

- **Liquefied petroleum gas and natural gasoline columns**
  The unit is to separate liquefied petroleum gas from natural gasoline. The liquefied petroleum gas from the tower head will be sent further to hydrogen sulfide removal unit. Meanwhile, natural gasoline from the tower bottom will be sent to be kept in the products storage for delivering to the customers via ship or truck.

- **Utility equipment**
  **Hydrogen sulfide**
  Removal unit is to remove hydrogen sulfide from the liquefied petroleum gas in order to yield the desired quality of the product. After the test, the gas will be sent to be kept in the depot prior to the customer delivery by ship or truck.

- **LPG and natural gasoline depot**
  Two 6,000-cubic meter LPG spheres, two natural gasoline spheres with a capacity of 250 and 4,000 cubic meters.
The V Gas Separation Unit

Being the largest gas separator, the fifth Gas Separation Unit first came on stream in 2005. In overall, it adopts the same production process as the first unit i.e. turbo expander process. Nevertheless, the technology applied in the project is state of the art in order to achieve higher efficiency in processing the gas. Ethane from the plant is more purified to respond to the needs of the customers. With the PINCH technology, the plant can reduce the amount energy used in the production process. In addition, it can also decrease the amount of water due to the use of thermal oil to produce heat in replace of steam. In adsorption process, amines (aMDEA) solution is used to remove carbon dioxide. The process is more efficient than benfield unit of the first gas separation plant. Difference of technology adopted at the two plants can be summarized below:
The comparison of technology of the Gas Separation Plant Unit I and V

<table>
<thead>
<tr>
<th>Description</th>
<th>GSP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unit I</td>
</tr>
<tr>
<td>Processing capacity (MMscfd)</td>
<td>390</td>
</tr>
<tr>
<td>Ethane recovery rate</td>
<td>82</td>
</tr>
<tr>
<td>CO₂ removal process</td>
<td></td>
</tr>
<tr>
<td>Technology</td>
<td>Benfield</td>
</tr>
<tr>
<td>Solution</td>
<td>K₂CO₃</td>
</tr>
<tr>
<td>CO₂ Reduction ability (ppm)*</td>
<td>7,000</td>
</tr>
</tbody>
</table>

- Note: the ability to remove carbon dioxide illustrating the amount of carbon dioxide left in the natural gas.

PTT also plans to construct the sixth unit of gas separation plant in Rayong province which is due to complete in 2010. The plant will boost the capacity to produce ethane and methane which are important raw materials of petrochemical industry as well as liquefied petroleum gas and natural gasoline, the vital products to strengthen energy security of the kingdom.
The overall benefit of the gas separation plant can be observed as follows:

1. **Generate a saving** of foreign currency from importing energy worth 300,000 million baht per year.

2. **Reduce the cost of industry raw material.** The plants help the establishment of small industries as well as the development in the future. These industries can improve the production capacity for export to overseas market which will generate income to the country in return.

3. **Preserve the national resources by reducing deforestation.** This results from the use of LPG instead of charcoal and wood and the maximization of natural gas in stead of using it as fuel only.

4. **Enhance the economic security** due to the dependency reduction from imported energy as well as the capacity to produce raw materials for various industries which provides assurance for economic development and subsequent security in a number of ways.

5. **Generate jobs in the local area.** The project creates jobs for the people which will reduce the mobility of local people to look for jobs in the cities.

### Environmental impact measures

The gas separation plant is a unit to extract hydrocarbon components of the natural gas. Natural gas is a raw material fed into the plant while fuel is received from outside and part of energy is also from the plant to extract hydrocarbon components from the natural gas. The products will be stored in depots before delivery to customers. Waste will also be sent to waste disposal unit and treated to be in a condition that is harmless to environment before disposal.

Waste management of the plant in order to make least effect on environment as much as possible takes place right from the beginning i.e. from the design of the plant to conform to the international standard and supervision the construction to meet the planned design. Furthermore, the equipments must be efficient and pass the standard. The environment of area where waste is emitted or contained is monitored and assessed. The inspection also expands to cover the community environment which must be undertaken periodically and compared continuously.
In operating the gas separation plant Unit I, II, III and V in Rayong Province and the Unit IV in Khanom, Nakhon Sri Thammarat Province, PTT takes into account the effect on environment and well being of the public surrounding the plants. Therefore, PTT has always strictly monitored the environment quality. Before the construction, environmental impact assessment or EIA was conducted as required by the National Environment Conservation and Promotion Act 1992 to submit to the Office of Environmental Policy and Planning, Ministry of Science, Technology and Environment. The study spells out the measure to prevent and correct impact on environment as well as the following procedure to monitor the environment. Up until present, PTT has continued to monitor and report the monitor of environment to the Office of Environmental Policy and Planning, Ministry of Science, Technology and Environment. From the monitor of environmental quality of the five plants since the establishment, the reports show that the qualities of the air, noise, water, waste from production, are better than the stipulated standard of the announcement of the Ministry of Science, Technology and Environment and Ministry of Industry.

In addition, the Rayong and Khanom Gas Separation Plant received EIA award and was selected to be the best industries that acquire best environment management and maintenance in compliance to the measures in the report of environment management according to the Office of Environmental Policy and Planning, Ministry of Science, Technology and Environment. The Khanom Plant, in particular has received the EIA awards for four consecutive years (1999-2002) apart from other standards and awards.
Not only the aforementioned conformance to the required legal standard, in managing the work, the Gas Separation Plants also apply productivity tools such as 5S, suggestion system, a self maintenance program, QC and mini QC as well as place importance on energy saving, safety and quality, safety, occupational health and environment impact minimization from production process. The plants operate under the PTT’s policy on quality, safety, health and environment. At present, the five plants are certified the following standards:

- ISO/IEC 1725, a standard for testing laboratory
- ISO 9001: 2000, a management standard
- ISO 14001: 2004, an environment management standard
- TIS 18001, an occupational health and safety management standard
- TLS 8001, a Thai labor standard
- National outstanding business operator (productivity, quality, safety and environment categories)
- Best Industry Award 2005
- Thailand Quality Award (TQC) two years in a row from 2004-2005
- Thailand Quality Award 2006 (TQA)
Another paramount mission of the gas separation plants is to improve the well being of the community in the area as well as render social support to foster relationship with the community through various activities. These include:

- Constructed Her Royal Highness Princess Sirindhorn Herb Garden
- Participating in reforestation project
- Conducting 5S and environment, PTT Gas for youth project
- Mobile medical service
- Safe Community Project by sending technicians to check LPG equipment in the communities and schools
- Support of materials for education and social purposes

Rayong Gas Separation Plant
555 Sukhumvit Road, Map Ta Phut, Muang District, Rayong 21150
Tel 0 3868 5000-7 Fax 0 368 5008

Khanom Gas Separation Plant
123 Moo 8, Thong-Nian, Khanom District, Nakhon Si Thammarat 80210
Tel 0 7552 8023-5 Fax 0 7552 9140