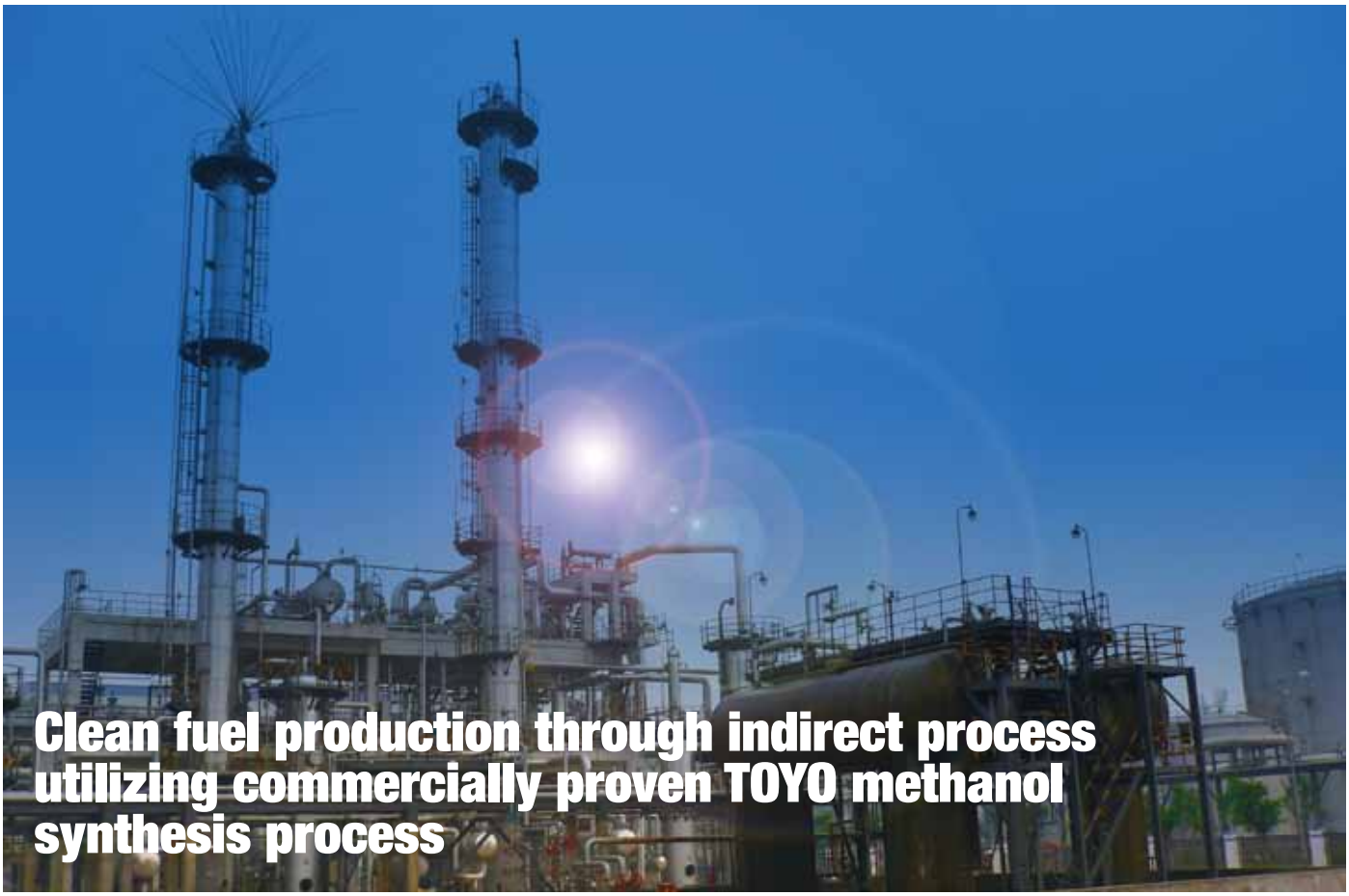
TOYO DME TECHNOLOGY

Substitute for LPG and Diesel



Clean fuel production through indirect process utilizing commercially proven TOYO methanol synthesis process

TOYO DME Technology Concept

Toyo Engineering Corporation (TOYO) developed indirect Di-Methyl Ether (DME) production technology consisting of synthesis gas generation, methanol synthesis and DME synthesis processes. DME has been used as clean fuel substituting LPG emitting virtually no sulfur oxide or particle matters. With its high cetane number and extremely low toxicity, the uses for power plant fuel and diesel alternative are also expected. DME can also be feedstock for olefins and gasoline production as well as hydrogen source for fuel cell.

Key features of TOYO DME Technology concept are ;

- Simple DME synthesis process, lower investment cost
- Production ratio flexibility of methanol (0 - 100 %) and DME (100 - 0 %) on market demand
- Commercially proven combination of methanol synthesis and DME synthesis
- DME synthesis unit easily installed beside the existing methanol plant
- No carbon dioxide produced in DME synthesis process

TOYO's commercially proven large scale methanol production process enables the operators to convert any methane rich resources to transportable, clean and high value liquid, DME. In addition, plant operators can choose preferred DME/methanol production ratio which suits market demand.

Chemical Reactions

Regardless of the chemical reaction route, i.e., direct or indirect, the process to produce DME from natural gas feedstock is made up of the reactions to reform raw material methane into synthesis gas mainly composed of $CO+H_2+CO_2$ using steam or oxygen as oxidant and to generate methanol from the synthesis gas as the first step and then to dehydrate it into DME. The direct route makes methanol synthesis reaction and DME synthesis reaction occur in one reactor. On the other hand, the indirect route makes these reactions in separate reactors. TOYO DME technology is employing the indirect route composed of synthesis gas generation technology that has high reliability based on more than 100 project experiences and its unique methanol production technology.

The principle of DME production by methanol dehydration is shown below (Fig.-1).

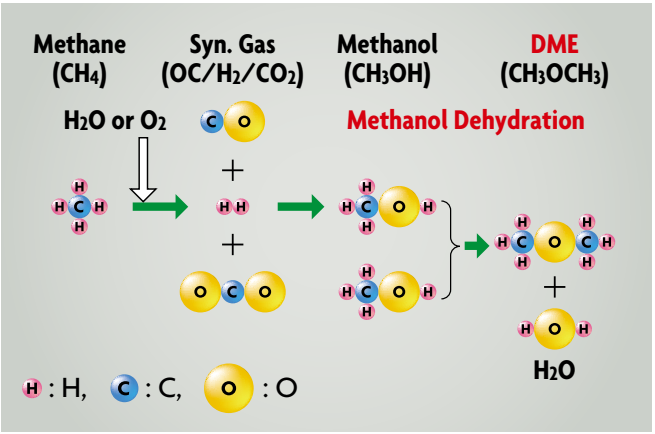


Fig.-1 : Chemistry of indirect DME production

Process Configuration

TOYO DME Technology is the combination process of proven methanol production technology and the simple, low cost DME synthesis process. The process has two reaction steps. Methanol is firstly produced from synthesis gas, and then after removing by-product water, DME is produced via methanol dehydration reaction.

This indirect route has a couple of advantages such as ;

- Optimum reactor type selection
- Reactor operation at optimum conditions for each reaction step
- Easy to remove reaction heat from the reactor due to less reaction heat against the direct route

Fig.-2 shows block flow diagram of TOYO DME Technology.

Methanol production : Application of the high performance MRF-Z® reactor developed by TOYO which has the specific features of multi-stage indirect cooling and a radial flow to the methanol synthesis unit enables to construct the unit with a capacity of 6,000 t/d in a single train, while other technologies require multiple reactors.

DME production : DME synthesis based on methanol dehydration process is very simple. Dehydration catalyst is of alumina basis available from the manufacturers approved by TOYO. Feed methanol is fed to a DME reactor after vaporization. The synthesis pressure is 1.0 to 2.0 MPaG. The inlet temperature is 220 to 250 °C and the outlet is 300 to 350 °C. Methanol conversion to DME is 75 to 80 % in the reactor. Produced DME with by-product water and unconverted methanol is fed to a DME column after heat recovery and cooling. In the DME column DME is separated as the light product. Water and methanol are discharged from the bottom and fed to a methanol column for methanol recovery. The purified methanol from the column is recycled to the reactor after mixing with feedstock methanol.

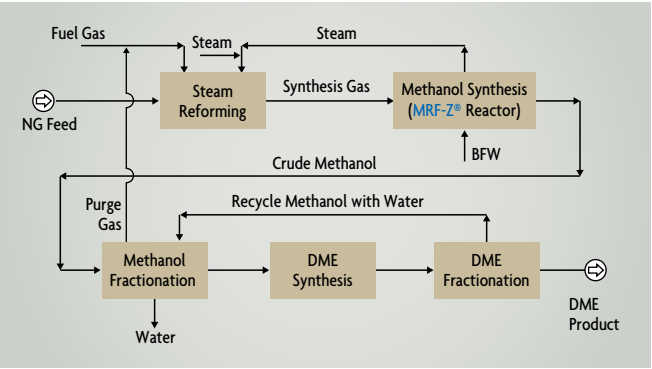


Fig.-2 : Block flow diagram of TOYO DME Technology

Typical Plant Performance

Typical plant performance of TOYO DME Technology is shown below. This extra-large scale DME process is trademarked as TOYO JumboDME® plant, maximum single train process including Steam Reformer, MRF-Z® Methanol Reactor, DME Reactor and Distillation Columns.

Plant Capacity	3,500 t/d
NG Consumption	163 MMSCFD (4.37 mmNm^3/d)
Raw water Consumption	1,100 m^3/h (As make-up)
Plant Area	200m x 130 m (Process & Utilities) 150m x 60m (DME storage tank)

Commercially Proven Process

TOYO has been awarded and completed four licensing and engineering contracts for DME production plants in China since 2003 as shown in the experience list.

Client	Location	Capacity (tons/year)	Start-up
Lutianhua Group Inc.	Luzhou, Sichuan	10,000	2003
Lutianhua Group Inc.	Luzhou, Sichuan	110,000	2006
Shenhua Ningxia Coal Group	Lingwu, Ningxia	210,000	2007
Shanxi Lanhua Clean Energy	Jincheng, Shanxi	140,000	2008

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