P-09	Keywords	Y4	system or software	Z3	Natural gas	L	Technical services

Toyo Engineering Corporation

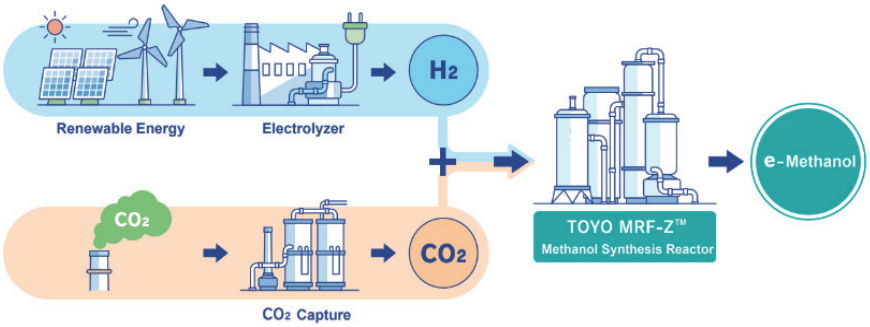
g-Methoanol™

Features

g-Methanol™ is Toyo Engineering's proprietary process for synthesizing e-methanol, uses hydrogen produced from renewable energy and carbon dioxide, captured from various emission sources. Toyo offers a comprehensive lineup of unique process technologies and services to support efficient and sustainable methanol production.

Key Features of g-Methanol™

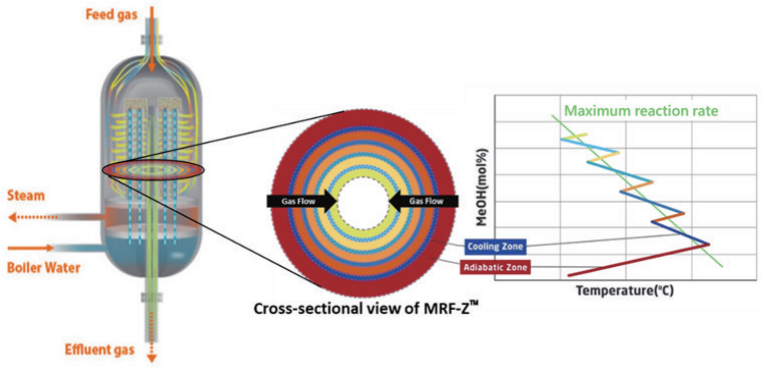
- ◆ High-efficiency methanol synthesis using TOYO's proprietary MRF-Z™ / MRF-Z Neo™ reactors
- ◆ Significant steam reduction achieved through ***SUPERHIDIC™***
- ◆ Environmental value assessed by LCA
- ◆ Smart design and operation by MethaMaster™ and MethaDynamics™



Basic Concept or Summary

◆ MRF-Z™/MRF-Z Neo™ reactor

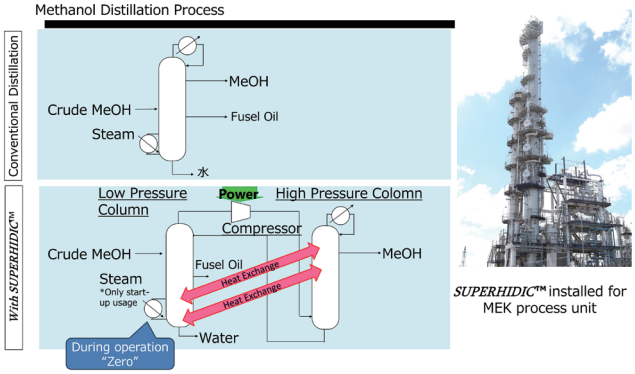
The MRF-Z™ reactor developed by TOYO, is a shell-and-tube type reactor, with catalyst packed on the shell side and boiler feed water flowing through the tubes. Feed gas is supplied from the top and flows from the outer shell toward the center, undergoing repeated reaction and cooling to form an ideal temperature profile. Since water is generated as a byproduct in e-methanol synthesis, catalyst life is generally shorter than in natural gas-based processes. The MRF-Z™ reactor addresses this with high reaction efficiency to reduce catalyst use and a structure that simplifies replacement. With a proven track record in natural gas-based methanol synthesis, it is also well-suited for e-methanol production. TOYO offers the MRF-Z Neo™, a lightweight version for small to medium-scale applications.



◆ Integration of ***SUPERHIDIC™***

In typical e-methanol production processes, steam is often insufficient. Using fossil-fuel boilers to compensate can lead to increased CO_2 emissions. TOYO's proprietary ***SUPERHIDIC™*** is an innovative distillation technology that incorporates **heat pump principles** to drastically reduce steam consumption.

This enables operation **without the need for a boiler under normal conditions**, minimizing environmental impact.

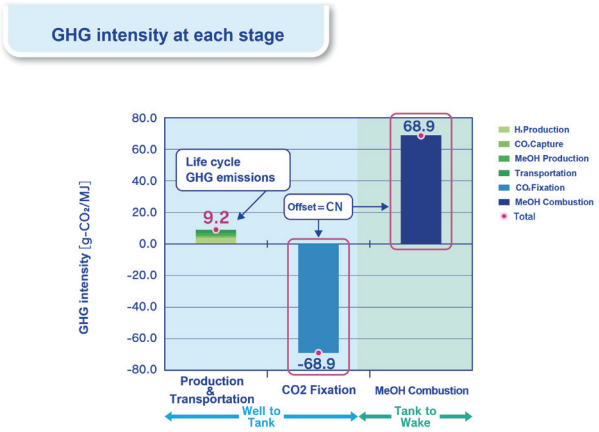


SUPERHIDIC™ installed for MEK process unit

Effects or Remarks

◆ GHG emission reduction through the g-Methanol™ process

Life Cycle Assessment (LCA) was evaluated for the g-Methanol™ process, assuming production in India, marine transport to Singapore and use as marine fuel there. Under the EU's FuelEU Maritime regulation, GHG intensity requirements will become increasingly stringent toward 2050. The g-Methanol™ process can meet these future thresholds (approx. 18.2 g-CO_2eq/MJ), demonstrating its potential as a sustainable marine fuel solution.



◆ Design and operation support under renewable energy fluctuations

The g-Methanol™ process is equipped with advanced tools to handle the variability of renewable energy sources.

MethaMaster™ supports optimal plant design by simulating different energy input scenarios, while MethaDynamics™ enables real-time operational adjustments.

Together, they ensure stable and efficient production even under fluctuating renewable energy conditions.

Installation in Practice or Schedule

Domestic The g-Methanol™ process is being promoted for commercial deployment in Japan, targeting petrochemical, chemical and power companies. TOYO is actively working with domestic partners to support the transition to low-carbon methanol solutions.

Overseas ◆ g-Methanol™ track record

While similar plants are still rare worldwide, TOYO licensed its g-Methanol™ process to NTPC Limited, India's state-owned power utility, in 2021.

On June 3, 2025, the plant successfully achieved its first drop of methanol, synthesized from CO_2 captured at the NTPC site and hydrogen produced via water electrolysis.

◆ Toyo Engineering is actively promoting the g-Methanol™ process to petrochemical, chemical, and power companies worldwide as part of its global business strategy.

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