

g-Methanol™

Proprietary e-Methanol
Production Technology



Building a Carbon-Neutral Future

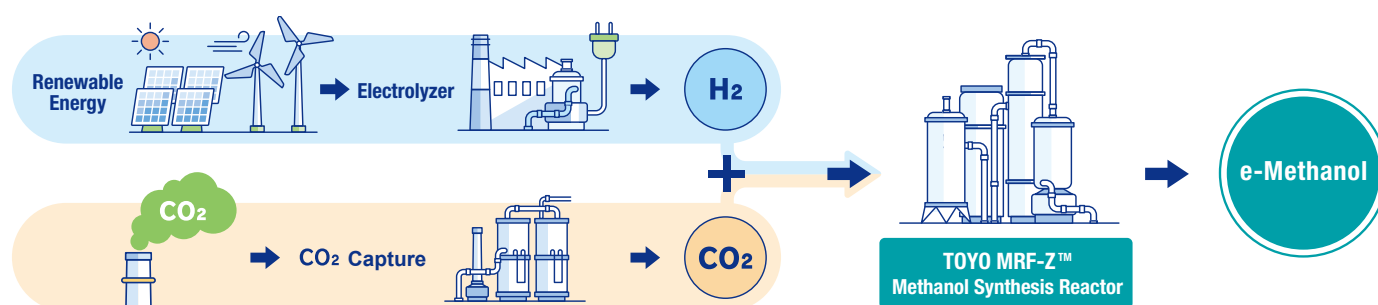


What is g-Methanol™ ?

g-Methanol™ technology is TOYO's proprietary process for producing e-methanol using hydrogen derived from renewable energy sources and CO₂ captured from various emission sources.

TOYO provides a high-efficiency methanol synthesis process, advanced

distillation technology designed to reduce carbon emissions, and digital solutions that support plant design and operation that can adapt to fluctuations in renewable energy. Through this integrated approach, TOYO delivers comprehensive project support, from basic design to operational assistance.



Key Features of g-Methanol™

Efficient & Innovative Process

Direct synthesis of methanol from CO₂ and H₂ using TOYO's MRF-Z™ reactor

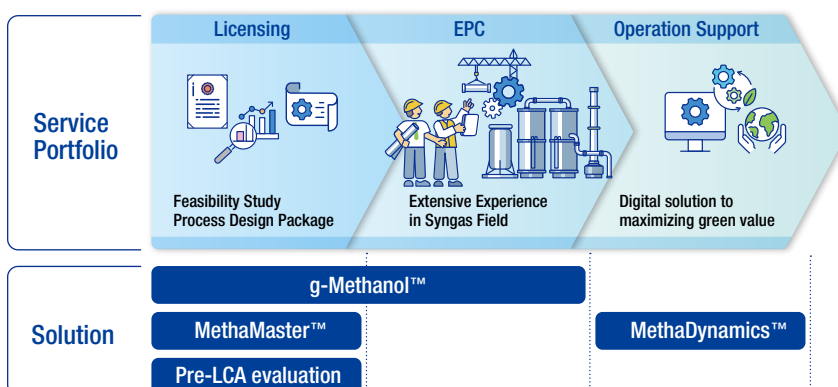
Significant reduction in reboiler steam consumption with TOYO's *SUPERHIDIC™*

Smart Solutions for e-Fuel Issues

Optimal design for adapting to renewable energy fluctuations with TOYO's Methamaster™

Operational support under renewable energy fluctuations with TOYO's MethaDynamics™

Service Portfolio



■ MRF-Z™ / MRF-Z Neo™ Reactor – TOYO's proprietary methanol synthesis reactor that achieves high efficiency

MRF-Z™ is a proprietary methanol reactor designed by TOYO to achieve high-efficiency methanol synthesis. It features a shell-and-tube structure, with catalyst packed in the shell side and boiler water flowing through the tube side. The feedstock is supplied from the top of the reactor, flows from the outer edge toward the center, undergoing repeated reactions and cooling, thereby forming an ideal temperature profile. This enables methanol synthesis at the maximum reaction rate zone and optimizes catalyst usage. The reactor has a proven track record

in conventional natural gas-based methanol synthesis, offering high reliability. Furthermore, it is flexible enough to be applied to e-methanol synthesis processes that use different feedstocks.

In addition, TOYO offers the compact and high-efficiency model “MRF-Z NEO™,” designed for the growing small-to medium-scale e-methanol market. This model maintains the performance and reliability of the original while achieving a lighter design.

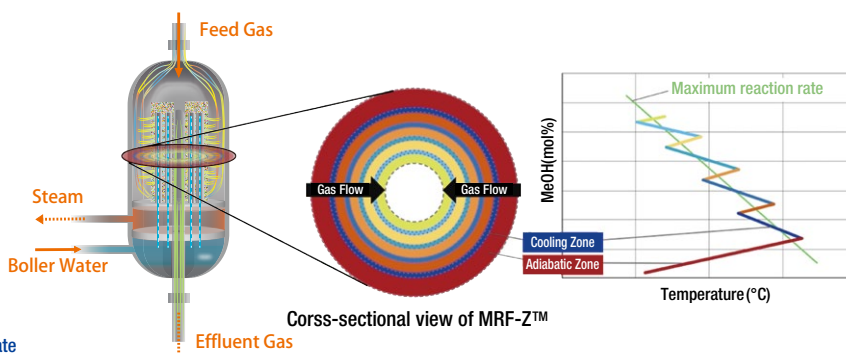
Key Features of MRF-Z™, MRF-Z Neo™

Process Design Approach

Small ΔP , Energy Saving	Radial flow of feed gas
Energy Saving	Recovery and utilization of reaction heat as steam
Min. Catalyst Volume	Realizing efficient synthetic reaction
Easy Catalyst loading / Unloading	Catalyst is loaded in shell-side

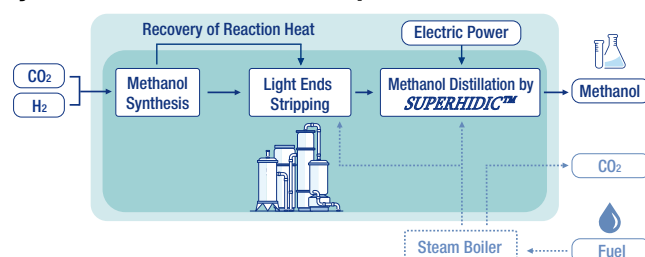
Mechanical Design Approach

Enhanced Mechanical Durability	Bayonet Tubes for Heat Stress Relief
Consistent Reaction Conditions	Even Gas Distribution with Orifice Plate



■ SUPERHIDIC™ – A distillation process that significantly reduces steam consumption

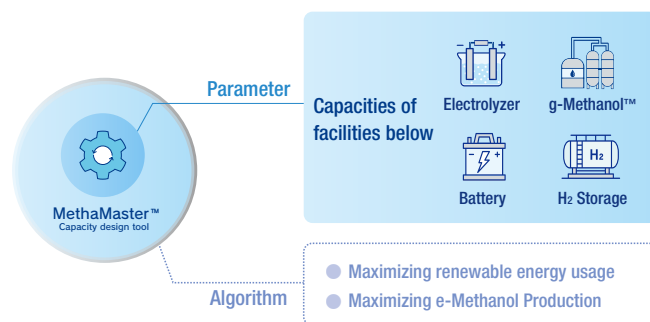
In a typical e-methanol production process, the steam generated from the methanol synthesis reaction is often insufficient to meet the plant's operational needs. As a result, additional steam must be produced using fossil-fuel boilers, which in turn increases CO₂ emissions. TOYO's proprietary technology, **SUPERHIDIC™**, is an innovative distillation process that incorporates heat pump technology. It significantly reduces steam consumption and minimizes environmental impact by eliminating the need for boilers during normal operation.



■ MethaMaster™ – A tool to optimize plant design for variable renewable energy conditions steam consumption

MethaMaster™ is a design support tool that proposes an optimal facility configuration to minimize the Levelized Cost of Methanol (LCOM), based on the renewable energy generation profile at the construction site. Using a proprietary algorithm, it quickly analyzes hundreds of case studies by varying the capacities of four key components: water electrolysis units, methanol synthesis plants, batteries, and hydrogen storage systems. It comprehensively evaluates project constraints, average daily production, operating rate, and LCOM to recommend the most suitable configuration.

With MethaMaster™, it is possible to design systems that maximize the use of renewable electricity and support rapid project deployment.



■ MethaDynamics™ – TOYO's proprietary operational support tool for dynamic response to renewable energy variability

MethaDynamics™ is an operational support tool. It automatically creates optimal operation plans using power generation forecasts and methanol shipment schedules. On-premises systems flexibly control each facility based on the optimum plans. By implementing this tool, it becomes possible to both effectively utilize renewable electricity and ensure stable plant operation. Furthermore, it enables fine-tuned load adjustments automatically, which is expected to reduce the Levelized Cost of Methanol (LCOM) by approximately 20%.

