

SUMMARY

A dimethyl ether (DME) plant with a capacity of 60,000 tons per year, utilizing direct synthesis from syngas produced through the gasification of oil palm empty fruit bunches (EFB), is designed as an effort to convert biomass waste into an environmentally friendly alternative fuel while supporting the government's program to reduce dependence on imported liquefied petroleum gas (LPG). Dimethyl ether possesses physical properties similar to LPG, making it a potential fuel for both household and industrial applications. Oil palm empty fruit bunches are selected as the feedstock due to their abundant availability in Indonesia, high lignocellulosic content, and potential to be converted into synthesis gas (syngas) as a raw material for DME production.

DME production in this plant is carried out through a direct synthesis process using syngas generated from EFB gasification. The process begins with feedstock preparation involving size reduction and drying, followed by gasification using a circulating fluidized bed gasifier to produce syngas containing CO, H₂, CO₂, CH₄, and other components. The syngas is subsequently purified through separation and CO₂ absorption using activated MDEA solution, then compressed before being fed into a multitubular fixed-bed reactor employing a bifunctional catalyst. The reaction products are further purified through several separation and distillation stages to obtain DME that meets the required product specifications. The direct synthesis process is selected because it integrates methanol synthesis and methanol dehydration into a single reactor, resulting in higher conversion, fewer process units, and improved process efficiency compared to the indirect synthesis route.

The plant capacity is determined based on the projected national demand for DME as an LPG substitute, the availability of EFB feedstock, and a comparison with the capacities of existing DME plants worldwide. Based on national energy demand projections, DME demand in 2030 is estimated to reach approximately 1,181,575 tons per year to support a blending program consisting of 20% DME and 80% LPG. Therefore, a production capacity of 60,000 tons per year, representing approximately 5% of the projected national demand, is selected to contribute to domestic DME supply while considering technical, economic, and feedstock availability aspects. The plant is planned to be located in the Dumai Industrial Estate, Riau Province, based on feedstock availability, transportation access, utility support, and industrial development potential.

Economic analysis indicates that the DME plant utilizing oil palm empty fruit bunches is feasible for construction. The economic evaluation yields a Profit on Sales (POS) of 64.1%, a Return on Investment (ROI) of 50%, a Pay Out Time (POT) of 4 years and 9 months, an Internal Rate of Return (IRR) of 17.03%, a Break Even Point (BEP) of 18.07%, and a Shut Down Point (SDP) of 6.77%. These economic indicators demonstrate that the proposed plant offers attractive profitability, a relatively short capital recovery period, and a low minimum operating capacity, indicating that the project is technically and economically feasible for implementation as part of Indonesia's renewable energy development based on biomass resources.

Keywords: *Dimethyl ether, gasification, direct synthesis, oil palm empty fruit bunches, renewable energy.*