Opinions

A Methanol makeover for India: Opportunities & challenges

Expanding the use of methanol across various energy applications could significantly boost India's methanol economy and cut down energy imports

Methanol economy in India: Opportunities & challenges Energy Watch

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India's total primary energy demand stood at 39 exajoules in 2022–23, with coal contributing 55 percent, crude oil 28 percent, natural gas 5.7 percent, and the remaining coming from renewable energy sources, hydroelectric power, and nuclear energy. To meet this demand, India has relied significantly on imports, including 17 percent coal, 85 percent crude oil, 44 percent natural gas, and 95 percent methanol.

the form of olefins) in plastic industries, energy applications, and wastewater and effluent treatments. It is predominantly produced through coal gasification and natural gas reforming. Producing 1 tonne of methanol requires approximately 1.5 tonnes of coal or 0.69 tonnes of natural gas.

According to the Department of Chemicals and Petrochemicals, India's annual methanol demand was 2.97 million metric tonnes (MMT) in 2022–2023, with the country spending Rs 75 billion on imports. Domestic production reached 0.7 MMT, relying largely on imported natural gas and operating at a capacity utilisation of 34–58 percent. In the same period, India spent Rs 1,370 billion to import 26.3 billion cubic meters of natural gas and Rs 12,600 billion to import 232.7 MMT of crude oil.

> *As a sulphur-free chemical, methanol helps eliminate sulphur oxide emissions, and its tailpipe emissions are significantly lower compared to conventional fuels*

Applications of methanol

The primary use of methanol in India is as a feedstock for producing a range of chemicals, including formaldehyde, acetic acid, dimethyl ether, olefins, and methyl tertiary-butyl ether. Formaldehyde is used to produce resins, disinfectants, pesticides, and so on. Acetic acid finds applications in producing vinegar, food additives, dyes for the textile industry, plastics, and various chemicals used in the paint sector. Dimethyl ether serves as an alternative to diesel in compression ignition engines because of its high cetane number and can also replace liquefied petroleum gas as a clean cooking fuel.

Olefins are essential feedstocks for producing ethylene and propylene, which are further used to manufacture a wide array of polymers, including polyethylene, polypropylene, and polyvinyl chloride, all critical to the plastics industry. Methyl tertiary-butyl ether functions as a high-octane fuel additive, improving the performance of internal combustion engines. Additionally, methanol is utilised in wastewater treatment as a carbon source to aid in nitrogen removal.

> *According to a recent study, the demand for methanol is growing at a rate of 6 percent per year under the business-as-usual scenario*

tailpipe emissions are significantly lower compared to conventional fuels. In addition to road transport, methanol can be used as a fuel for marine vessels and railway locomotives. Unlike stack emissions from industries, which can be controlled with carbon capture technologies, managing tailpipe emissions from vehicles is much more challenging. Fuel shift, such as transitioning to methanol, is crucial to address transport-related emissions in internal combustion engines effectively. Methanol can also be used to generate power in two ways: as a fuel for direct combustion in gas turbines or as a fuel for portable power generation using fuel cells.

Opportunities

According to a recent study, the demand for methanol is growing at a rate of 6 percent per year under the business-as-usual scenario. However, if methanol use is mandated for energy and cooking fuel applications, this growth rate is expected to increase significantly. To mitigate the risks of rising import costs and price volatility (due to the demand for natural gas), it is crucial to adopt a strategic approach for domestic methanol production using local resources and innovative methods. Potential domestic feedstocks for methanol production include coal, biomass (such as agro-residues and municipal solid waste), and captured carbon dioxide from industrial point sources and hydrogen. Strategically, a combination of these feedstocks should be explored across short, mid, and long-term timeframes to enhance energy security. This approach would foster a circular economy, create new jobs, and drive advancements in research and development related to carbon capture and utilisation, hydrogen production, coal gasification, and methanol synthesis and its value chain.

> *Although the country is striving to reduce imports, there are currently no robust policies to support the sustainable production and utilisation of methanol, particularly in energy applications*

Currently, India has two green methanol plants utilising captured CO_2. One is located in Telangana at the Singareni Thermal Power Station, with a plant capacity of 180 kg per day, built by Singareni Collieries Company Limited in collaboration with Ohmium International, the Jawaharlal Nehru Centre for Advanced Scientific Research, Breathe Applied Sciences, and Spirare Energy. The other, located in Madhya Pradesh at the Vindhyachal Thermal Power Plant, has a plant capacity of 10 tonnes per day and was developed in collaboration with NTPC Limited and Jakson Green.

L&T, 2 others bid for NLC's Rs 4,400-cr Lignite-to-Methanol project: Sources

Challenges

Although the country is striving to reduce imports, there are currently no robust policies to support the sustainable production and utilisation of methanol, particularly in energy applications. A key challenge in producing green methanol is the high capital and operational expenses. Coal India Limited plans to establish a coal-based methanol production plant with a capacity of 0.7 MMT per year at an estimated project cost of Rs 6,000 crore. A recent study by the Center for Study of Science, Technology and Policy (CSTEP) explored the production of green methanol using captured CO_2 from hard-to-abate industries and green hydrogen. The study found that to produce enough green methanol to meet domestic demand and avoid imports, a capital expenditure of Rs 9,000–17,000 crore and operational expenses of around Rs 20,000 crore per annum (with 80 percent allocated to green hydrogen production) would be required. Under this approach, the levelised cost of green methanol was estimated to be Rs 90–120 per kg, which is two–three times higher than the cost of conventional methanol.

> *If India mandates the use of 20 percent methanol in the transportation sector as a substitute for petrol and diesel, it could result in savings of Rs 2,520 billion on crude oil imports*

transportation, power generation, and cooking fuel could significantly boost India's methanol economy. This shift would also reduce the country's reliance on imports of direct methanol, natural gas, and crude oil, thereby saving on import costs. According to the CSTEP study, producing methanol using captured CO_2 and green energy could repurpose 4.4 MMt of CO_2, create a demand for 0.7 MMT of green hydrogen, and drive a renewable electricity demand of 55 terawatt-hours (TWh). This approach could help the country save Rs 75 billion per annum on methanol imports. Additionally, if India mandates the use of 20 percent methanol in the transportation sector as a substitute for petrol and diesel, it could result in savings of Rs 2,520 billion on crude oil imports.

energy transition | carbon emissions | methanol | energy | crude oil import

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