Production Cost and Carbon Footprint of High Performance Biomass-Derived Dimethylcyclooctane as a Jet fuel Blendstock

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Project Goals: Predict the impact of JBEI research results on biofuel selling price and carbon efficiency.

Biomass-derived 1,4-Dimethylcyclooctane (DMCO) is a performance-advantaged jet fuel that can reduce greenhouse gas emissions relative to conventional Jet-A and extend the range and efficiency of aircraft with its 9.2% higher energy-density and improving combustion properties.[1] This study provides the first technoeconomic analysis and life-cycle greenhouse gas assessment for DMCO product using three different hydrogenation catalysts and two different bioconversion pathways. With current technologies and yields, the platinum-based catalyst results in the lowest production cost and carbon footprint of DMCO of $8.4/L-Jet A and 72.3 gCO2e/MJ, respectively. However, when the conversion process is fully optimized, hydrogenation with the Raney Ni-based catalyst results in the lowest cost and carbon footprint of DMCO of $1.4/L-Jet A and 19.8 gCO2e/MJ, respectively. The optimized scenario can be thought of as a theoretical floor for cost and emissions, with biomass sorghum yields exceeding >25 metric-ton/ha and near-theoretical conversion rates of sugar-to-isopentenol, isopentenol-isoprene, and isoprene-to-DMCO. While still more costly to produce that Jet-A, DMCO offers performance advantages that may facilitate early adoption in markets that place a high value energy density and other fuel properties, offering an opportunity to further optimize production through early demonstrations and scale-up and bring down the minimum selling price.

References

1. Rosenkoetter, K. E.; Kennedy, C. R.; Chirik, P. J.; Harvey, B. G. [4 + 4]-cycloaddition of isoprene for the production of high-performance bio-based jet fuel. Green Chem. 2019, 21, 5616–5623.

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