Lignin-based jet fuel packs more power for less pollution

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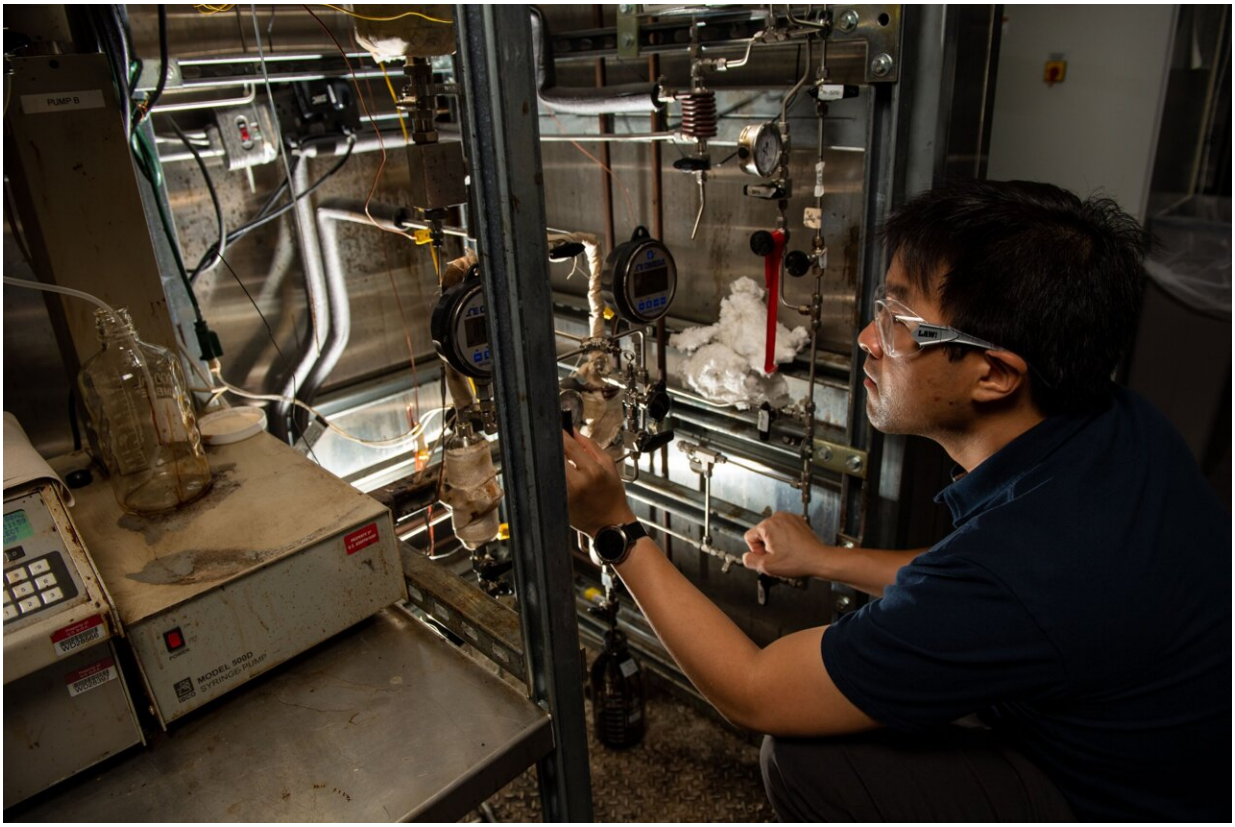

A Pacific Northwest National Laboratory scientist at Richland, Wash., helps develop a sustainable fuel component as part of research into bio-based jet fuels. Credit: PNNL

An experimental plant-based jet fuel could increase engine performance

and efficiency, while dispensing with aromatics, the pollution-causing compounds added to conventional fuels, according to new research.

In a study published in the journal *Fuel*, researchers analyzed a Washington State University-developed jet fuel based on lignin, an organic polymer that makes plants tough and woody.

Using a range of tests and predictions, the researchers examined fuel properties critical to jet engine operation, including seal swell, density, efficiency, and emissions. Their results suggest that this sustainable fuel could be mixed with other biofuels to fully replace petroleum-derived fuels.

"When we tested our lignin jet fuel, we saw some interesting results," said Bin Yang, professor with WSU's Department of Biological Systems Engineering and corresponding author on the study. "We found that it not only had increased energy density and content but also could totally replace aromatics, which are a real problem for the aviation industry."

"Aromatics are associated with increased soot emissions, as well as contrails, which are estimated to contribute more to the climate impact of aviation than carbon dioxide," said Joshua Heyne, co-author, University of Dayton scientist and current co-director of the joint WSU-Pacific Northwest National Laboratory Bioproducts Institute. "Aromatics are still used in fuel today because we do not have solutions to some of the problems they solve: they provide jet fuel with a density that other sustainable technologies do not. Most unique is their ability to swell the O-rings used to seal metal-to-metal joints, and they do this well."

"We want to fly safely, sustainably, and with the lowest impact to human health," Heyne added. "The question is, how do we do all of this as economically as possible?"

Yang developed a patented process that turns lignin from agricultural waste into bio-based lignin jet fuel. Such sustainable fuel could help the aviation industry reduce dependence on increasingly expensive fossil fuels while meeting higher environmental standards.

The WSU-developed, lignin-based fuel's properties "offer great opportunities for increasing fuel performance, higher fuel efficiency, reduced emission, and lower costs," authors wrote in *Fuel*. "The fact that these molecules show sealant volume swell comparable with aromatics opens the door to develop jet fuels with virtually no aromatics, very low emissions, and very high-performance characteristics."

"The lignin-based fuel we tested complements other sustainable aviation fuels by increasing the density and, perhaps most importantly, the ring-swelling potential of blends," Heyne said. "While meeting our material needs, these sustainable blends confer higher energy densities and specific energies without using aromatics."

"This process creates a cleaner, more energy-dense fuel," Yang added. "That's exactly what sustainable aviation fuels need for the future."

More information: Zhibin Yang et al, Lignin-based jet fuel and its blending effect with conventional jet fuel, *Fuel* (2022). DOI: 10.1016/j.fuel.2022.124040

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