SUSTAINABLE ALTERNATIVE **JET FUELS** AND **EMISSIONS** REDUCTION

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FACTSHEET

Aviation Carbon Emissions

The carbon footprint of jet fuel emissions is one of several challenging environmental issues facing the aviation industry today. Airlines and other aviation industry stakeholders have supported the development and use of sustainable alternative jet fuels (SAJF) for more than 10 years to reduce net greenhouse gas (GHG) emissions from aircraft. SAJF are produced from non-petroleum sources and have been shown to deliver significant reductions in net GHG emissions on a lifecycle basis. SAJF may be a significant contributor to the airlines' commitment to meeting internationally agreed upon GHG reductions under the UN International Civil Aviation Organization's Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). The use of SAJF could also become an important component of airlines' commitment to supporting airports' sustainability goals (Scope 3 GHG emissions).

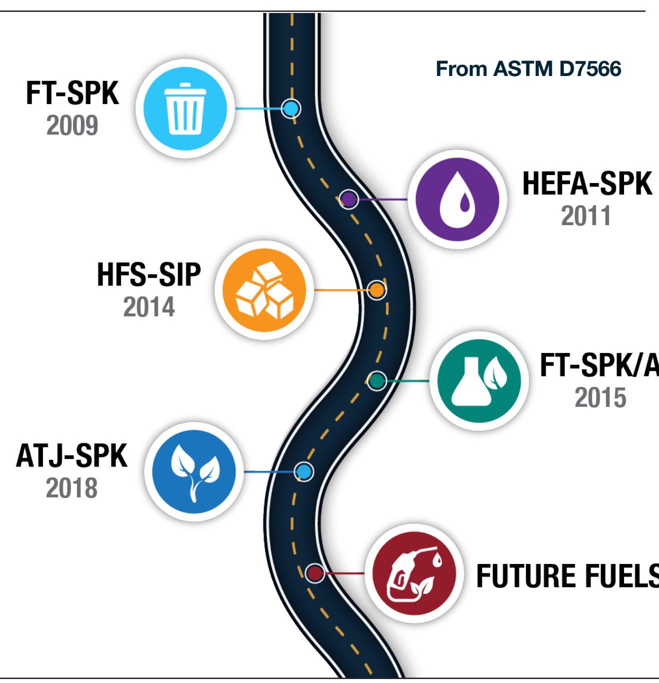
Air Quality Benefits of SAJF

The use of SAJF reduces key air pollutants as well as GHG and Hazardous Air Pollutants (HAPs). Emissions of particulate matter (PM) and sulfur oxides (SO_X), both pollutants of concern in many urban areas, are significantly reduced as outlined in this fact sheet. Moderate reductions of carbon monoxide (CO) and unburned hydrocarbons (UHC) are also achieved without any increase in emissions of oxides of nitrogen (NO_X). These reductions could give airports flexibility to grow under their State Implementation Plan (SIP) constraints. Additionally, these fuels reduce emissions of ultrafine particles, not just the regulated larger particles. Recently published studies suggest that ultrafine particles are a key air pollutant near airports and may have human health-related impacts. Reduced ultrafine emissions could improve local air quality. Use of SAJF to reduce aircraft emissions could be a win-win for airports and airlines. This study evaluates the air quality benefits of using SAJF to reduce GHG and pollutant emissions and quantifies the reductions. The study also demonstrates the impact of SAJF through emissions modeling supported by an easy-to-use tool that airports can apply to their emission inventories.

Alternative Jet Fuels

ASTM International maintains a standard specification D1655 for aviation turbine fuels. The aviation industry and ASTM also established a definitive standard for synthetic blending components for jet fuel, designated by ASTM D7566. To date, ASTM has defined five annexes in D7566 for producing different synthetic blending components, referred to as alternative jet fuels. When produced sustainably, these fuels are referred to as SAJF. These fuels types are listed below.

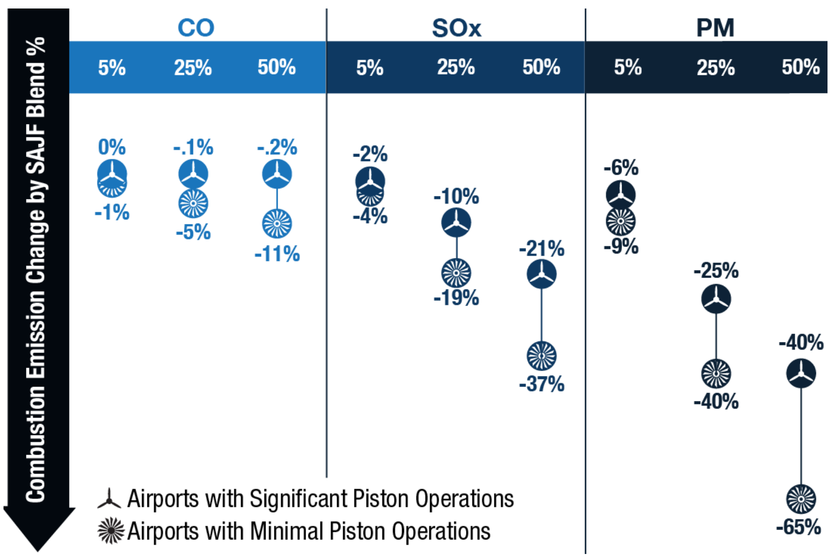
1. FT-SPK is produced by converting mixtures of syngas (carbon monoxide and hydrogen) to hydrocarbon fuel molecules by use of Fischer-Tropsch reactors. The syngas can be derived by gasifying a wide range of materials including petrochemical resources such as coal and natural gas, as well as various sources of renewable biomass such as municipal solid waste, agricultural waste, forest waste, wood, and energy crops.
2. HEFA-SPK converts the hydrocarbons found in fats, oils, and greases using hydroprocessing technology.
3. HFS-SIP is made from sugars fermented to produce farnesene, a 15-carbon hydrocarbon molecule, which is subsequently hydroprocessed.
4. FT-SPK/A is produced much like FT-SPK with the intentional addition of light aromatic compounds from various non-petroleum sources.
5. ATJ-SPK is created by using standard refinery processes to convert various C2-C5 alcohols that are typically derived from renewable feedstocks such as sugar crops (cane, sorghum, beet, corn), or sugars saccharified from lignocellulose.



Comparative Characteristics Net Carbon Dioxide (CO_2) Impact

Net GHG emissions from SAJF are determined by comparing their lifecycle emissions to the lifecycle emissions of traditional petroleum fuels. Lifecycle emissions include all GHG emissions from production through aircraft engine combustion. All petroleum fuels are considered to have the same lifecycle GHG emissions (reference level of 89g CO_2e/MJ), based on a worldwide survey of petroleum-based jet fuel production. However, every SAJF's CO_2e impact is somewhat different, with the largest difference due to the specific feedstock and required processing. Fuels produced under each individual ASTM-defined annex have similar feedstock and processing methods, thus they have similar lifecycle emissions (e.g., grain oils and hydroprocessing). However, the variation might be larger when comparing grain oil versus brown grease, even though the feedstocks are both lipids. Similarly, feedstock and processing methods can be dramatically different between annexes and as a result, emissions may also vary significantly annex to annex. The potential GHG emissions reduction benefits from using SAJF could be significant when compared to conventional jet fuel, and in some cases could exceed 100% (e.g., with biochar sequestration, or avoidance of other GHGs associated with the feedstock). The airlines are expected to select appropriate SAJF by considering a wide range of criteria, including sustainability, policy requirements, price, producer reputation, and supply chain issues. This is one of the reasons the industry is pursuing multiple production pathways and feedstocks: to enable the most appropriate production in every part of the world, and to do so sustainably, while also achieving significant net GHG emissions reductions for the sector.

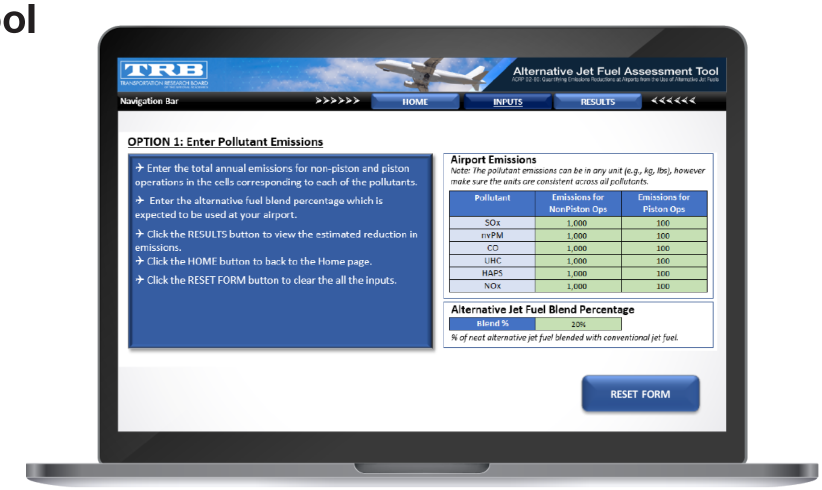
Emissions Changes and Air Quality Impacts



A synthesis of 51 emissions measurement reports shows that ASTM-certified SAJF—when blended with conventional jet fuel as defined in D7566—significantly reduces SO_X and PM emissions, generally reduces CO emissions, and minimally reduces or has no effect on NO_X and HAPs emissions. The impact of SAJF on UHC emissions is uncertain and requires further experimentation, as it appears to be driven by both the blend ratio and the engine operating conditions. The results presented here provide a first-order estimate of the reduction in combustion emissions at airports for various SAJF blend ratios. The results are based on analysis conducted at 12 representative airports with various operational characteristics such as fleet mix, (i.e., number of jet, turboprop, and piston aircraft). For each blend ratio in the figure, the uppermost percentage is indicative of potential emissions reduction at airports with predominantly jet and turboprop operations. The lowermost percentage is indicative of potential emissions reduction at airports with predominantly piston operations and fewer (less than 20%) jet and turboprop operations.

Alternative Jet Fuel Assessment Tool

The Alternative Jet Fuel Assessment Tool is an Microsoft Excel-based tool designed to help airports estimate the reduction in aircraft Landing Take-Off (LTO) cycle emissions from the use of SAJF. The tool models emissions of SO_X, PM, CO, UHC, NO_X, and HAPs. The tool provides two options to estimate the percentage reduction in emissions at the specified SAJF blend percentage. The first option uses the airport's annual emissions inventory for each pollutant. The second option uses a description of the airport's operational characteristics. Both options present the user with an input form to collect the necessary data for running underlying impact factor calculations. The tool outputs the expected reduction in each pollutant's emissions along with an uncertainty bound at the specified SAJF blend percentage. The tool also plots the expected reduction in each pollutant's emission at various SAJF blend percentages.



RESOURCES:

- Commercial Aviation Alternative Fuels Initiative (CAAFI) website: http://www.caafi.org/
- ACRP Web-Only Document 41: Alternative Jet Fuels Emissions: Quantification Methods Creation and Validation Report: www.trb.org/main/blurbs/179509.aspx

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