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Particulate emissions of a turboshaft engine running on HEFA-SPK and its Jet A-1 blends

Alexander Rabl, Marius Rohkamp, Mohammad Reza Saraji-Bozorgzad, Christian Helcig, Reetu Sallinen, Jesse Vilja, Jan Bendl, Thomas Adam, Andreas Hupfer, Volker Gümmer

The Technical University of Munich, TUM School of Engineering and Design, Institute of Turbomachinery and Flight Propulsion, Boltzmannstr. 15, 85748 Garching, Germany
alexander.rabl@tum.de

Global aviation substantially contributes to air pollution, emitting various pollutants, including CO_2, CO, NO_x, and particulate matter (PM), primarily in the form of soot. In this study, comprehensive measurements on an Allison 250 C20B turboshaft engine to explore the impact of sustainable aviation fuel (SAF) on emissions were conducted. 100% HEFA-SPK and two conventional Jet A-1 fuel blends with 30% and 50% HEFA-SPK content were tested. The emission results were then compared to pure Jet A-1.

The focus of the study was measuring particulate matter in terms of number and size. The engine power settings were selected based on thrust ratios specified in the International Civil Aviation Organization's (ICAO) Landing and Take-off-cycle (LTO-cycle). Multiple measurement techniques were utilized to characterize PM emissions, including the use of two distinct electrical mobility analyzers (an SMPS and a DMS 500). Furthermore, a concentration particle counter (CPC) was employed to validate the reliability of the results.

The measurement results indicate a reduced PM number and size with increasing HEFA-SPK content. The decrease in PM number exhibited a linear trend for the 30% and 50% HEFA-SPK blends for all power settings and was more pronounced when using 100% HEFA-SPK. Additionally, a more significant reduction in PM number emissions, up to 82%, was observed at lower power settings, such as Ground Idle (GI), compared to higher power settings, like Take-Off (TO), where the reduction was up to 40%. Furthermore, the emitted particles when burning HEFA-SPK are, on average, smaller than when burning conventional Jet A-1. This is reflected in the mode shift of the measured particle size distributions. The mode shift is again especially pronounced for 100% HEFA-SPK. The reason for this is considered to be the chemical composition of the fuel.