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Effect of biofuel additive on particle size distribution

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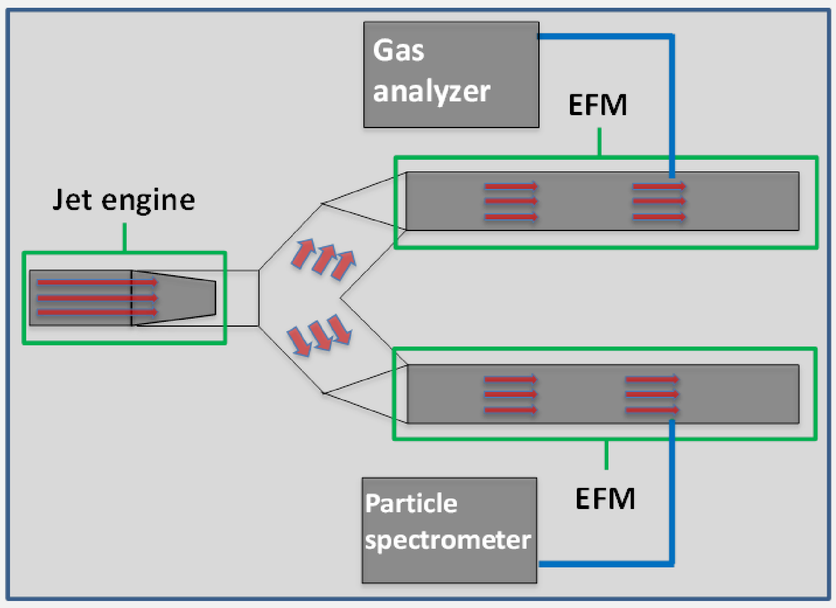
Abstract

The development of air transport contributes to the increase in the number of flight operations, resulting in the need to increase the number of aircraft. The result of the dynamic growth of air transport is increasing demand for fossil fuels, generating increased exhaust emissions. Emissions from air transport, adversely affect air quality, especially in the airports areas; it is also a cause of greenhouse effect. Current situation contributed to the exacerbation of the requirements for environmental performance of aviation powertrains. One way to meet the requirements for aviation powertrains in the field of environmental protection, is the introduction of alternative fuels intended for the supply of aircraft engines. The most common alternative fuels are particularly ethanol and esters of vegetable origin. Alternative fuels designed for use in air transport must meet strict criteria, including physicochemical properties directly affecting the combustion process, production costs, availability, and safety. The aim of this study was to determine the size distribution of particles emitted by the jet engine GTM-120 fuelled with Jet A-1 and its blend with bioester FAME (Fatty Acid Methyl Esters) in a 1:1.

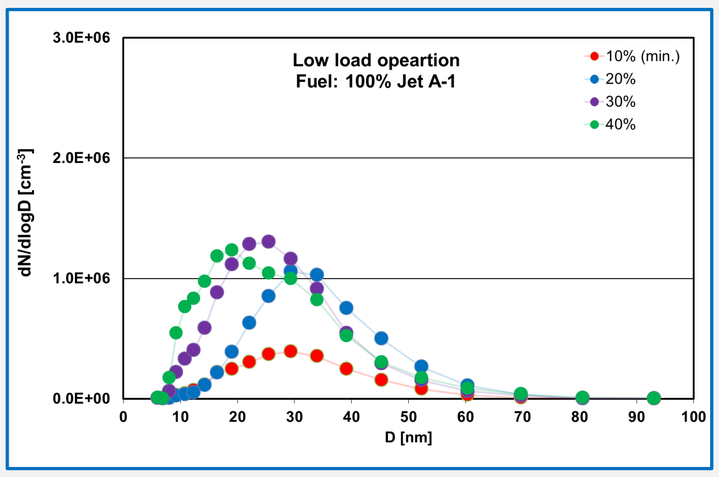
Methodology

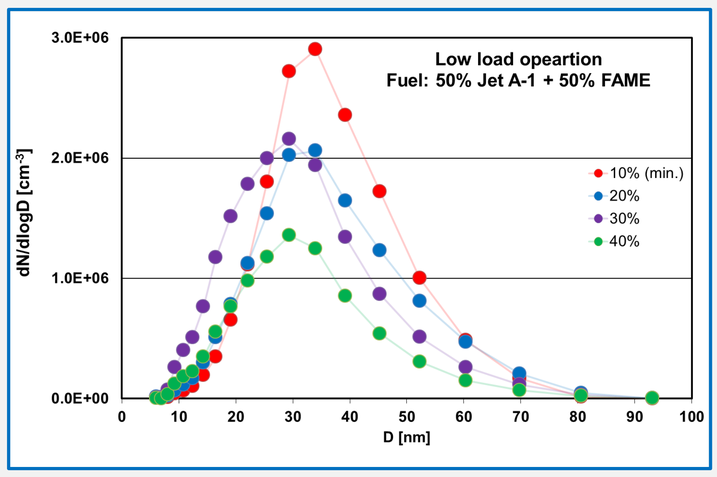
Studies on the effects of bioester admixture on the emission of PN were carried out using a GTM-120 jet engine installed on a stationary workbench. The engine consists of a single-stage radial compressor which is connected to a single stage axial turbine. The GTM-120 engine uses an annular combustion chamber and the fuel is supplied to the set of vaporizers. Measurement of particle diameters was performed with a EEPS 3090 (engine exhaust particle sizer™ spectrometer) mass spectrometer. It enabled the measurement of a discrete range of particle diameters (from 5.6 nm to 560 nm) on the basis of their differing speeds.

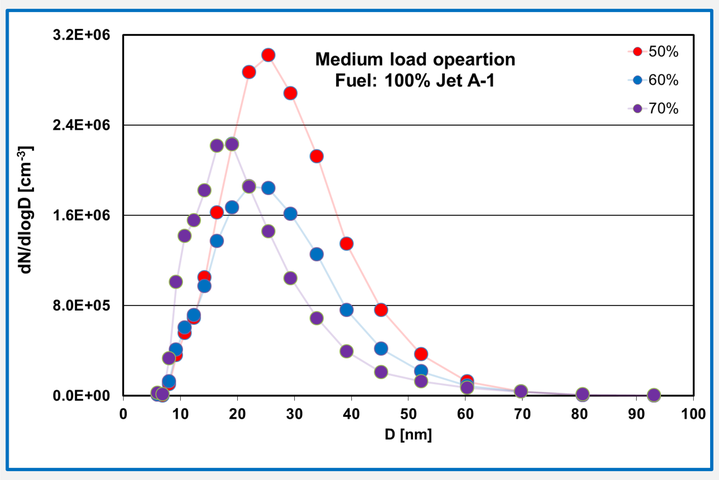


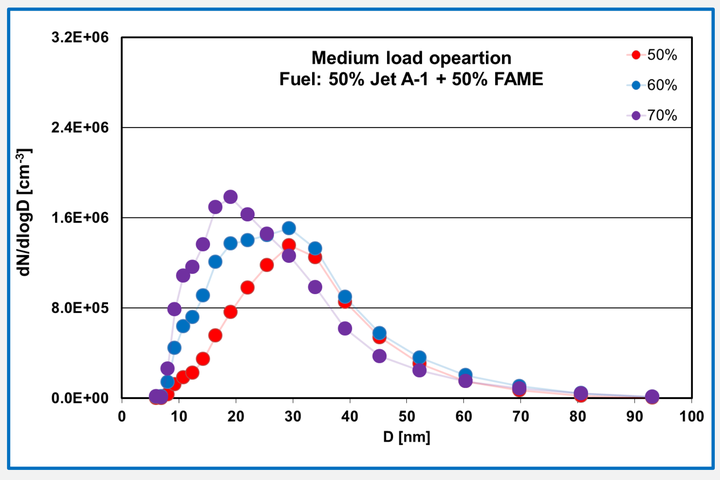
Results

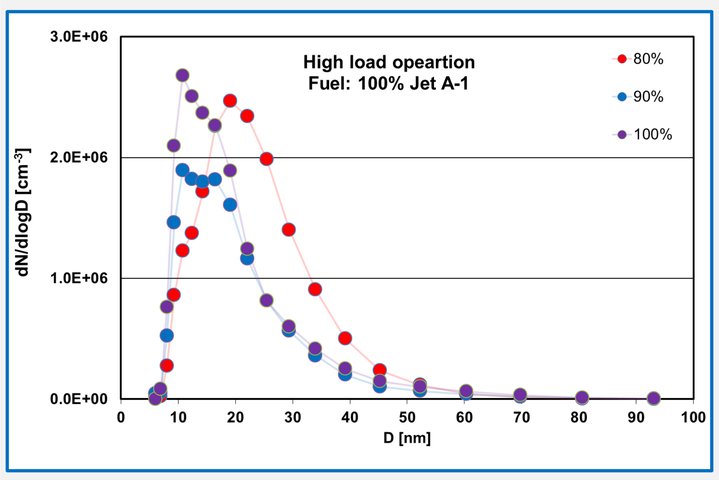
Determination of the size distribution of particle depending on the fuel used made it possible to determine the effect of bioester on the emissivity of the jet engine. Measurements were carried out under laboratory conditions on a prepared test stand. Using an apparatus for measurement of particle emissions from jet engine the particle size distributions were determined.

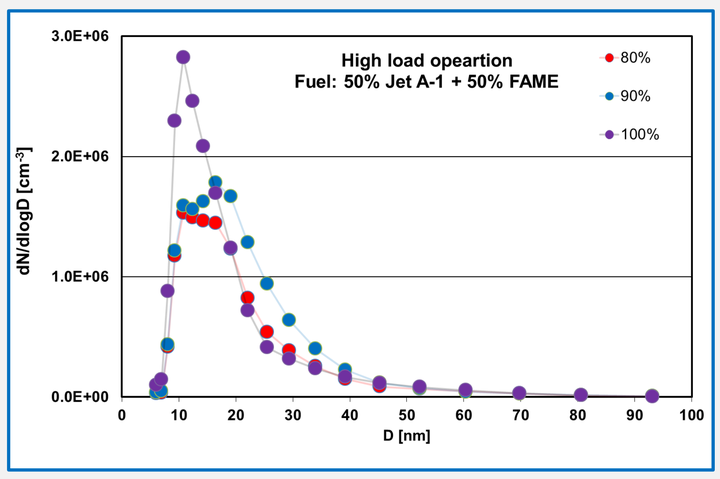












Conclusion

The result of biofuel use as an additive to jet fuel, was the change of size distribution of particles emitted by turbine engine in relation to distributions received during engine operation fueled with pure Jet A-1. For the first three points of measurement (low load operation) values of the characteristic diameter of determined size distributions of particles, turned out to be higher by 20% for the engine fueled with FAME additive. Obtained results of the measurement for medium load operation indicate on the increase of the diameters of the particulate matter in the case of the bioester use as additive to Jet A-1 in relation to size distribution of particles emitted by jet engine supplied with Jet A-1 without any additive compound. Analyzing the measuring points for the load values of 80%-90% was found that bioester addition causes no effect on size distribution of emitted particles. In load values of 90%-100% no significant differences between particle size distribution obtained for both fuels were found and for maximum value of load (100%) dimensional distributions were very similar. It has been found that increasing the load values of the engine, regardless of the type of fuel used, effects in reducing the diameter value of emitted particles.

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