The investigation of the influence of the oxygen additive to the jet fuel on the particle emissions from a small turbine engine

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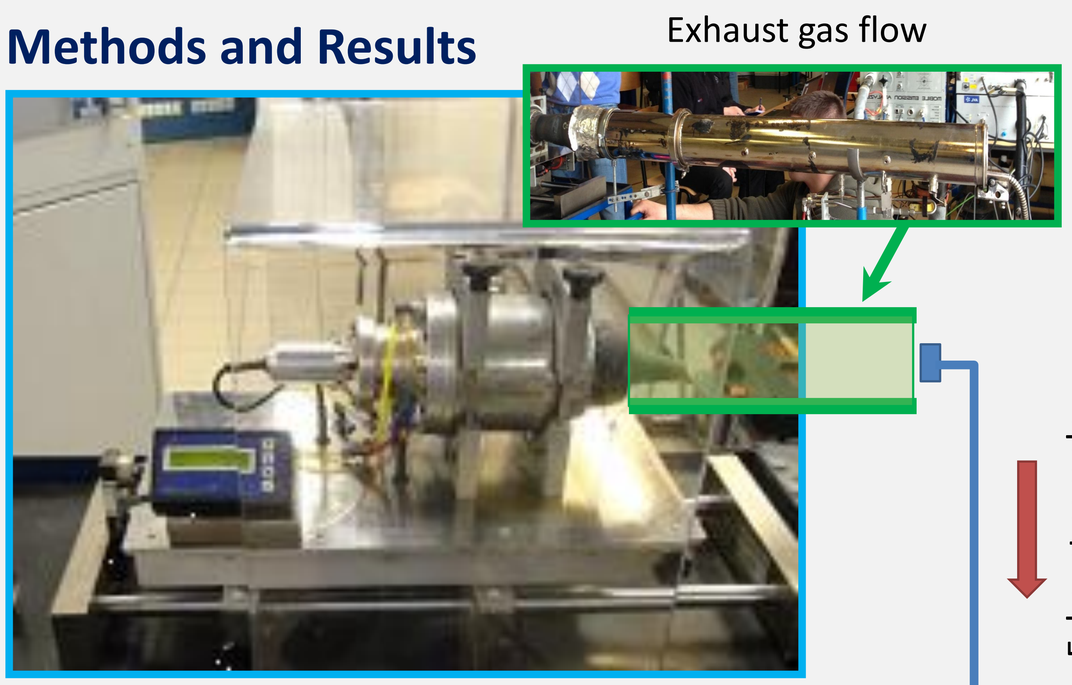
Abstract

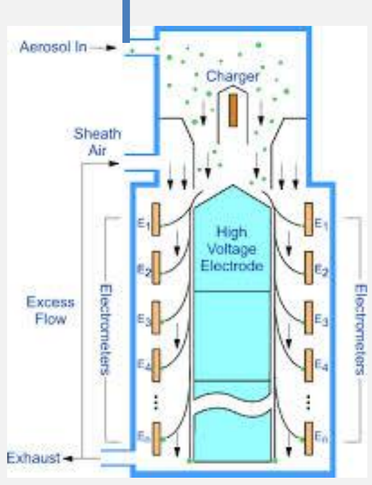
The paper presents the results of investigations and analyses related to the potential for use of the JET A-1 with an oxygen additive ($CH_3(OCH_2CH_2)_3OCH_3$) in small turbine engine. An evaluation has been performed of the influence of different contents of the additive on the particle emission.

Tests of the particle emissions in the exhaust gases were conducted for four fuels with different contents of oxygen additive. During the first phase the distribution of particles diameters was investigated for exhaust fumes from engine fueled with JET A-1 with no additive. The results of the measurements obtained are reference for comparing results of tests carried out with the use of the remaining fuels: JET A-1 with 10, 20 and 30 percentage share of oxygen additive. The additive utilized in the tests is a substance generally used in the chemical industry as a solvent. In accordance with the chemical formula $CH_3(OCH_2CH_2)_3OCH_3$, one molecule of the compound contains 4 oxygen atoms, therefore some changes might be expected in the process of fuel combustion with the participation of such an additive promoting reduction in the number of particles. The test involved measurement of the number of particles and their diameter distribution for 12 points of the engine operation, which have been characterized by the value of thrust within the range from K_{min} = 10 N to K_{max} = 120 N.

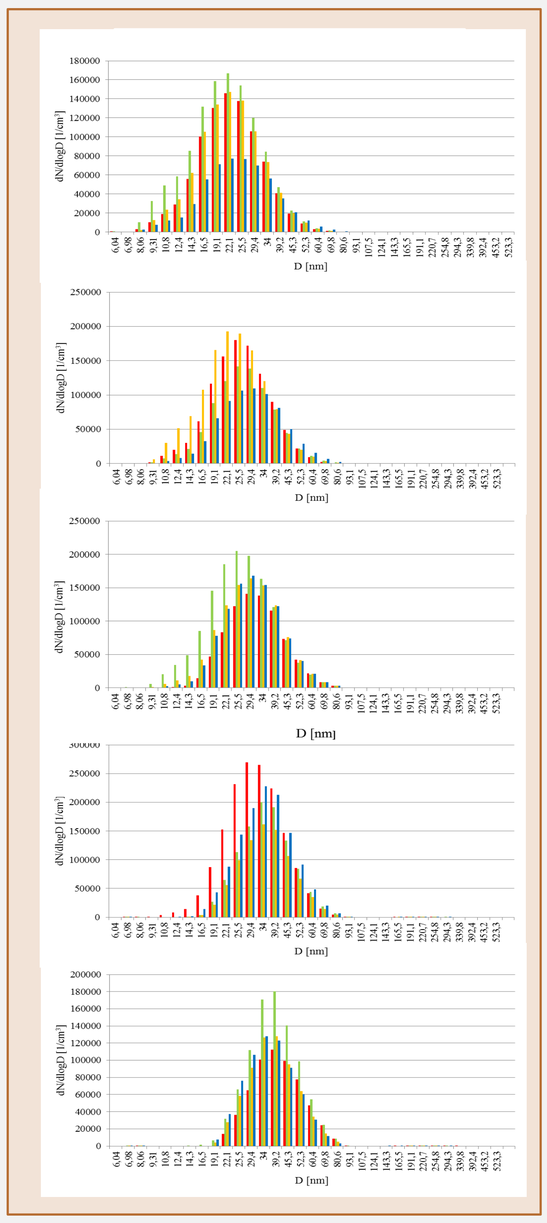
Analysis of the test results involved particle size distribution in exhaust fumes of engine powered with fuels with different contents of oxygen additive. These are functional dependencies between the relative number of particles from a given range of diameters and the average size of a particle. Distributions have been developed for each test values of thrust and for each type of fuel powering the engine. The selected characteristics of distributions are shown in Figure.

Methods and Results





Exhaust gas analysis



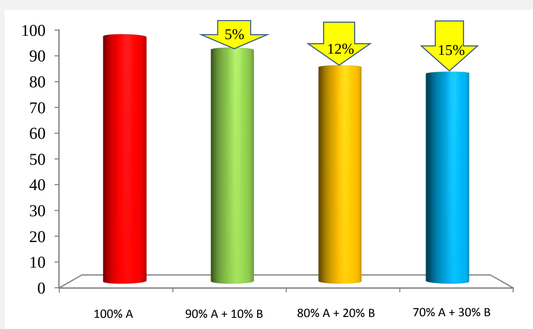
max Power min

A = Jet A-1

B = $CH_3(OCH_2CH_2)_3OCH_3$

- 100% A
- 90% A + 10% B
- 80% A + 20% B
- 70% A + 30% B

$\sum$



Conclusion

The results obtained indicate the similarity of the particle size distribution for all values of thrust and show changes in the number of particles for individual size distributions. These changes depend on the percentage of additive in the fuel and on the thrust of the engine. Use of the $CH_3(OCH_2CH_2)_3OCH_3$ additive does not cause changes in the particle size distribution, and only helps to reduce their number in all measuring ranges. These changes result in a reduction in total emissions of particles by about 10%.

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