Emission Indices of current Flight Gas Turbines compared with EURO IV Diesel Car Emission Standard

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Keywords: Soot emission index, flight gas turbine, EURO IV,

Poster abstract:

The best method to compare the quality of combustion processes is to compare the emission indices (mg pollutant / kg fuel). In this work we measured emission indices (EI's) of flight gas turbines and compared it with the modern EURO IV diesel car emission standard.

In a diesel piston engine there is always ignition and extinguishing of the flame. Therefore higher emissions are not surprising and filter systems are necessary to reach the standards. The EURO IV standard for diesel cars allows 25 mg particulate matter per kilometre, or **5 mg / passenger km** (five passengers). Assuming the average fuel consumption of a EURO IV diesel car is ~5 kg diesel / 100 km, the allowed emission index of modern diesel cars is 500 mg soot / kg fuel.

In a flight gas turbine, a special property of the combustion process is the continually burning flame. Despite the fact that in principle no filter system can be used behind a flight gas turbine, soot emissions are expected to be relatively low. For current medium to large passenger aircraft, existing emission indices from measurement programs are suggested around 36 mg soot / kg fuel for cruise condition. Assuming the average cruise fuel consumption of a 150 seat passenger aircraft is 2700 kg fuel / hour and the average speed is 800 km / hour, the soot emissions would be around 100 g / hour, or 125 mg / km, or **0,8 mg / passenger km** for such an aircraft.

So far, no soot emission indices for small flight gas turbines (used in business jets) and helicopter gas turbines have been available. As a result of this work it is clearly shown that the emission indices of current small flight gas turbines are lower than the allowed emission indices of modern EURO IV diesel cars.

Emission measurements tests are done behind a Turbomeca Makila 1A1 helicopter engine and two Pratt & Whitney PW545 Turbines.

12th ETH-Conference on Combustion Generated Nanoparticles
August 23rd - 25th 2008

Institute of
Combustion Technology

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The best method to compare the quality of combustion processes is to compare the the emission indices (EI).

EI = mg pollutant / kg burned fuel

Euro IV diesel car:

- 25mg particulate matter / km
- assumed fuel consumption 5 kg diesel / 100 km
-allowed emission index for EURO IV diesel cars:

EI = 500 mg soot / kg diesel

or 5 mg soot / passenger km

Current medium to large passenger aircraft

EI = ~ 35 mg soot / kg fuel (cruise condition)

Example: 150 seat passenger aircraft
Cruise fuel consumption: 2700 kg / hour
Average speed : 800 km / hour
Soot emission:~ 100 g / hour or 125mg / km
or 0,8 mg soot / passenger km

The combustion process in gas turbines is much better than in diesel piston engines. In diesel engines there is always ignition and extinguishing of the flame. This results in „high emissions“.

In gas turbines there is a continually burning flame. Emission Indices are low without any aftertreatment.

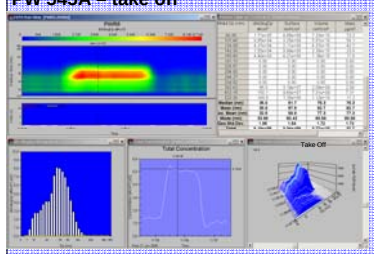
Emission Indices of flight gas turbines are lower than the allowed emision indices of EURO IV diesel cars

Emission Indices

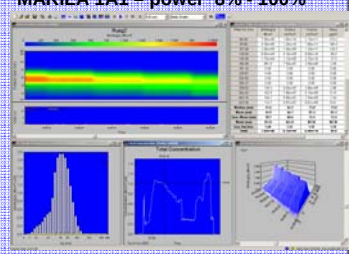
PW 545A (Cessna Citation)

Makila 1A1 (Helicopter engine)

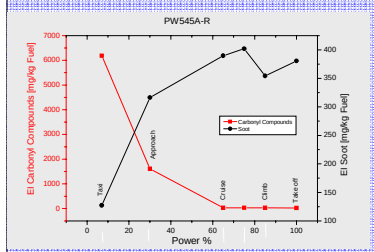
PW 545A – take off

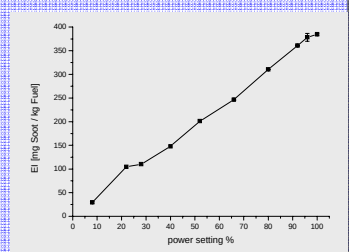


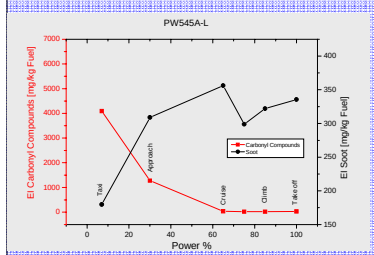
MAKILA 1A1 – power 8% - 100%



mass / kg fuel
EI_{Soot} = 25 mg – 400 mg soot
EI_{ald} = 0 mg – 6250 mg aldehyde

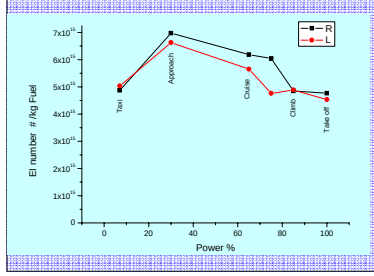


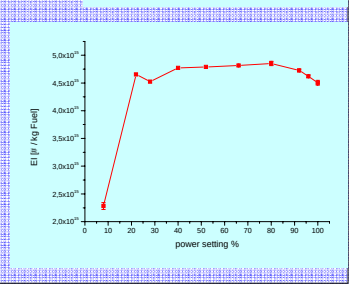




particle # / kg fuel

$EI_{\#}$ = $2x10^{15}$ - $7x10^{15}$





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für Luft- und Raumfahrt e.V.
in der Helmholtz-Gemeinschaft

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