Results from the European Project PartEmis

Aircraft Engine Exhaust Particles -

Physical and Chemical Properties of

PartEmis Objectives

The understanding of pollutant formation and transformation in an aircraft engine will be improved in the course of combined experimental and modelling work on an aircraft engine combustor and a Hot End Simulator (HES) which simulates the turbine section of a real aircraft engine.

Experimental results will be used to develop and validate chemical models to predict the transformation of trace species during their passage from the combustor exit to the engine exit plane, particular emphasis will be put on the prediction of aerosol precursors and soot.

Test Conditions

Simulated cruise conditions (33000 ft), combustor inlet temperatures simulate old (T = 566 K) and modern (T = 766 K) technology engines; Fuel sulphur content (FSC) : 0.05, 0.41, 1.27 g kg⁻¹;

Turbin sections: Combustor exit, HES high p, HES intermediate p, HES low p

Condensation Particles

The nucleation of volatile conden-

sation particles in the cooling exhaust gas inside the sampling line is triggered by the availability of condensable gases and by the aerosol surface density of the pre-existing combustion particles.

Formation conditions

- high FSC ➔ high H₂SO₄

- top panel: time evolution of 4-7 nm volatile particles concentration in the sampling line, as a function of the FSC

- low surface area density of combustion aerosol

- bottom panel: number of nucleated condensation particles, as a function of the combustion aerosol surface area and FSC.

Combustion Products in the Engine Exhaust

Fuel

\[ C_8H_{16} + S \]

H₂O, CO₂, NOₓ, CO

Particles

Particles

Hydration Properties

Fraction of particles activated as cloud condensation nuclei based on measured size distributions:

- measured activation ratio

- H₂SO₄ - H₂O particles

- ≥ 97% SO₂,

- 2.7% gaseous

- H₂SO₄ coated graphite

Hygroscopic growth measurements pure insoluble graphite

Chemical Composition

OC - BC partitioning is independent of particle size; TC is correlated to volume distribution, chemo-sorbed sulphate is correlated to surface distribution; sulphate coverage corresponds to < 1 monolayer H₂SO₄

Airbus A 310 (1991)

Boeing B 737 (1987)

Airbus A 340 (1993)

PartEmis modern

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