Particle Emission from the Aircraft Engine Testing Cycles

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Emissions from aircraft engines and their potential influence on local and global environmental concerns have become the subject of intensive study by scientists. Environmental problems to be considered in relation to these emissions could include: climate change and local and regional air pollution due to volatile organic compounds (VOC) such as UHC, and particulate matter (PM) emissions. The particles emitted can affect in a local area to: public health, agriculture production and ecosystems, buildings and infrastructure.

The aircraft engines are tested in modern test bed, for the purpose of studying and developing new generation engines (higher power/efficiency ratios, and less contamination). One of the most advanced installations in the world for testing aircraft engines with a thrust of up to 140,000 pounds is the Turbojet Test Centre, TTC/INTA. In the tests performed in TTC emissions from engine are expelled through a duct (detuner) up to exit stack. Previously the hot gas from engine is mixed with air sucked from the test cell, resulting in a natural dilution.

During a series of aircraft engine tests carried out in TTC the PM emission to the atmosphere have been monitored. A particle sample was continuously extracted from stack and its concentration and size distribution were simultaneously measurement using a Scanning Mobility Particle Sizer (SMPS) and a Condensation Particle Counter (CPC), after 100:1 dilution by two ejector diluters.

The results showed that in the measurement point the variations in the properties of the particle sample were sensitive enough to the changes in engine power, so that the measures were able to reflect transients of the test cycle without time offset. It can be seen that particle concentration varies in a way opposite to the engine power applied, while particle size distribution mode, median or geometric mean increase with increasing power (figure 1).

Usually smoke number increases with higher engine power output (EPA, 1978), the same as the particle mass (Hagen, 2006; Herndon, 2006). However, the contrary effect has been found when measured away from engine exit (Miake-Lye, 2009). Some studies have reported a decrease in particle concentration with increasing engine power beyond the stage point of the engine (EASA, 2012).

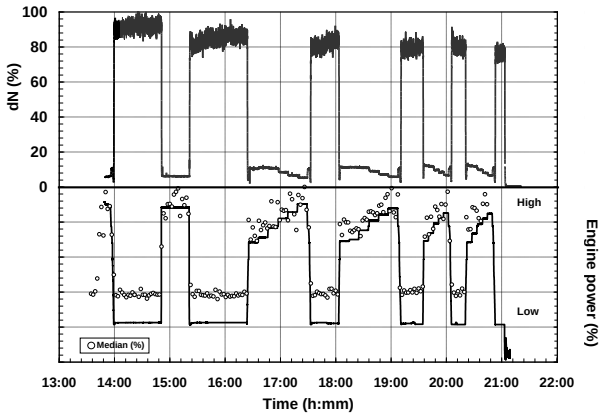

Figure1. Engine power, concentration and median diameter of particle vs. test time.

Regarding particle size distribution, it was found to be bimodal; modes of nuclei (20-30 nm) and accumulation (60-70 nm). The concentration of the nucleus mode was always higher than the accumulation one. When the engine power increased, the accumulation mode resulted to be dominant and nucleus were not significant, while if it decreased the main mode was the nucleus one, in agreement with other studies, (Whitefield, 2006; EASA, 2011; EASA, 2012; Lobo, 2011), in which smaller particles are found at lower engine power output, all of them measured in test beds and next to airport courses.

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