Combustion aerosol standard generator for aeronautic fuel

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The potential impact of aircraft emissions on climate and air quality has motivated the development of new engine technologies and fuel blends aiming at reducing these emissions. Nowadays there are different alternative fuels being tested in blends with traditional kerosene, like Fischer-Tropsch or Hydro-processed Esters and Fatty Acids (HEFA) fuels. Field test of different fuels using real engines of combustion chambers are technically demanding. In addition, the amount of fuel needed for these tests are sometimes limited and therefore limits in turn systematic studies on the impact of fuel composition on emitted particles. Such studies cover not only number and size distributions of the emitted particles, but also their complete physico-chemical characterization, and are particularly challenging.

Combustion standard aerosol generator (CAST, Jing 1999) was developed as a stable and controlled source of soot for calibration proposes. The standard CAST unit uses a confined propane flame to produce soot particles. By controlling the air/fuel ratio, different properties of soot like particle size, organic carbon content etc. can be controlled in a reproducible way. On the other hand this design was limited to gas fuels.

In 2003 a novel CAST unit capable of working with liquid fuels was developed (Jing 2003). This unit adds a nebulizer to produce liquid fuel droplets that are ignited by the existing propane flame. So far this unit has been tested with diesel fuel.

In 2012 JING Ltd. has developed another novel model of CAST for liquid fuel. In this work we present, up to our knowledge, the first tests of this liquid CAST unit made at ONERA with aeronautic JetA1 fuel.

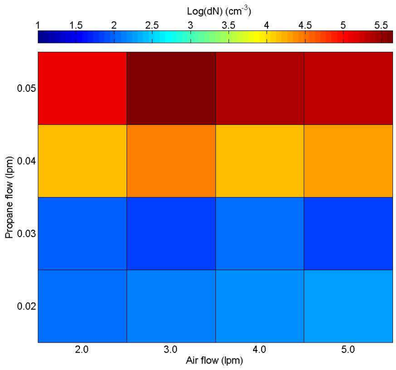

Figure 1. Impact of tested air and propane flows (without kerosene) in measured total particle number

As a first test, we studied different combinations of propane and air flows without adding kerosene. The aim of this preliminary test was to estimate the most favourable settings of air and propane to be used together with kerosene to avoid contributions from the propane flame to the soot particles formed. As can be seen in Fig. 1 flows of propane equal or below 0.03 lpm resulted in negligible amounts of particles formed independently of the air flow used. Based in this preliminary test, we chose 0.03 lpm of propane as standard setting for the experiments with kerosene.

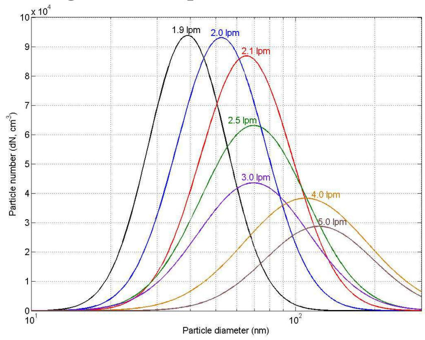

Figure 2. Different fitted size distributions obtained with a SMPS using 0.03 lpm propane flow, 60 mbar partial pressure nitrogen over jetA1 kerosene, 20 lpm of quenching flow and air flows between 1.9 and 5.0 lpm

As can be seen in Fig. 2 fixing 0.03 lpm of propane flow and 60 mbar partial pressure of nitrogen over kerosene, different particle number and size distribution can be obtained by adjusting air flow. Higher air flow produces less particles, but with larger sizes compared to low air flow settings. These first results show how liquid CAST unit using aeronautic fuel is a stable and controlled source of soot particles. Thus it can be used to study particle produced by a wide variety of aeronautic fuels, not limited only to standard kerosene blends, but also alternative fuels.

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Jing, L. (1999) *3rd ETH Workshop "Nanoparticle Measurement*", ETH Hönggerberg Zürich.

Jing, L. (2003) *7th ETH Conference on Nanoparticle Measurement,* ETH Hönggerberg Zürich.