Design and implementation of a mixture fraction diagnostic for aerosol-laden turbulent jets

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HIGHLIGHTS

• Design and analysis of a high-speed, spatially resolved mixture fraction diagnostic in flow laden with DBP vapor and particles
• Final design is a pointwise toluene LIF measurement using a 266 nm DPSS Nd:YAG laser at a 20 kHz repetition rate
• Fluorescence modeling and design analysis supporting the choice of toluene for an environment with potential interference from DBP vapor
• Description of design analysis of subsystems including a toluene vapor seeder and an absorption cell for monitoring concentration
• Preliminary measurements to be made in June, 2016 for presentation at the Lisbon Symposium

ABSTRACT

A facility has been built to study the aerosol formation processes in supersaturated jets using Phase-Doppler Interferometry (PDI). Experimental studies with this facility will investigate theories which propose a critical relationship between the local temperature and vapor concentration, properties which can be related to the local mixture fraction, and the aerosol density and growth rate. In order to be able to condition the PDI measurements on these local properties, a spatially and temporally resolved tracer-based laser-induced fluorescence diagnostic has been designed to measure the mixture fraction of fluid originating from the vapor laden jet. The diagnostic uses toluene vapor excitation at 266 nm to produce a fluorescence signal which is measured and related to a corresponding mixture fraction. This work presents a summary of the performance models and subsequent design analysis that has been used to finalize the design of the mixture fraction diagnostic. Preliminary measurements will be carried out in the summer of 2016.