Soot Volume Fraction Experimental Data
from
Ethylene-Hydrogen and LPG Nonpremixed Flames Stabilized on a Bluff Body Burner

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Summary

This document provides a brief description of the soot data collected from four bluff-body flames. Soot volume fraction was measured using the Laser-induced incandescence (LII) technique at various axial heights about the bluff-body. The bluff-body burner dimensions are: outer diameter (D_B)=50 mm and a concentric jet diameter (D_J)=3.6 mm. The face of the bluff-body burner has a heat-resistant ceramic coating. The burner was mounted within a wind tunnel with an exit cross section of 150 × 150 mm^2.

FLAME CONDITIONS

Soot volume fraction data are available for the following flame conditions:

Flame Type	Fuel (mole fraction)	Jet exit velocity (m/s)	Jet exit Reynolds Number (cold flow)	Heat output (kW)	Coflow Velocity (m/s)
Flame A	Ethylene: 1.000 Hydrogen: 0.000	74.2	30900	41.7	23
Flame B	Ethylene: 0.671 Hydrogen: 0.329	102.1	30800	41.9	23
Flame C	Ethylene: 0.487 Hydrogen: 0.513	130.7	30440	42.6	23
Flame D	LPG: 1.000	36.3	30474	32.0	23

Fuel Composition:
Ethylene – 99.0% purity
Hydrogen – 99.0% purity
LPG (molar)– 97.35% propane, 1.35% ethane, 1.20% butane, 0.07% nitrogen, and 0.03% carbon dioxide.

MEASUREMENT TECHNIQUE

Laser Induced Incandescence, LII:
A full description of the measurement technique has been presented in a previous publication Qamar et al. 2009. Briefly, the output of an Nd: YAG laser at 1064 nm was used for the LII excitation. The laser beam was shaped into a sheet with a vertical height of ~80 mm and a thickness of ~0.3 mm in the measurement region. The LII operating fluence was maintained at ~0.9 J/cm^2 throughout the experiment to ensure that the LII signal observed is independent of laser fluence variation.

The LII signal was detected through a 430 nm optical filter onto an intensified CCD (ICCD) camera. The gate width of the camera was set to ~40 ns and the timing was set to be prompt with respect to the LII excitation process. The LII signal was calibrated via laser beam extinction measurements.

N. H. Qamar, Z. T. Alwahabi, Q. N. Chan, G. J. Nathan, D. Roekaerts, K. D. King, Combustion and Flame 156 (2009) 1339–1347.

SUMMARY OF DATA AVAILABLE

The data contains radial profiles at different axial position above the burner exit z/D_J = 5 to 148. The following information can be derived readily from the radial profiles:

- Mean soot volume fraction
- Intermittency

Data sets download:
Flame_A_int.txt: The radial and axial intermittency profile for Flame A.
Flame_A_svf_ave.txt: The radial and axial averaged soot volume fraction profile for Flame A in *ppb*.
Flame_B_int.txt: The radial and axial intermittency profile for Flame B.
Flame_C_svf_ave.txt: The radial and axial averaged soot volume fraction profile for Flame B in *ppb*.
Flame_C_int.txt: The radial and axial intermittency profile for Flame C.
Flame_A_svf_ave.txt: The radial and axial averaged soot volume fraction profile for Flame C in *ppb*.
Flame_D_int.txt: The radial and axial intermittency profile for Flame D.
Flame_D_svf_ave.txt: The radial and axial averaged soot volume fraction profile for Flame D in *ppb*.
The values in the first column of the text files correspond to the axial distances from the burner face normalized with the jet diameter D_J (3.6mm).
The values in the first row of the text files correspond to the radial distances of the data from the jet centreline, normalized with respect to D_J.

CITING THE DATA:

[1] S. Deng, M.E. Mueller, Q.N. Chan, N.H. Qamar, B.B. Dally, Z.T. Alwahabi, G.J. Nathan, "Hydrodynamic and chemical effects of hydrogen addition on soot evolution in turbulent nonpremixed bluff body ethylene flames", Proceedings of the Combustion Institute 36 (2017) 807-814

[2] M.E. Mueller, Q.N. Chan, N.H. Qamar B.B. Dally, H. Pitsch, Z.T. Alwahabi, G.J. Nathan, "Experimental and computational study of soot evolution in a turbulent nonpremixed bluff body ethylene flame", Combustion and Flame, Volume 160, Issue 7, July 2013, Pages 1298-1309