<u>Sooting Flames # 2</u>

These flames have been investigated by two groups.

Apparatus

The flames were produced by a 60 mm diameter water-cooled porous-plate laminar premixed flat-flame burner at atmospheric pressure (McKenna model). The reactant mixture at the burner exit was surrounded by an annular nitrogen flow to eliminate peripheral diffusion. The burner was cooled using water at room temperature with a flow rate sufficiently high. The flame was stabilized using a 125 mm diameter circular aluminum plate with a 30 mm hole in the center that was mounted 32 mm above the burner surface.

Measurements

Stream-wise velocities were measured along the flame axes using laser velocimetry (LV).

Temperatures were measured through 3 different techniques, namely

- within the soot-containing regions of the flame using multiline emission measurements (effectively 2-color pyrometry measurements) [Ref 1]. See notes below.
- using a spectral line reversal technique (769.9 nm emission line of potassium). In regions where substantial absorption of the radiation by soot particles was observed, temperature was determined using two-color pyrometry [Ref 2]

Concentrations of major gas species were measured by isokinetic sampling and gas chromatography [Ref 1]. Experimental uncertainties were less than 15% for mole fractions greater than 0.5%. The CH* Chemiluminescence profiles in the flame were determined also.

Soot volume fractions were measured using 3 different techniques, namely

- Laser-extinction measurements at 632.8 nm. Refractive indices from Dalzell and Sarofim. [Ref 1]
- Isokinetic sampling from the flames followed by measurement of the gas and soot volumes in the samples (gravimetric method with an assumed soot density of ρ=1850 kg/m^3). [Ref 1]
- Laser-extinction measurements at 524.5 nm. Refractive indices from Dalzell and Sarofim. [Ref 2]

Soot primary particle diameters were by analysis of TEM (thermophoretic sampling).

Conditions

Pressure: 1 atm
Cold gas velocity (at 1atm and 298K): 6.73 cm/s

ϕ=2.34 (C/O=0.78) – Fuel: 14.08 % - O2: 18.05 % - N2: 67.87 %

- Temperature profiles
- Velocity profiles
- Species profiles (CO, CO2, H2O, C2H4, C2H2, CH4, H2, CH*)

- Soot volume fraction
- Primary particle diameter

ϕ=2.64 (C/O=0.88) – Fuel: 15.60 % - O_2: 17.73 % - N_2: 66.67 %

- Temperature profiles
- Velocity profiles
- Species profiles (CO, CO_2, H_2O, C_2H_4, C_2H_2, CH_4, H_2, CH^*)
- Soot volume fraction
- Primary particle diameter

ϕ=2.94 (C/O=0.98) – Fuel: 17.0 % - O_2: 17.4 % - N_2: 65.6 %

- Velocity profiles
- Species profiles (CO, CO_2, H_2O, C_2H_4, C_2H_2, CH_4, H_2)
- Soot volume fraction
- Primary particle diameter

Notes

The temperatures measured by Xu & Faeth are larger than the adiabatic flame temperatures (by 200 or 300K) and should not be used.

The velocity measurements in Ref 1 suggest possible buoyancy and 2D effects.

References

1. F. Xu, P.B. Sunderland, G.M. Faeth, Combust. Flame 108 (1997) 471–493.
2. A.V. Menon, S.-Y. Lee, M.J. Linevsky, T.A. Litzinger, R.J. Santoro , Proc. Comb. Inst. 31 (2007) 593-601.