# Delft Adelaide Flame

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This work was undertaken at the Turbulent, Energy and Combustion (TEC) laboratory at the University of Adelaide.

## ABSTRACT

The aim of the document is to provide a brief description of data base of the piloted natural gas flame. Laser-induced incandescence (LII) soot volume fraction measurements have been performed.

The burner used in this study is described in detail by Peeters *et al.* [1]. It consists of a round fuel tube of 6 mm inner diameter, *d*, surrounded by an annular tube of ID and OD of 15 mm and 45 mm, respectively, through which primary air is supplied. The pilot flames are positioned at the rim between the central pipe and the air annulus. The experiment was performed with inlet conditions similar to ‘‘Flame III”. Following Nooren *et al.* [2], Dutch natural gas was simulated on a molar basis by diluting Adelaide natural gas with nitrogen at a ratio of 0.15 moles of nitrogen with every mole of Adelaide natural gas. The compositions of the fuel are shown in the later section. The fuel jet velocity was 21.9 m/s (Re = 9700) and the primary air velocity was 4.4 m/s (Re = 8800). The pilot flames were fed with a premixed mixture of hydrogen, acetylene and air at an equivalence ratio of 1.7. The heat released from the pilot flames was less than 1% of the total thermal power of the flame.

## FLAME CONDITIONS

The composition of the Adelaide natural Gas in mole percentage:

| *Component* | *Mole percentage* |
|---|---|
| $CH_4$ | 79.89 |
| $C_2H_6$ | 3.72 |
| $C_3H_8$ | 0.17 |
| $C_4H_{10}$ | 0.02 |
| $C_5H_{12}$ | 0.01 |
| $C_6H_{14}$ | 0.01 |
| $N_2$ | 13.97 |
| $O_2$ | 0.00 |
| $CO_2$ | 2.22 |

## MEASUREMENT TECHNIQUE

LII:
A full description of the measurement technique has been presented in a previous publication. [3].

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.

**AVAILABILITY OF DATA**

Please contact Shaun Chan (Email: qing.chan@unsw.edu.au) or Gus Nathan (Email: graham.nathan@adelaide.edu.au) for more information.

**SUMMARY OF DATA AVAILABLE**

We have the radial profiles from 46 to 144 *d*. The following information can be derived readily from the radial profiles:

- Mean soot volume fraction
- Intermittency

The figures in the previous publication [3] are available upon request.

Data sets download:

Text files (best viewed using Excel):
int.txt: The radial and axial intermittency profile for the flame.
svf_ave.txt: The radial and axial averaged soot volume fraction profile for the flame in ppb.

PDF files:
conc-int.pdf: 2-dimensional distribution of the soot intermittency value within flame.
conc-svf-inst.pdf: Selective collage of unrelated, instantaneous images of soot volume fraction within flame.
conc-svf-ave.pdf: 2-dimensional distribution of averaged soot volume fraction within flame.
total_soot_volume.pdf: Total soot volume per unit height of the flame obtained from the radial integration of the averaged soot volume fraction at each height.

The values in the first column of the text files correspond to the axial distances of the data from the burner face. The values in the first row of the text files correspond to the radial distances of the data from the jet centreline. These values are normalized with respect to *d*.

**REFERENCES**

[1] T.W.J. Peeters, P.P.J. Stroomer, J.E. de Vries, D.J.E.M. Roekaerts, C.J. Hoogendoorn, Proceedings of the Combustion Institute 25 (1994) 1241–1248.

[2] P.A. Nooren, M. Versluis, T.H. van der Meer, R.S. Barlow, J.H. Frank, Applied Physics B 71 (2000) 95–111.

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