Fast gas analysis traversing a methane flame

It is important to determine the origin of gaseous emissions within burner flames to optimise nozzle design (e.g. for gaseous or pulverised coal burners). This was investigated by traversing a sample probe through the centre-line of a methane flame using fast continuous mechanical actuation of 200 mm.s^{-1}. The methane flame was generated by a simple Bunsen burner running lean at $\lambda = 1.3$. The sample probe utilised an external vacuum pump to transport gas from the flame to a manifold, from where the Cambustion fast gas analysers were connected, as shown in Figure 1.

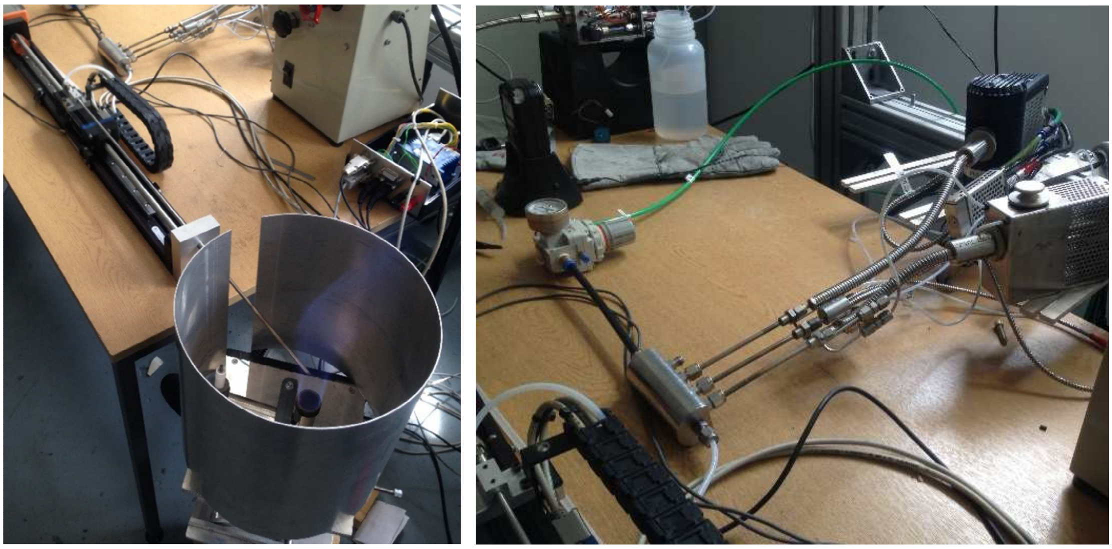
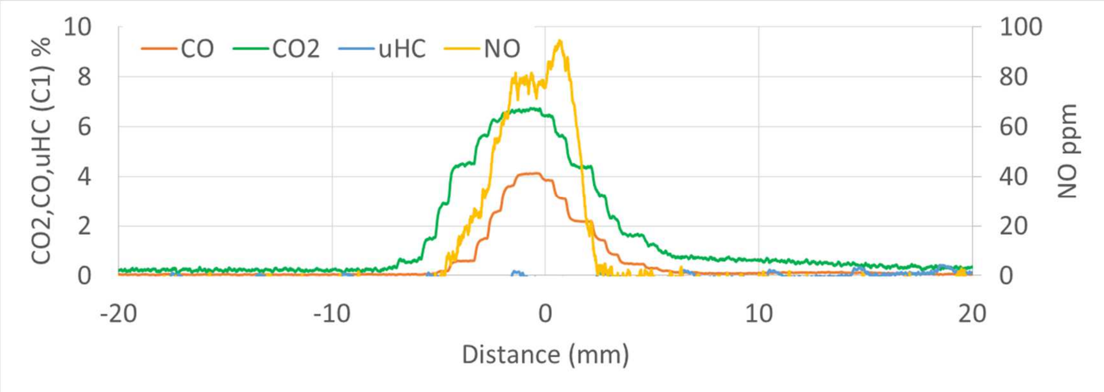
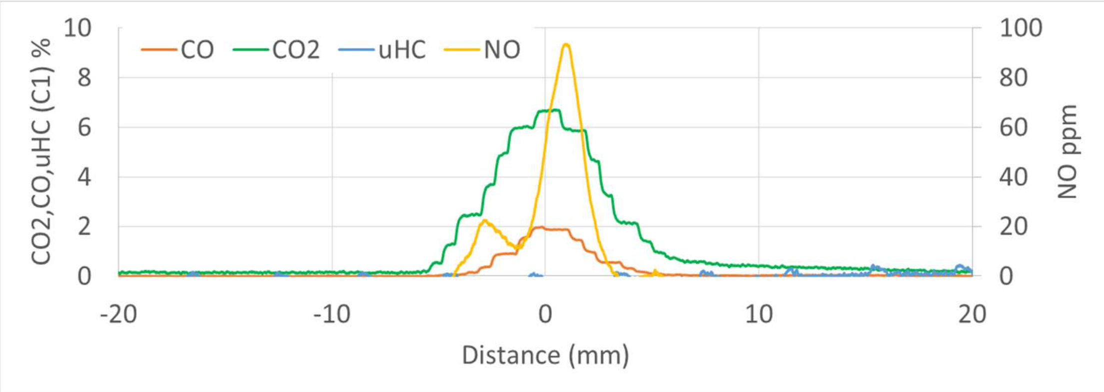


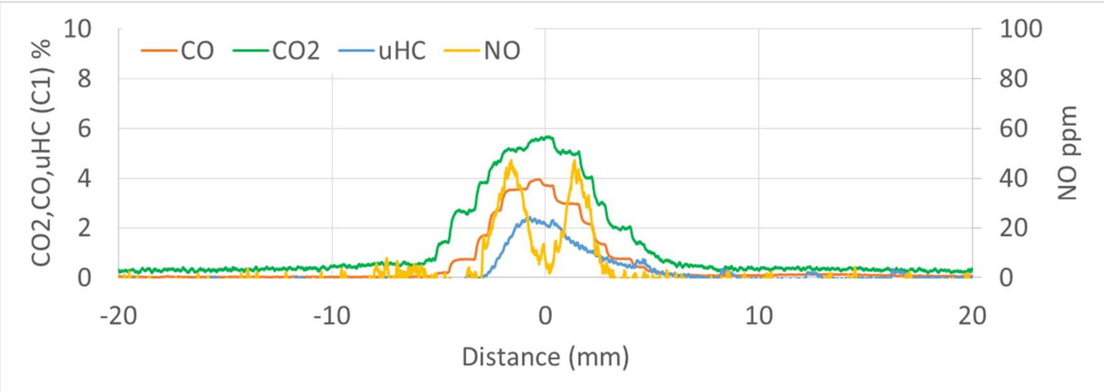
Figure 1: Experimental set up of methane flame with traversing sample probe.

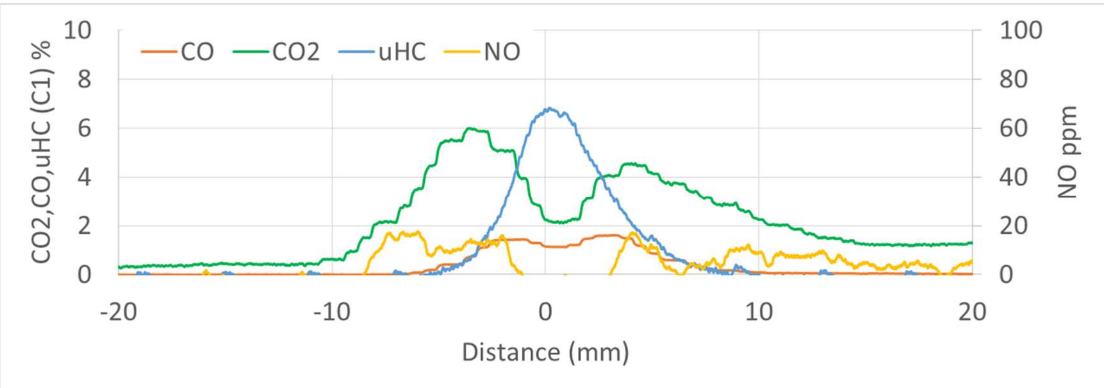
The fast CLD500 was used to detect NO concentration [ppm], the fast HFR500 FID was used to detect unburned HC [%], and the fast NDIR500 to used measure CO [%] and CO_2 concentrations [%].

The following plots present the spatial variation of emissions as the methane flame is traversed at four different vertical positions through the flame (uppermost plot being nearest the top of the flame).









It can be observed that a significant portion of the NO emissions originated from the highest vertical position through the flame approximately evenly distributed around the centre-line. This was attributed to an increased flame temperature at this point (although not measured within this study).

Unburned HC are only detected in the lower two traverses of the flame, prior to their consumption further up the flame.

A video of the flame, the traverse and sampling arrangement can be viewed at:

https://www.youtube.com/watch?v=jyaLT1j5mnQ