DEVELOPMENT OF INNOVATIVE MEASUREMENT SYSTEM FOR GAS SAMPLING AND IN-FLAME ANALYSIS (CO, CO_2, NITROGEN SPECIES, HYDROCARBONS)

G. Coraggio[1], M. Faleni[1], L. Tognotti[1,2], M. Gamba[3], F. Botteghi[3], S. Armani[3]
giovanni.coraggio@ifrf.net
[1] International Flame Research Foundation, Via Salvatore Orlando 5, 57127, Livorno, Italy
[2] Dipartimento di Ingegneria Civile e Industriale, Università di Pisa, Largo L. Lazzarino 2, Pisa, Italy
[3] Gamba & Botteghi, Via Spagna, 38, 57010, Guasticce, Italy

One of the main activities in IFRF is probe development. The first goal is to obtain accurate measurement results in new combustion conditions such as oxy-fuel combustion. The second goal is to enhance the actual measurement capabilities of the probes in order to be able to measure more chemical quantities, such as nitrogen species at low concentrations. They are essential for the study of the NO_X production (NH_3, HCN) and provide more accurate data for kinetic sub-model validation purposes.

A prototype probe was designed with a quartz tip, to avoid reactions within the hot sampling duct. In addition, there are several thermocouples in the sampling duct to monitor the rapid cooling of the sampled gas down below 300°C. The sampled gas temperature is kept above 150°C to avoid water condensation.

The probe is connected to a FTIR (Fourier Transform Infrared Spectroscopy) analyser, manufactured by the Finnish company Gasmet, and adapted to IFRF needs. The FTIR is coupled with a paramagnetic O_2 analyser manufactured by the Italian company Orion following the global design of the system made by Gamba & Botteghi.

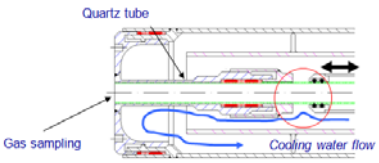

Fig. 1 Tip of the quartz probe with adjustable cooling section

The key advantages of FTIR spectroscopy include multicomponent analysis capability, good sensitivity and excellent specificity.

This system is able to provide real time concentration data in the sampled gas of the following components O_2, CO_2, H_2O, CO, N_2O, NO, NO_2, SO_2, NH_3, HCN. All these quantities are measured with a relative error within 5% if the system is used in flue gas, where relatively constant ranges of component concentration are present. Some problems arise when the sampling is carried out in a flame, where the presence of interferent species does not allow using the spectra database defined for flue gas measurements.

System development focused on sampling methods including sampled gas dilution and spectral analysis. The latter included the creation of new spectra libraries for calibration to allow in flame measurement of species including fuel partial oxidation species. The results of several tests, from a 40 KW burner of a drop tube furnace (IPFR), to 3 MW low NO_X burners in semi-industrial furnaces, are presented.

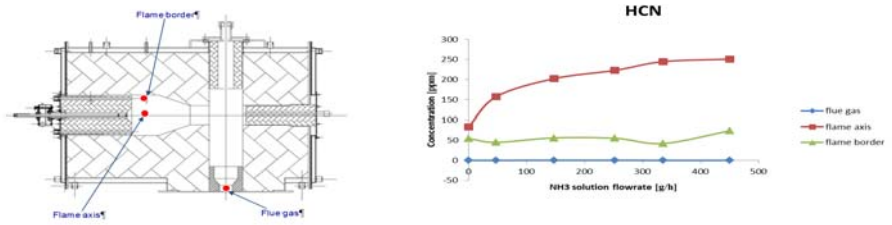

Fig. 2 HCN concentration profiles in IPFR precombustor

10.4405/profic2014.B5