Measurement of CO\textsubscript{2} and H\textsubscript{2}O concentration by laser Induced plasma fluorescence
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ABSTRACT

Since absorption bands of H\textsubscript{2}O and CO\textsubscript{2} do not exist within commercially available laser wavelength, conventional laser induced fluorescence technique could not be applied for the concentration measurements. In the present paper, nonintrusive techniques for H\textsubscript{2}O and CO\textsubscript{2} concentration measurements have been developed using a laser induced plasma fluorescence. It is based on the gas breakdown phenomena, which originates from the multiphoton ionization (MPI) and the absorption of laser radiation by electrons that gained sufficient energy to ionize the gas. This technique is verified experimentally varying gas concentrations of H\textsubscript{2}O and CO\textsubscript{2} at atmospheric pressure condition. In Fig. 1, the fluorescence emission spectrum of H\textsubscript{2}O\textsuperscript{+} is presented in the wave region of 662-688 nm, varying the H\textsubscript{2}O volumetric concentration 0 to 42%. As water vapor concentration increase the fluorescence intensity on 668.6 nm band tends to increase. In Fig. 2, the relative fluorescence emission spectrum of CO\textsubscript{2}\textsuperscript{+} of 412.08 nm and 415.95 nm bands are shown varying CO\textsubscript{2} volumetric concentration, 0 to 100 %. The fluorescence of 412.08nm and 415.95nm bands linearly increases with increase of CO\textsubscript{2} concentration, whose characteristics is different from H\textsubscript{2}O. The effect of laser beam energy on the fluorescence intensities has also been made clear. It has been demonstrated in this study that although gas breakdown is a complicated phenomena, ND:YAG laser intensity approximately over 350 mJ would induce fluorescence of ionized gas molecules, H\textsubscript{2}O\textsuperscript{+} and CO\textsubscript{2}\textsuperscript{+}, which could be applied for the measurement of H\textsubscript{2}O and CO\textsubscript{2} concentrations, respectively. The present method has demonstrated its validity at atmospheric pressure condition which is encountered in many thermo-fluid facilities.

![Fig. 1. Effect of H\textsubscript{2}O concentration on the 668.6 nm H\textsubscript{2}O\textsuperscript{+} fluorescence spectrum](image1)

![Fig. 4. Effect of CO\textsubscript{2} concentration on the 412.08 nm and 415.95 nm CO\textsubscript{2}\textsuperscript{+} fluorescence spectrum](image2)