Paper 12.4

Measurement of CO_2 and H_2O concentration by laser Induced plasma fluorescence

by

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ABSTRACT

Since absorption bands of H_2O and CO_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_2O and CO_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_2O and CO_2 at atmospheric pressure condition. In Fig. 1, the fluorescence emission spectrum of H_2O^+ is presented in the wave region of 662-688 nm, varying the H_2O 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_2^+ of 412.08 nm and 415.95 nm bands are shown varying CO_2 volumetric concentration, 0 to 100 %. The fluorescence of 412.08nm and 415.95nm bands linearly inereases with increase of CO_2 concentration, whose characteristics is different from H_2O. 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_2O^+ and CO_2^+, which could be applied for the measurement of H_2O and CO_2 concentrations, respectively. The present method has demonstrated its validity at atmospheric pressure condition which is encountered in many thermo-fluid facilities.

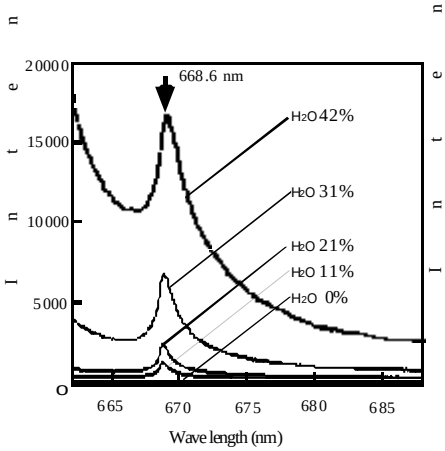

Fig. 1. Effect of H_2O concentration on the 668.6 nm H_2O^+ fluorescence spectrum

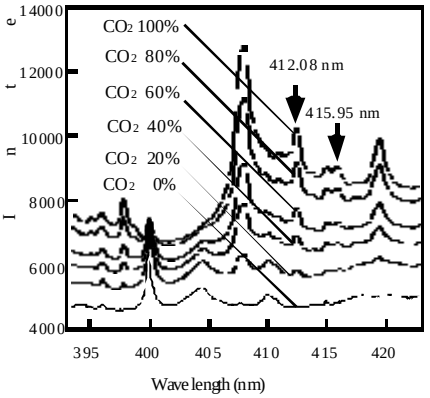

Fig. 4. Effect of CO_2 concentration on the 412.08 nm and 415.95 nm CO_2^+ fluorescence spectrum