APPLICATION OF PLANAR LASER-INDUCED FLUORESCENCE FOR THERMOMETRY IN SWIRL COMBUSTION CHAMBER

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Abstract: The paper presents the results of testing a method of temperature distribution measurements based on planar laser-induced fluorescence (PLIF) of a hydroxyl radical (OH) using excitation of $A^2\Sigma^+ - X^2\Pi$ (1–0) band. Thermometry is based on the ratio of the fluorescence intensity for (2–0) and (0–0) and (1–1) bands. For the most common excitation lines $Q_2(7)$, $Q_1(8)$, $R_1(14)$, and $P_1(2)$, numerical simulation of fluorescence spectra was performed using the LASKIN software. It was shown that the maximum temperature sensitivity is achieved for $Q_1(8)$ transition. It was found that quenching of fluorescence has a minor effect on the accuracy of temperature measurement. In the present work, a measurement procedure for a laminar premixed flame and turbulent premixed swirling flame in a model combustion chamber was experimentally developed. It was shown that this technique is effective for detecting high-temperature regions in turbulent flames. However, the combination of this approach with particle image velocimetry (PIV) requires the use of a more efficient optical filter to separate the weak fluorescence intensity of the (2–0) band transition and the radiation scattered by particles.

Keywords: planar laser-induced fluorescence; planar thermometry; OH fluorescence

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Figure Captions

Figure 1 Sketch of experimental setup and equipment

Figure 2 Photographs of the laminar conical flame (*a*) and turbulent premixed swirling flame (*b*)

Figure 3 Time-integrated OH fluorescence spectra excited by $Q_1(8)$ transition of (1–0) band for different temperatures: (*a*) $T = 2000$ K; and (*b*) $T = 1600$ K

Figure 4 Ratios between fluorescence intensity for spectral ranges 260–270 nm (I_1) and 300–320 nm (I_2) for different transitions depending on temperature: *1* — $R_1(14)$; *2* — $P_1(2)$; *3* — $Q_1(8)$; and *4* — $Q_2(7)$. The symbols demonstrate the effect of oxygen concentration for the $Q_1(8)$ transition at different fuel-to-air equivalence ratios: *5* — $\Phi = 0.6$; *6* — 0.8; and *7* — $\Phi = 1$

Figure 5 PLIF images I_1 (*a*) and I_2 (*b*) for laminar premixed flame

Figure 6 Temperature field obtained after calibration

Figure 7 PLIF images I_1 (*a*) and I_2 (*b*) (no smoothing) for turbulent swirling flame in a combustion chamber without PIV tracers

Figure 8 Temperature field without PIV tracers

Figure 9 PLIF images I_1 (*a*) and I_2 (*b*) for a turbulent swirling flame in a combustion chamber with PIV tracers

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