PIV measurements of the local burning velocity in laminar Bunsen flames of methane-air mixtures

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Bunsen flame is a classical example of an axisymmetric concave flame configuration where the increase of local burning velocity by flame compression (negative stretch) is shown, noticeably at the flame tip. At any point the flame is curved and strained, and each effect contributes separately to the strain rate of the flame area which changes the local burning velocity with respect to the burning velocity of a planar flame. By assuming that both contributions are linear, the reactive mixture is characterized by the two proportionality factors, which are known as Markstein lengths. In quasi planar configurations, the Markstein lengths are equal and the two effects add up into a single term: the so-called flame stretch. Markstein lengths can be determined experimentally by simultaneously measuring the curvature of the flame, the strain rate of the flow and the local burning velocity of the flame. To achieve this goal, we have set up a laminar jet burner and used a PIV system to measure the gas flow velocity in the vertical cross-section through the axis of methane - air Bunsen flames. The PIV system is composed by a double Nd:YAG pulse laser (New Wave 120XT) with a sheet forming emission optics, a double-shuttered camera (PCO, 13921040 pixels) and a pulse generator (ILA). To track the flow, the air is seeded with oil droplets formed by evaporation - condensation in a seeding chamber inserted in the air line. The laser sheet allows the visualization of the oil droplets before they evaporate in the flame preheating region, which permits the determination of the upstream gas flow velocity with the ViDPIV cross-correlation software. Even more, the long exposure picture of each PIV couple allows to receive enough flame radiation, in the laser wavelength that goes through the filter of the camera, to visualize the reactive front position and measure the local front curvature.