The Visualization and Acoustics of a Laminar Premixed Impinging Flame

by
E.C. Fernandes[(1)] and R.E. Leandro[(2)]

Laboratory of Thermofluids, Combustion and Energy Systems
The Center for Innovation, Technology and Policy Research, IN+
Instituto Superior Técnico
Av. Rovisco Pais, 1049-001 Lisbon, Portugal
(1) ecfernandes@dem.ist.utl.pt
(2) robert.leandro@dem.ist.utl.pt

ABSTRACT

The present experimental work characterizes the general behavior of premixed laminar disc flame impinging onto a plate with controlled temperature. The experimental techniques used were microphones, high-speed digital cinematography, chemiluminiscence, planar laser visualization and LDV.
The disc flame unsteadiness, driven by vortex shedding, is found to oscillate periodically with frequency and Sound Pressure Level increasing with Re and inverse of nozzle-to-plate distance. A mathematical model of the combined system (flame and burner) showed that the oscillations frequency are a function of the burner acoustic characteristics (damping factor), and the time taken by a perturbation to travel from the burner mouth to the flame tip close to the impinging plate. The predicted frequency, obtained with this model, fits the experimental data suggesting the validity of the mathematical modeling, empirical formulation and used assumptions.

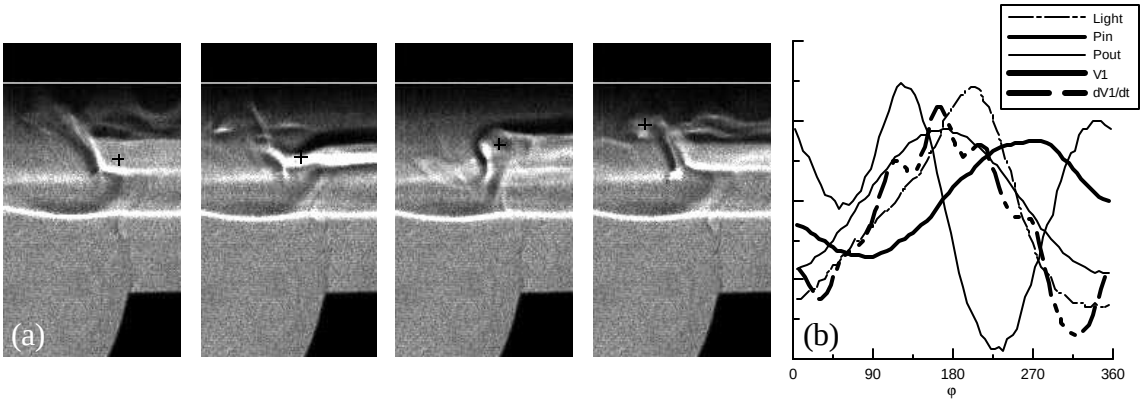

Fig. 1 (a) Laser visualization of a resonant impinging disc flame, where flame/ vortex interaction is visible. (b) Typical periodic evolution of the flame's light emission, pressure inside the burner, pressure outside the burner, velocity at the burner exit and its respective time derivative.