# Influence of a DC electric field on the stability of a diffusion flame

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When applying an electric field to a flame, ion and electron collisions with neutral gas molecules influence flame shape, combustion intensity, structure, burning velocity or production of soot. We are interested by the effect of DC electric field on flame instability mechanisms. Experimental setup consists of a coflow burner with central methane jet (3.6 mm ID) with a fixed 4.5 $cm^3$/s flowrate and annular air jet (10 mm ID) with flowrate varying from 0 to 46 $cm^3$/s. A DC power supply used as an electrical source is connected to a metal grid placed at 140 mm above the burner rim ground connected. Flame front images are obtained through CH* emission recorded by a Pimax2 ICCD camera equipped with a narrowband filter (430 nm ± 20 nm FWHM). Series of 300 images (354*1018 pixels, gain 200 and exposure time 5 ms) with a scale of 0.08 mm/pixel are used to define an averaged flame length.

Without applying a DC electric field, the flame is attached to the burner rim without air coflow and is lifted with air coflow; flame position from the burner rim increasing with the air exit velocity. A flickering instability which is characterized by an oscillation of the tip of the flame at a frequency between 10 Hz and 20 Hz is always present with and without air coflow.

When a DC electric field is applied results show that without air coflow, the flame becomes stable for a voltage between 2 and 6 kV. Above 6 kV, another type of instability different from the flickering one is observed. With air coflow the flame is lifted. When a DC electric field is applied, the lift height decreases until the flame reattached to the burner. Flame reattaches at 3 kV for 33 $cm^3$/s air flowrate and 7.4 kV for 46 $cm^3$/s air flowrate. Flame Instability is observed beyond 9 kV for 33 $cm^3$/s air flowrate and 10 kV for 46 $cm^3$/s air flowrate. These observations are confirmed by the measurement of the amplitude variation of the average flame length and of the flame CH* luminosity versus the electric field strength.

Application of an electric field modifies the flame stability: without air coflow flickering instability disappears until a voltage value that generates instability due to the applied electric field. In the presence of air coflow, the electric field reattaches to the initially lifted flame to the burner and produces flame instability. All these effects could be explained by the ionic wind which originates from repeated collisions between ions and neutral gas molecules and interacts with inertia and buoyancy phenomena developing in air along the flame. Measuring the current as a function of the voltage will help better understand the effect of the electric field on the ions motion and its influence on the flame.

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