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Effects of CO₂-H₂O dilution on the characteristics of CH₄-air-O₂ flames

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Context and objectives
- Study of non-premixed turbulent flames stabilized by a swirler
  - Control of pollutant emissions / emissions standards
  - Improve performances of combustion plants
- Investigations on flame characteristics
  - Effects of oxygen enrichment
  - Effects of steam and CO₂ dilution
  - Effects of swirl intensity

The numerical computations were conducted with COSILAB software
- Freely propagating methane-air flames.
- One-dimensional premixed flame.
- GRI-mech 3.0 mechanism.
- Atmospheric pressure and 300K.
- Equivalence ratio : from 0.8 to 1.2
- Oxygen enrichment : from 21% to 30%vol.
- Dilution : (0-20%vol) for both CO₂ and H₂O.

- With O₂ : notable increase in flame temperature and laminar burning velocity.
- With dilution: significant decrease in laminar burning velocity, the effect of CO₂ is greatest.

Experimental study
- OH⁺ chemiluminescence
  OH⁺ intensity distributions of methane/air swirling flames diluted by CO₂, H₂O and EGR, in the case of 21% O₂ for S_n=0.8 and φ=0.8.
  - The flame becomes taller and unsettled with dilution.
  - CO₂ has greater effect on the flame lift-off heights.

- Laser Doppler Anemometry
  Axial velocity and RMS profiles at z=30mm with & without CO₂ and water vapor dilution for S_n=1.4 and φ=0.8.
  - With CO₂ and H₂O dilution, the maximum velocity is higher and the flow is narrower.
  - Root Mean Squares are higher in the case of dilution.

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