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Numerical analysis of characteristics of biogas and syngas combustion

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RenewValue Project
- European project: ERANETMED2-72-169
  - RQ2: Energy and Environment Collaborative Innovation Project - Mobility
- Subject: Local sustainable renewable energy supply for vulnerable communities in arid and semi-arid Mediterranean zones (MENA)
- Partners: ICARE CNRS (France), Université Rostock, DBFZ (Germany), Ibn Tofail University (Morocco), INSAT and ENIT (Tunisia), Politecnico di Torino (Italy)
- Duration: 3 years (2018-2021)

ICARE tasks and objective of the study
- Development of modular adapted energy concept
  - Gasifier - multi-fuel burner - boiler
- Characterization of syngas and biogas flames
  - Experimentally: stability, pollutant emissions, temperature
  - Numerically: Calculations of laminar burning velocity, flame temperature, pollutants (NOx, CO)...
- This poster: some results of calculations

Combustion characteristics _ calculations
- Laminar flame velocities ($S_l$)
- Flame temperatures ($T_i$)
- Chemical species distributions
- Pollutant emissions (NO, CO...)
- Pathways of chemical reactions

Case of CH₄-air flame
- Laminar burning velocity with equivalence ratio: CH₄-air, at 298 K, 1 bar
- Laminar burning velocity with initial temperature and pressure : CH₄-air, 1 bar, $\Phi=1$

Biogas flame calculations
- Flame velocity with equivalence ratio: CH₄-CO₂ (90/10 and 80/20%)

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Laminar burning velocity of CO-H₂-air flames: 90/10% and 50/50 % CO-H₂

Syngas flame calculations
- Results are validated, with 4 mechanisms of chemical reactions
- $S_i \uparrow$ with $T_i$ : $\Rightarrow$ Heating of gas intake induces a better combustion
- $S_i \downarrow$ with $P_i$

Results compared and validated with experimental results
- With $+$H₂: $S_i$ max at $\Phi = 2.5$ (CH₄-air; at $\Phi = 1.05$)
- $+$H₂: $S_i \downarrow$ ; $S_{\text{flame}}$: 190 at 50% of H₂, 90 at 50%H₂ against 38 cm.s⁻¹ CH₄-air
- $+$H₂: higher reactivity, higher flammability limits, higher velocity, higher T

Temperature, NOx and CO emissions of CH₄-CO₂-air flames with CO₂
- Flame temperature decreases with CO₂ addition
- NOx $\downarrow$ with CO₂
- CO $\downarrow$ with CO₂
  $\Rightarrow$ It is necessary to find a good balance to meet the standards

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