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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), Universität Rostock, DBFZ (Germany), Ibn Tolui 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 ($T_f$)
- Chemical species distributions
- Pollutant emissions (NO, CO...)
- Pathways of chemical reactions

For different parameters: $T$, $P$, $X_i$, $\phi$
- With different mechanisms of reactions

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

- Results validated by experiments from the literature
- Laminar burning velocity ($S_l$) decreases with CO₂ addition

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

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

- Results are compared and validated with experimental results
- With $+H_2$; $S_l$ max at $\Phi = 2.5$ (CH₄-air; at $\Phi = 1.05$)
- $+H_2 \Leftrightarrow S_l \Leftrightarrow$; $S_{max}$: 190 at 50% of $H_2$, 90 at 50%$H_2$ against 38 cm$^3$ s$^{-1}$ CH₄-air
- $+H_2$: higher reactivity, higher flammability limits, higher velocity, higher T

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