Flame-wall Interactions Influence On Thermoelectric Power Generation

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Motivation

- Electric power need is increasing.
- No connection to the electric grid in poor and remote areas.
- Need to reduce greenhouse gas emissions.
- Improve efficiency of combustion process.
- Use of biogas/H_2.
- Small scale/portable systems.

Experimental Section

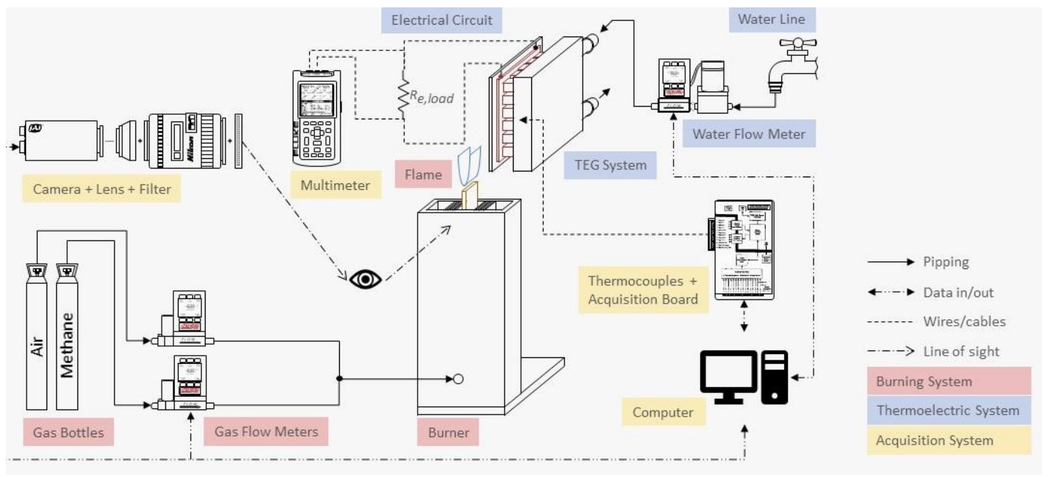


Figure 1: Schematic view of the experimental setup.

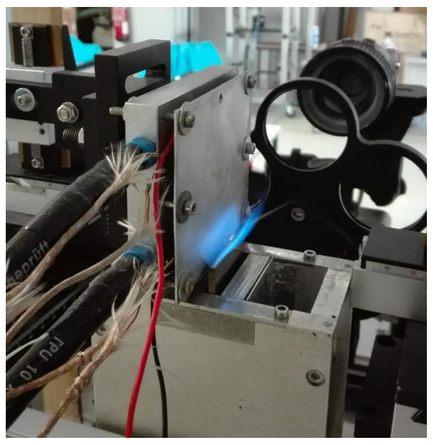
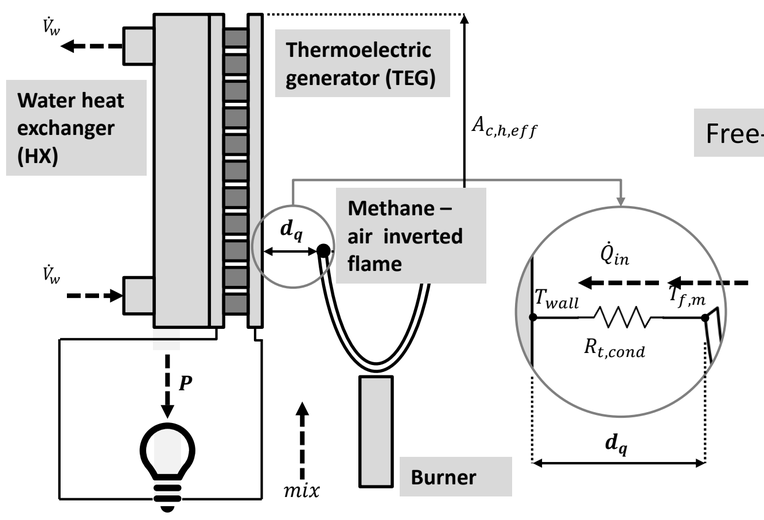


Figure 2: Photo of the experimental setup.

- ***Gas***: Methane
- ***Wall material***:
  Aluminium ($\kappa = 237\ Wm^{-1}K^{-1}$)
  Stainless Steel ($\kappa = 60.5\ Wm^{-1}K^{-1}$
- ***TEG***: European Thermodynamics Ltd
  model GM250-49-45-30 (P_{max}= 7.5 W)

Mathematical Model



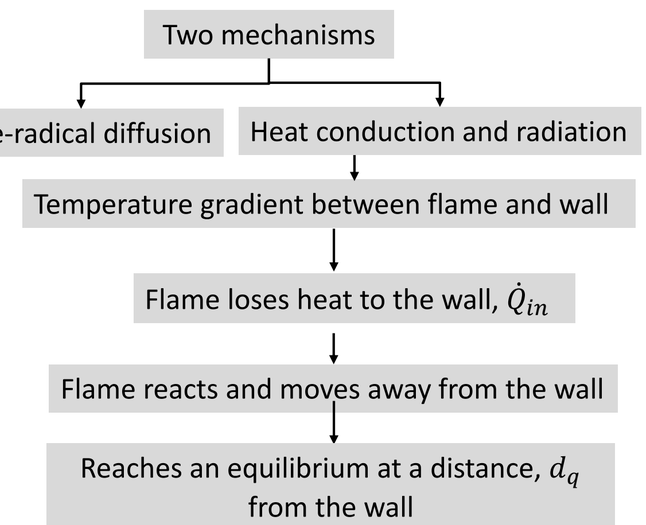


Figure 3: Schematic view of the interface.

$$d_q = \frac{A_{c,s,eff}\kappa_{mix}}{\dot{Q}_{in}}(T_{f,m} - T_{wall})$$

$$T_{wall} = \bar{T}_h + \frac{\dot{Q}_{in}}{A_{c,s,eff}}\left(\frac{t_{wall}}{\kappa_{wall}} + \frac{t_{tc}}{\kappa_{tc}}\right) = \bar{T}_h + \dot{Q}_{in}R_{t,wall}$$

$$P = \dot{Q}_{in} - \dot{Q}_{out}$$

$$\dot{Q}_{in} = \frac{T_{f,m} - \bar{T}_h}{\frac{t_{wall}}{k_{wall}A_{c,h,eff}} + \frac{d_q}{k_{mix}A_{c,h,eff}} + \frac{t_{tg}}{k_{tg}A_{c,h,eff}}}$$

$$P(d_q) = \frac{T_{f,m} - \bar{T}_h}{\frac{t_{wall}}{k_{wall}A_{c,h,eff}} + \frac{d_q}{k_{mix}A_{c,h,eff}} + \frac{t_{tg}}{k_{tg}A_{c,h,eff}}} - \dot{Q}_{out}$$

$$P(d_q) \approx \frac{C_1 k_{wall}}{C_2 + C_3 + d_q k_{wall}} - C_4 \longrightarrow P(d_q) \propto \frac{1}{d_q}$$

Outlook

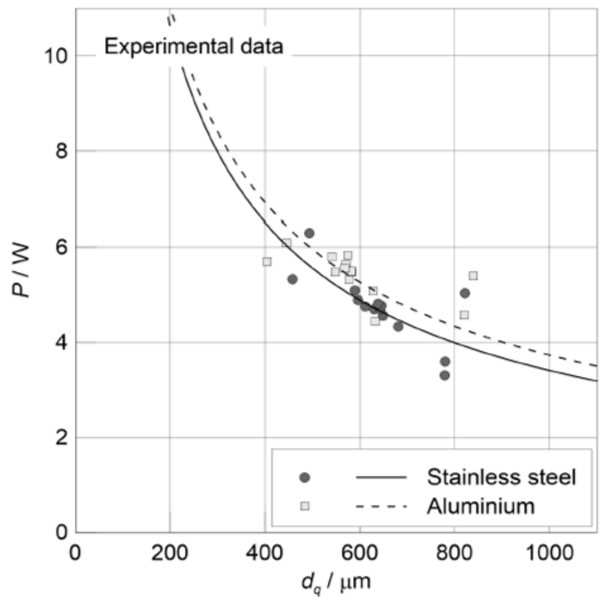


Figure 4: Electrical power generated P relation with quenching distance d_q.

- To obtain maximum electrical power generation P the quenching distance d_q should be reduced

$$P_{SS}(d_q) = \frac{450}{d_q^{0,707}} \qquad P_{Al}(d_q) = \frac{395}{d_q^{0,675}}$$

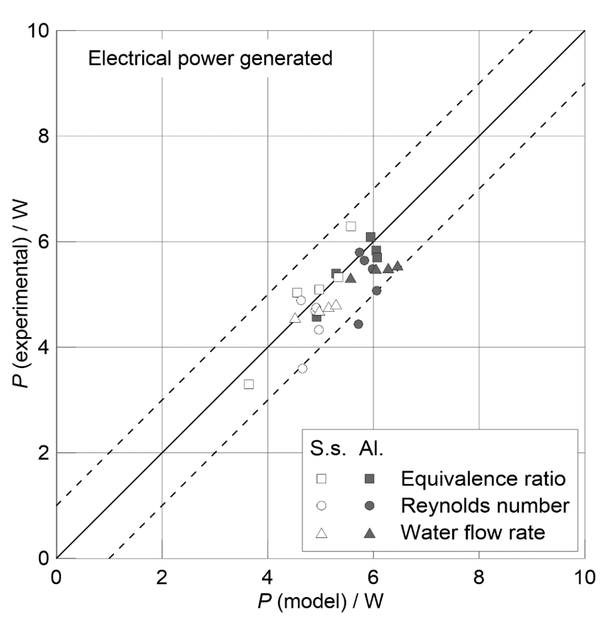


Figure 5: Experimental vs Model results.

Acknowledgments:

FCT Fundação para a Ciência e a Tecnologia

LARSyS Laboratory of Robotics and Engineering Systems