Literature notes

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1 Turbulent burning rates of methane and methane–hydrogen mixtures

Link: Simone's Bibtex/Burn rate, turbulent velocity, consumption speed/1-s2.0-S0010218009000431-main.pdf
DOI: http://dx.doi.org/10.1016/j.combustflame.2009.02.001

1.1 Introduction

- Potential for using existing natural gas infrastucture to transport a mixture of methane and hydrogen from production site to end user. Hydrogen can then be extracted from the mixture and used to power fuel cells or burned directly.
- Challenges: Safety implications on client and infrastructure (clients would receive a mixture of methane and hydrogen, current infrastructure designed for methane transport).
- Some properties of hydrogen flames:
  - More reactive than natural gas.
  - Laminar burning velocity: $S_l(H_2) \approx 5.8S_l(CH_4)$ (at stoichiometry)
  - Wider flammability limit.
- Scope: Identify and quantify the level of risk associated with accidental released of natural gas-hydrogen mixtures in **turbulent** events (most likely). To formulate and validate explosion and ignition models, turbulent and laminar burning velocities are necessary.
- **Turbulent flame velocity (u_t):** depends on:
  1. Flow field: RMS turbulent velocity + eddy length scale.
  2. Flame chemistry: Laminar burning velocity (u_l), laminar flame thickness ($\delta_l = v/u_l$), sometimes a Lewis/Markstein number.
  3. Both the elements aforementioned are also influenced by temperature and pressure (as one would imagine).
- These effects on u_t are usually compressed into a compact form involving dimensionless numbers (usually $u_t/u' = f(K) = g(Da)$ where K is the Karlovitz stretch factor and Da is Damköhler's number). Both the K and Da relate the chemical + turbulent eddy lifetimes.