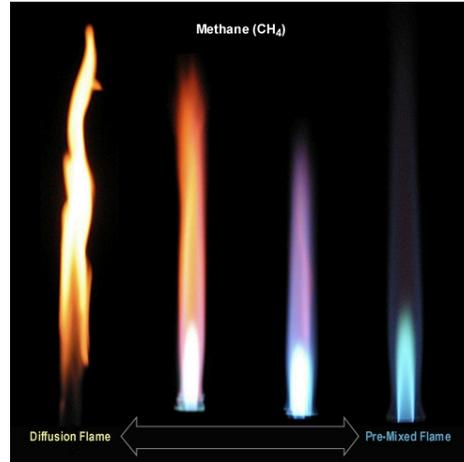
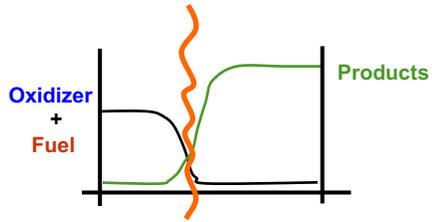


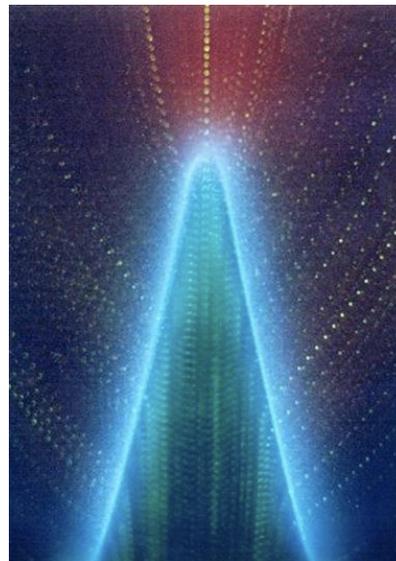
Premixed Flames

1



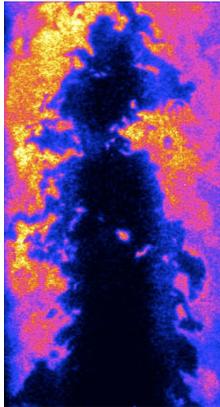
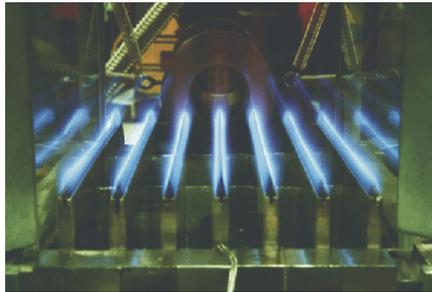
Bunsen Flames

2



More Flames

3



Questions

4

- Why are the flames blue?
- Why are they shaped that way?
- How fast is the flame?
- How thin is the flame?
- How do these depend on T , P , ϕ ?
- What are the basic combustion properties?
- Why and how are premixed flames used?
- What are safety considerations?



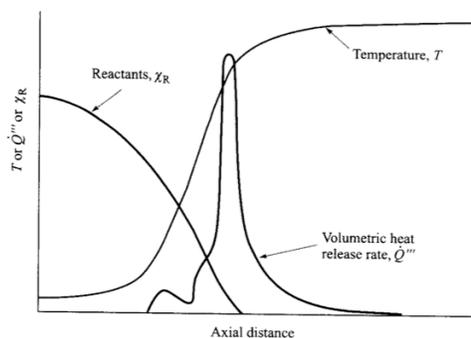
Premixed Characteristics

- Premixed flames link previous concepts
 - Kinetics
 - Transport
 - Thermochemistry / Stoichiometry
- Laminar flames are a prerequisite for turbulent flames.
- Reactants are premixed, but can be rich or lean
- Flame speed is an intrinsic and fundamental property of these flames. Also, flame thickness
- Flames are:
 - Local
 - Self-sustaining,
 - Subsonic (deflagration). Supersonic → detonation, different mechanism.



General Flame Structure

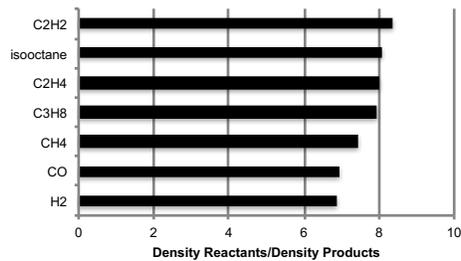
- Flames propagate as a combustion “wave”
- Thin, High T reaction zone.
- Wave:
 - Inlet: Heat, species diffuse from reaction zone into “preheat zone”, where fuel/air begin to react.
 - Outlet: reactions slow/stop and hot products leave the reaction zone
- Density ratio ~ 7
- Thickness ~ 1 mm
- Flame speed ~ 0.5 m/s



Const. P Adiabatic Density Ratios

7

	rho react (kg/m ³)	rho prod (kg/m ³)	rho/rho
H ₂	0.85	0.12	6.86
CO	1.16	0.17	6.92
CH ₄	1.12	0.15	7.47
C ₃ H ₈	1.20	0.15	7.94
C ₂ H ₄	1.17	0.15	8.01
isooctane	1.23	0.15	8.10
C ₂ H ₂	1.16	0.14	8.36

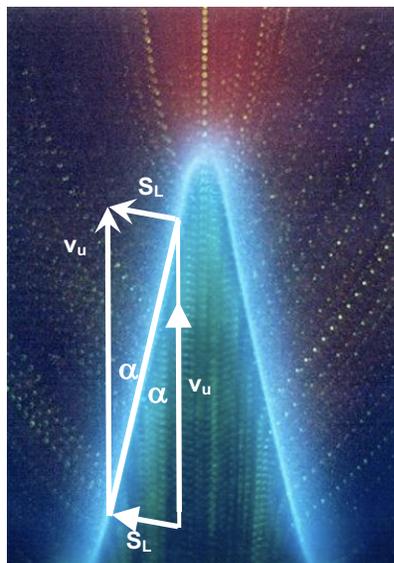


Bunsen Flame—Speed

8

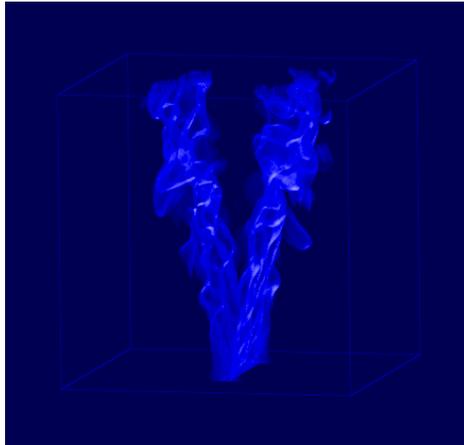
- Why is the flame angled?
- What would happen if it were not?
- Given the verticle (tube) velocity v_t , can you find the flame speed (symbolically) using this picture?

$$S_L = v_u \sin(\alpha)$$



Turbulent V-Flame

9



Flame Stabilization

10

- Flames stabilized by
 - Blowing gas above the flame speed → angled flame
 - Blowing gas below flame speed → flame rushes toward burner.
 - Flashback is a major safety hazard!
 - Burner stabilized flame
 - Water cooled, ceramics, tubes, sintered metal.
 - Heat loss.

