Key words Or Question???

Subject: **combustion engineering**
Topic: **flame**
Week: **2**

Diffusion Flames

What the flame diffusion

In combustion, a diffusion flame is a flame in which the oxidizer and fuel are separated before burning. Contrary to its name, a diffusion flame involves both diffusion and convection processes.

Is take place when the sources of fuel and oxidizer are physically separate so that the energy release is limited primarily by the mixing process .There is no fundamental flame speed as in the case of premixed.

When the Diffusion flames is occurs?

Diffusion flames occur with flowing gases ,with vaporization of liquid fuels ,and with devolatilization of solid fuels.

example of a diffusion flames

A candle flames is an example of a diffusion flames .
Wax is melted, flows up the wick and vaporized.
Air flows upward due to natural convection .
The reaction zone is between the air and the fuel
Zones Air diffuses inward and fuel diffuse outward.
In hydrocarbon flames , soot particles are produced giving rise to luminosity.

Laminar premixed flames

Laminar premixed flames

A combustion reaction started at a local heat source in a quiescent fuel-air mixture at ambient conditions will propagate as a laminar flame .chemical reaction take place in a relatively thin zone ,and the flame moves at a fairly low velocity

Stoichometry calculations

Stoichiometry of chemical reactions means that species react in exact proportions

TYPES OF COMBUSTIBLE MIXTURES

FUEL MIXTURE		
Rich	**Stoichiometric**	**Lean**
Excess of fuel	Stoichiometric content of fuel and oxygen	Excess of oxidizer

For stoichiometric hydrocarbon mixtures in ambient air the flame is approximately 1mm thick and moves at about (0.5 m/s).The pressure drop through the flame is very small (1Pa),and the temperature in the reaction zone is high (2200-2600 k).

What is the Effect of stoichiometry on laminar burning velocity?.

it can seen in fig 1. that the laminar burning velocity for a particular fuel can vary by a factor **3**depending on the fuel/air ratio. The rich and lean limits of flammability are also shown in this figure laminar flames will not occur above or below these limits

Hydrogen has the highest velocity and widest limits of flammability while methane has the lowest burning velocity and the narrowest limits.

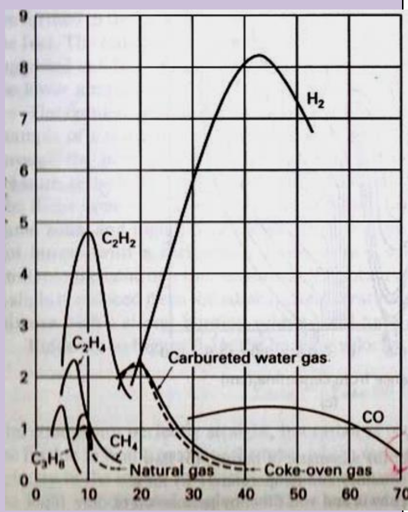


Fig. 1

When the maximum burning velocities are found?

The maximum burning velocities are found just to the rich side of stiochiometric .The fame temperature is highest near the stoichiometric and the lowest near the flammability limits figure 2.Higher laminar burning velocity is associated with a higher flame temperature The effect of nonreactive additives such as nitrogen or argon is to reduce the flame temperature and the Laminar burning velocity.

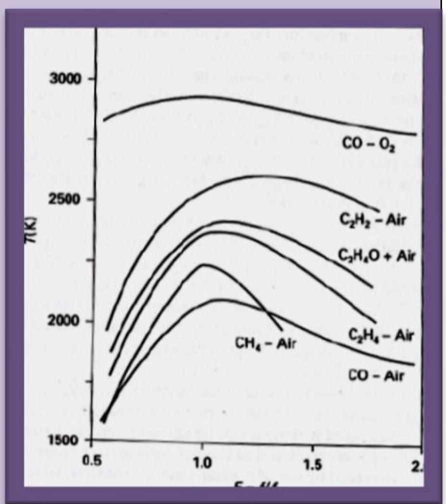
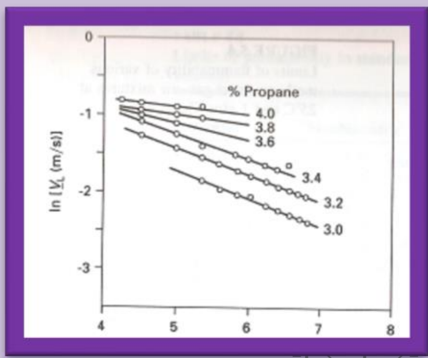


Fig2

	Effect of reactant pressure and temperature on laminar burning velocity
The burning velocity	The burning velocity is defined as the flame relative to the unburned reactants The laminar burning velocity depends on fuel type fuel-air mixture ratio and initial temperature and pressure of the reactants For slow burning mixtures (VL<0.6 m/s)the burning velocity decreases with increasing pressure for fast –burning mixtures (VL>0.6 m/s)**,** the value of **ß** either zero or slightly positive
On What the pressure dependence ?	the observed pressure dependence can be expressed as a power law **,**(VL=a$\boldsymbol{p}^{ß}$)**,** where **p** is the pressure in atmospheres and **ß** varies from(0 to – 0.5) for example , the burning velocities for propane – air mixtures at various pressures are shown in figure 
Why the increasing of pressure increasing the flame temperature?	Increased pressure increases the flame temperature because there is less dissociation, and hence the burning velocity however, less dissociation means less active radicals are available to diffuse upstream to enhance flame propagation. Both effects are important.
On What the temperature dependence?	The burning velocity increases with the temperature of the reactants The observed temperature dependence can also be expressed as a power law. In addition, the burning velocity increases as the second or third power of the absolute temperature. For example, the maximum burning velocity for propane-air goes from **40cm/s** to **140 cm/s** as the reactant temperature is increases from 300K to 617 K.

Structure of CH4-Air flame

The structure of a premixed flame in fig (4)shows the temperature distribution and selected species mole fraction profiles (the principal C-containing CH4,CO,and CO2) through a1-atm ,stoichiometric , CH4-Air flame .Here we see the disappearance of the fuel, the appearance of the intermediate species CO and bur nout of the CO to form CO2 .the CO concentration has its peak value at approximately the same location where the CH4 concentration goes to zero , whereas the CO2 concentration at first lags the CO concentration but the continues to rise as the CO is oxidized .

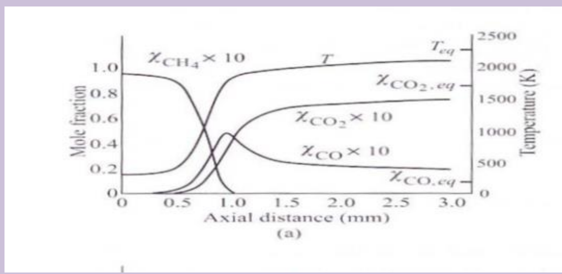


Fig 4

Summery /comment: