Metghalchi & Keck

$$S_L = S_{L,ref}\left(\frac{T_u}{T_{u,ref}}\right)^{\gamma}\left(\frac{P}{P_{ref}}\right)^{\beta}(1-2.1\,Y_{dil})$$

$T_u > 350K$

$T_{u,ref} = 298K$

$P_{ref} = 1atm$

$S_{L,ref} = B_m + B_2(\phi - \phi_m)^2$

$\gamma = 2.18 - 0.8(\phi - 1)$

$\beta = -0.16 + 0.22(\phi - 1)$

Y_{dil} = mass frac. of dilluent

Quenching, Ignition & Flammability

Quenching distance: found experimentally by observing whether a flame that is stabilized above a tube does or does not flashback for a particular tube diameter when the reactant flow is rapidly shut off

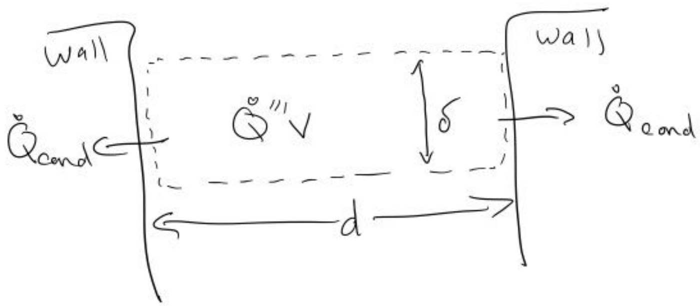
Ignition & quenching criteria

1) ignition will only occur if enough energy is added to the gas to heat a slab about as thick as a steadily propagating laminar flame to T_{ad}

2) rate of liberation of heat by chemical rxns inside the slab must ~ balance the rate of heat loss from the slab by

th. conduction

Simplified Quenching Analysis



$$\dot{Q}'''V = \dot{Q}_{cond,\,total}$$

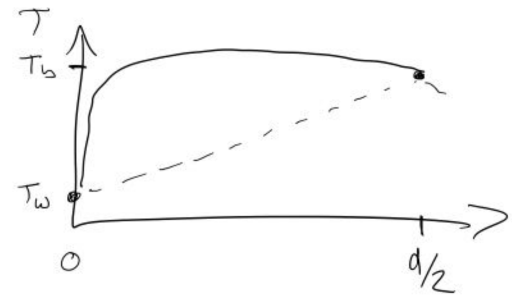
$$\dot{Q}_F''' = -\overline{\dot{m}_F'''}\,\Delta h_c \qquad V = \delta\, d\, L$$

$$\dot{Q}_{cond} = -kA\,\frac{dT}{dx}\bigg|_{\text{in gas @ the wall}}$$

$$A = 2\delta L$$

$$\left|\frac{dT}{dx}\right| = \frac{(T_b - T_w)}{d/2}$$ * lower limit

$| \;\; |$ $\quad d/2$



$$\left|\frac{dT}{dx}\right| = \frac{(T_b - T_w)}{d/b}$$

where $b \gg 2$

$$\dot{Q}'''V = \dot{Q}_{cond,\,tot}$$

$$\left(-\overline{\dot{m}_F'''}\,\Delta h_c\right)(d\,\delta\,L) = k\,(2\,\delta\,L)\,\frac{(T_b - T_w)}{d/b}$$

$$d^2 = \frac{-2kb\,(T_b - T_w)}{\overline{\dot{m}_F'''}\,\Delta h_c}$$

$$T_w = T_u$$

$$\Delta h_c = (a+1)\,c_p\,(T_b - T_u)$$

$$d^2 = \frac{-2kb\,(T_b - T_u)}{\overline{\dot{m}_F'''}\,(a+1)\,c_p\,(T_b - T_u)}$$

$$\alpha = k/\rho_u c_p$$

$$d^2 = \frac{-2\alpha b \rho_u}{\dot{m}_F'' (a+1)}$$

$$d = \left(\frac{-2\alpha b \rho_u}{\dot{m}_F''' (a+1)} \right)^{1/2}$$

$$= \sqrt{b}\, 2\alpha \left(\frac{-\rho_u}{2\dot{m}_F'' (a+1)\alpha} \right)^{1/2}$$

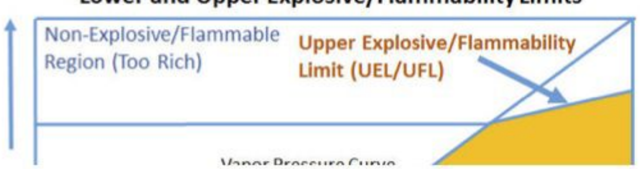
$$d = \frac{2\alpha\sqrt{b}}{S_L} \qquad \delta = \frac{2\alpha}{S_L}$$

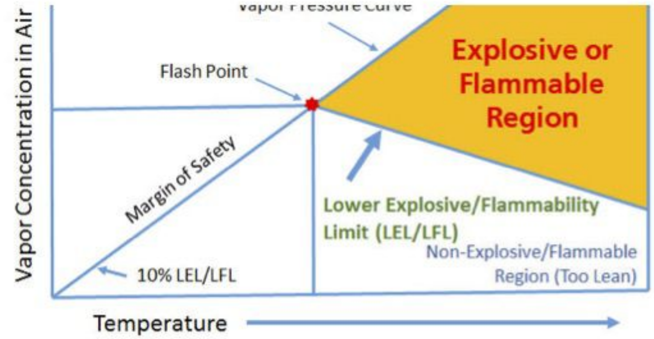
$$\boxed{d = \sqrt{b}\,\delta}$$

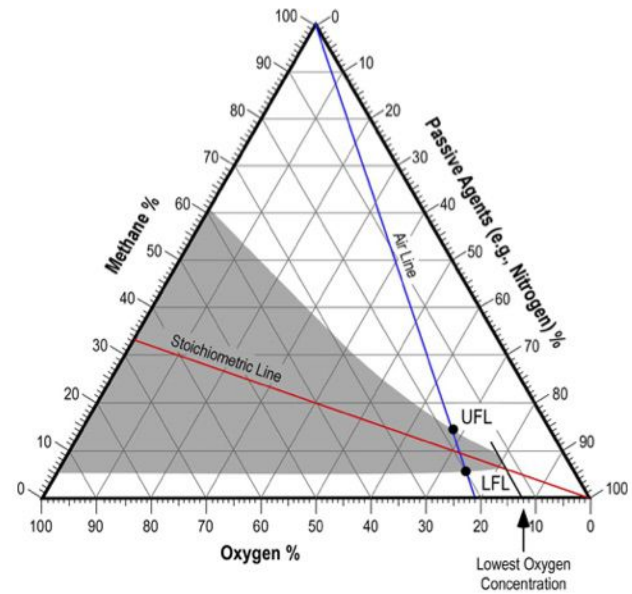
if $b \gg 2$ $\quad d > \delta$

Flammability Limits

Lower and Upper Explosive/Flammability Limits







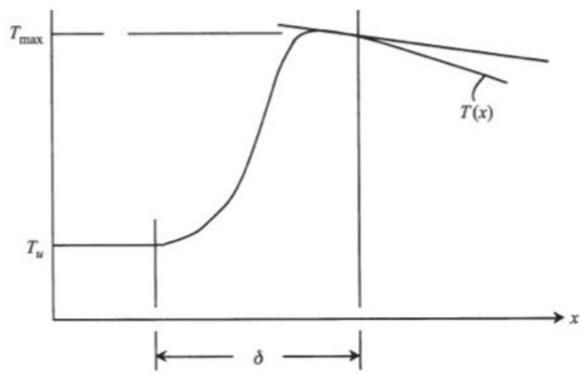


Figure 8.20 Temperature profile through flame with heat losses.