DISCUSSION:

I. Jet Flame Physical Description

> As the fuel flows along the flame axis, it diffuses radially outward, while the oxidizer diffuses radially inward.

> The flame surface can be defined as:

$$\text{Flame Surface} \equiv \begin{matrix}\text{Locus of points where} \\ \Phi \text{ equals unity}\end{matrix}$$

> The products formed at the flame surface diffuse radially both inward and outward

> An *overventilated* flame is where there is more than enough oxidizer in the immediate surroundings to continuously burn the fuel

> *Underventilated* flame is the opposite of an *overventilated* flame

> Flame length for an overventilated flame is determined at the axial location where:

$$\Phi(r = 0, x = L_f) = 1$$

> By ignoring the effects of heat released by reaction, the equation below provides a crude description of flame boundaries when $Y_F = Y_{F,\,stoic}$

$$Y_{\mathrm{F}} = \frac{3}{8\pi}\frac{Q_{\mathrm{F}}}{\mathcal{D}x}\left[1 + \frac{\xi^2}{4}\right]^{-2}$$

> When *r* equals zero, the flame length is approximately:

$$L_f \approx \frac{3}{8\pi}\frac{Q_{\mathrm{F}}}{\mathcal{D}Y_{\mathrm{F,stoic}}}$$

> Flame length is proportional to volumetric flow rate of fuel

> Flame length is inversely proportional to the stoichiometric fuel mass fraction

> Since $Q_F = v_e\pi R^2$, various combinations of v_e and R can yield the same flame length

> Since the diffusion coefficient *D* is inversely proportional to pressure, the height of the flame is independent of pressure at a given mass flow rate.

HISTORICAL THEORETICAL FORMULATIONS:

i. Burke and Schumann (1928)

- **Constant velocity field parallel to flame axis**
- **Reasonable predictions of L_f for round burners**

ii. Roper (1977)

- **Relaxed single constant velocity assumption**
- **Provides extremely good predictions**