Лекция 9

Диффузионное горение газов

(продолжение)

Энтальпия

$$uc_p \frac{\partial T}{\partial x} + \upsilon c_p \frac{\partial T}{\partial r} = \frac{ac_p}{r}\frac{\partial}{\partial r}\left(r\frac{\partial T}{\partial r}\right) + Qw_A \qquad (3)$$

$$u\frac{\partial c_A}{\partial x}\mathbf{Q} + \upsilon\frac{\partial c_A}{\partial r}\mathbf{Q} = \frac{D}{r}\frac{\partial}{\partial r}\left(r\frac{\partial c_A}{\partial r}\mathbf{Q}\right) - w_A\mathbf{Q} \qquad (4)$$

(3)+(4)*Q:

$$u\frac{\partial\left(c_pT + Qc_A\right)}{\partial x} + \upsilon\frac{\partial\left(c_pT + Qc_A\right)}{\partial r} = \frac{a}{r}\frac{\partial}{\partial r}\left(r\frac{\partial\left(c_pT + Qc_A\right)}{\partial r}\right)$$

$\boldsymbol{H=c_pT+Qc_A}$ **- энтальпия** **(9)**

$$u\frac{\partial H}{\partial x} + \upsilon\frac{\partial H}{\partial r} = \frac{a}{r}\frac{\partial}{\partial r}\left(r\frac{\partial H}{\partial r}\right) \qquad (10)$$

$$u\frac{\partial u}{\partial x}+\upsilon\frac{\partial u}{\partial r}=\frac{\nu}{r}\frac{\partial}{\partial r}\left(r\frac{\partial u}{\partial r}\right) \qquad (2)$$

$$u\frac{\partial H}{\partial x}+\upsilon\frac{\partial H}{\partial r}=\frac{a}{r}\frac{\partial}{\partial r}\left(r\frac{\partial H}{\partial r}\right) \qquad (10)$$

$$u\frac{\partial \tilde{c}}{\partial x}+\upsilon\frac{\partial \tilde{c}}{\partial r}=\frac{D}{r}\frac{\partial}{\partial r}\left(r\frac{\partial \tilde{c}}{\partial r}\right) \qquad (7)$$

Если $\nu = D = a$, то уравнения (2), (10), (7) совпадают

Решения уравнений (2), (10), (7) совпадут, если граничные условия будут одинаковыми.

Граничные условия:

$$H = c_p T + Q c_A$$

$$\tilde{C} = C_B - \sigma C_A$$

$x=0, \quad 0 < r < r_0$: $\quad u = u_0$; $\quad T = T_0$; $\quad c_A = c_{A0}$; $\quad c_B = 0$;

$$H = H_0 = c_p T_0 + Q c_{A0}; \quad \tilde{C} = \tilde{C}_0 = -\sigma C_{A0}$$

$x \geq 0, \quad r = 0$:

$$\frac{\partial u}{\partial r} = \frac{\partial T}{\partial r} = \frac{\partial c_A}{\partial r} = \frac{\partial c_B}{\partial r} = \frac{\partial H}{\partial r} = \frac{\partial \tilde{c}}{\partial r}$$

$r \to \infty$: $\quad u \to 0$; $\quad T \to T_\infty$; $\quad c_A \to 0$; $\quad c_B \to c_{B\infty}$;

$$H \to H_\infty = c_p T_\infty; \quad \tilde{C} \to \tilde{C}_\infty \to C_{B\infty}$$

Введем новые переменные:

$$\frac{u}{u_0}, \quad \frac{H - H_\infty}{H_0 - H_\infty}, \quad \frac{\tilde{c} - \tilde{c}_\infty}{\tilde{c}_0 - \tilde{c}_\infty}$$

x=0, 0< r < r₀: $\frac{u}{u_0} = 1, \quad \frac{H - H_\infty}{H_0 - H_\infty} = 1, \quad \frac{\tilde{c} - \tilde{c}_\infty}{\tilde{c}_0 - \tilde{c}_\infty} = 1$

x≥0, r = 0: $\frac{\partial}{\partial r}\left(\frac{u}{u_0}\right) = 0, \quad \frac{\partial}{\partial r}\left(\frac{H - H_\infty}{H_0 - H_\infty}\right) = 0, \quad \frac{\partial}{\partial r}\left(\frac{\tilde{c} - \tilde{c}_\infty}{\tilde{c}_0 - \tilde{c}_\infty}\right) = 0$

r → ∞: $\frac{u}{u_0} \to 0, \quad \frac{H - H_\infty}{H_0 - H_\infty} \to 0, \quad \frac{\tilde{c} - \tilde{c}_\infty}{\tilde{c}_0 - \tilde{c}_\infty} \to 0$