3 Solution near the slot

For small x, we take

$$\psi = \sqrt{x}\ f(\eta), \qquad \theta = \sqrt{x}\ g(x,\eta), \qquad \phi = \phi(x,\eta), \qquad \eta = \frac{y}{\sqrt{x}} \tag{12}$$

where ψ is the stream function defined in the usual way. Equations (8)-(10), after some algebra, become

$$2f''' + f\ f'' = 0 \tag{13}$$

$$\frac{2}{\sigma}\frac{\partial^2 g}{\partial \eta^2} + f\frac{\partial g}{\partial \eta} - f' g = 2xf'\frac{\partial g}{\partial x} \tag{14}$$

$$\frac{2}{S_c}\frac{\partial^2 \phi}{\partial \eta^2} + f\frac{\partial \phi}{\partial \eta} = 2xf'\frac{\partial \phi}{\partial x} \tag{15}$$

subject to

$$\left.\begin{array}{l} f = 0, \quad f' = 1, \quad \dfrac{\partial g}{\partial \eta} = -\phi\, e^{\frac{g\sqrt{x}}{1+\varepsilon g\sqrt{x}}} \\ \dfrac{\partial \phi}{\partial \eta} = \alpha\, \phi \sqrt{x}\, e^{\frac{g\sqrt{x}}{1+\varepsilon g\sqrt{x}}} \end{array}\right\} \quad \text{on} \quad \eta = 0$$

$$f' \to 0, \quad g \to 0, \quad \phi \to 1 \quad \text{as} \quad \eta \to \infty \quad (x > 0) \tag{16}$$

$$f = 0, \quad f' = 1, \quad g = 0, \quad \phi = 1 \quad \text{at} \quad x = 0 \quad (\eta > 0)$$

where primes denote differentiation with respect to η.

where $\varepsilon = \frac{T_c}{T_0} = \frac{RT_0}{E}$ is a measure of the activation energy and $\alpha = \frac{k_c RT_0^2}{QDEC_0}$ is called the consumption parameter.

4 Numerical solution

Equations (14) and (15) subject to (16) can be solved numerically for a) reactant consumption neglected, $\alpha = 0$, and b) reactant consumption included, $\alpha \neq 0$, respectively. Results could be presented on graphs for $\theta(x,0) = \theta_w(x)$, $\phi(x,0) = \phi_w(x)$ and the different values of α, ε and x when $\sigma = S_c = 1.0$.

5 Asymptotic solution for large x