Nondimensionalization of Haseloff et al. 2018

Pierce Hunter

1/24/2019

1 Definitions

$$[z] = h_s \qquad [s'] = \frac{n+2}{n+1}\frac{q_r}{A\tau_s^n h_s^2}\frac{\tau_s}{\rho g} \qquad [u] = Ah_s\tau_s^n$$

$$[v] = \frac{n+2}{n+1}\frac{q_r}{h_s} \qquad [T] = T_m - T_s$$

$$y = [z]\,Y \qquad z = [z]\,Z \qquad u = [u]\,U \qquad v = [v]\,V \qquad w = [v]\,W$$

$$s' = [s']\,S' \qquad p = \rho g\,[s']\,P \qquad T = [T]\,\mathcal{T} + T_m$$

$$\alpha = \frac{A\tau_s^{n+1}h_s^2}{k\,(T_m - T_b)} \qquad Pe = \frac{n+2}{n+1}\frac{\rho c_p q_r}{k} \qquad \nu = \frac{T_b - T_s}{T_m - T_s}$$

$$\tau = \frac{\tau_c}{\tau_s} \qquad \varepsilon = \frac{n+2}{n+1}\frac{q_r}{A\tau_s^n h_s^2}$$

2 Nondimensionalization of Equations

2.1 $4 \to 24$

$$\eta = \frac{A^{-1/n}}{2^{1/n}}\left[\left|\frac{\partial u}{\partial y}\right|^2 + \left|\frac{\partial u}{\partial z}\right|^2 + \left|\frac{\partial v}{\partial z} + \frac{\partial w}{\partial y}\right|^2 + 2\left|\frac{\partial v}{\partial y}\right|^2 + 2\left|\frac{\partial w}{\partial z}\right|^2\right]^{\frac{1-n}{2n}}$$

$$\frac{A^{-1/n}}{2^{1/n}}\left[\frac{[u]^2}{[z]^2}\left(\left|\frac{\partial U}{\partial Y}\right|^2 + \left|\frac{\partial U}{\partial Z}\right|^2\right)\right]$$

2.2 $2 \to 22$

$$\frac{\partial}{\partial y}\left(\eta\frac{\partial u}{\partial y}\right) + \frac{\partial}{\partial z}\left(\eta\frac{\partial u}{\partial z}\right) = 0$$

$$\frac{1}{[z]}\frac{\partial}{\partial Y}$$