$$\dot{u} = \frac{1}{r}\frac{\partial \phi}{\partial z}, \qquad \dot{\omega} = -\frac{1}{r}\frac{\partial \phi}{\partial r} \tag{24}$$

where ϕ is a velocity function, then the analogous differential equation for the time dependent flow of an arbitrary material becomes

$$\begin{aligned} &\frac{\bar{\sigma}}{\dot{\bar{\epsilon}}}\nabla_1^4\phi + \nabla_3^2\phi\,\nabla_2^2\left(\frac{\bar{\sigma}}{\dot{\bar{\epsilon}}}\right) \\ &+ \frac{2}{r}\frac{\partial}{\partial z}\left(\frac{\partial \phi}{\partial r} - \frac{2\phi}{r}\right)\frac{\partial}{\partial z}\left(\frac{\bar{\sigma}}{\dot{\bar{\epsilon}}}\right) \\ &+ 2\frac{\partial}{\partial z}\left(2\frac{\partial \phi}{\partial r} - \frac{\phi}{r}\right)\frac{\partial}{\partial r\,\partial z}\left(\frac{\bar{\sigma}}{\dot{\bar{\epsilon}}}\right) = 0 \end{aligned} \tag{25}$$

In the case of a Newtonian fluid, the ratio of the shearing stress to the rate of shear strain is a constant; and this constant is usually called the coefficient of viscosity μ. Using analogous terms, the following relation can be written for a Newtonian fluid.