Exam Formulas

CM4650 Polymer Rheology

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Navier-Stokes Equation: $\rho\left(\frac{\partial \underline{v}}{\partial t} + \underline{v} \cdot \nabla \underline{v}\right) = -\nabla p + \mu \nabla^2 \underline{v} + \rho \underline{g}$

Momentum Equation: $\rho\left(\frac{\partial \underline{v}}{\partial t} + \underline{v} \cdot \nabla \underline{v}\right) = -\nabla p - \nabla \cdot \underline{\underline{\tau}} + \rho \underline{g}$

Continuity Equation: $\frac{\partial \rho}{\partial t} = -\nabla \cdot (\rho \underline{v})$

Newtonian, incompressible fluid: $\underline{\underline{\tau}} = -\mu\left(\nabla \underline{v} + (\nabla \underline{v})^T\right)$

Generalized Newtonian fluid: $\underline{\underline{\tau}} = -\eta \dot{\underline{\underline{\gamma}}}$

Power-law model: $\eta = m\dot{\gamma}^{n-1}$

(Note that m and n are parameters of the model and are constants)

Carreau-Yasuda model $\eta(\dot{\gamma}) = \eta_\infty + (\eta_o - \eta_\infty)\left[1 + (\dot{\gamma}\lambda)^a\right]^{\frac{n-1}{a}}$

(Note that a, λ and n, η_o, and η_∞ are parameters of the model and are constants)

Elongational flow (uniaxial, biaxial): $\underline{v} = \begin{pmatrix} -\frac{\dot{\varepsilon}(t)}{2} x_1 \\ -\frac{\dot{\varepsilon}(t)}{2} x_2 \\ \dot{\varepsilon}(t) x_3 \end{pmatrix}_{123}$

Elongational flow (planar): $\underline{v} = \begin{pmatrix} -\dot{\varepsilon}(t) x_1 \\ 0 \\ \dot{\varepsilon}(t) x_3 \end{pmatrix}_{123}$

Shear flow: $\underline{v} = \begin{pmatrix} \dot{\varsigma}(t)\, x_2 \\ 0 \\ 0 \end{pmatrix}_{123}$

Tensor magnitude: $A = \left|\underline{\underline{A}}\right| = +\sqrt{\frac{\underline{\underline{A}} \cdot \underline{\underline{A}}}{2}}$