Example Answers

International Master's Programs of Chemical Engineering in the Graduate School of Engineering, Kyushu University (Academic Year from October, 2025)

Subject：Fluid Dynamics

(1.1)

$$-\frac{\mathrm{d}p}{\mathrm{d}z}+\mu\frac{1}{r}\frac{\mathrm{d}}{\mathrm{d}r}\left(r\frac{\mathrm{d}u_z}{\mathrm{d}r}\right)+\rho g_z=0$$

(1.2)

$$u_z=\frac{R^2}{4\mu}\left(\frac{\mathrm{d}p}{\mathrm{d}z}-\rho g_z\right)\left[1-\left(\frac{r}{R}\right)^2-\frac{1-\kappa^2}{2\ln\left({}^{1}\!/_{\kappa}\right)}\left(\frac{R}{r}\right)\right]$$
$$=\frac{\Delta P R^2}{4\mu Z}\left[1-\left(\frac{r}{R}\right)^2-\frac{1-\kappa^2}{2\ln\left({}^{1}\!/_{\kappa}\right)}\left(\frac{R}{r}\right)\right]$$

(1.3)

$$w=\frac{\pi R^4\rho\Delta P}{8\mu Z}\left[(1-\kappa)^4-\frac{1-\kappa^2}{2\ln\left({}^{1}\!/_{\kappa}\right)}\right]$$

(1.4) Simplified into the Hagen-Poiseuille equation

$$w=\frac{\pi R^4\rho\Delta P}{8\mu Z}$$

(2.1) $\sqrt{\tau_0/\rho}$

(2.2) The mixing length is the distance between two layers in the transverse direction, allowing lumps of fluid particles from one layer to reach the other and mix with the particles there.

(2.3) $\frac{u_x}{u_*}=2.5\ \ ln\left(\frac{yu_*}{v}\right)+5.5,\ \frac{yu_*}{v}>30$