1) $\frac{\partial}{\partial t}\int_{CV} \rho \, dV + \int_{CS} \rho \underset{\sim}{V} \cdot \underset{\sim}{n} \, dA = 0$

Assuming steady flow,

$$\int_{CS} \rho \underset{\sim}{V} \cdot \underset{\sim}{n} \, dA = 0$$

$$\dot{m}_{out} - \dot{m}_{in} = 0$$

$$\dot{m}_{out} = \dot{m}_{in}$$

radial v

$\downarrow$

$$\dot{m}_{in} = 1000 \times 2\pi \times 0.18 \times 0.03 \times 3\cos 60^\circ$$

$$= 50.89380099 \, kg\,s^{-1}$$

$$\approx 51 \, kg\,s^{-1}$$

2) $\frac{\partial}{\partial t}\int_{CV} \rho \, dV + \int_{CS} \rho \underset{\sim}{V} \cdot \underset{\sim}{n} \, dA = 0$

Assuming steady flow,

$$\int_{CS} \rho \underset{\sim}{V} \cdot \underset{\sim}{n} \, dA = 0$$

$$\int_{CS} \cancel{\rho}(-V)\, dA + \int_{CS} \cancel{\rho}\, u \, dA = 0$$

$$V(0.2)(1.0) = \int_0^{0.3} (4y - 2y^2) \times 1.0 \, dy$$

$$0.2V = \int_0^{0.3} 4y - 2y^2 \, dy$$

$$V = 5\left[\frac{4y^2}{2} - \frac{2y^3}{3}\right]_0^{0.3}$$

$$= 5\left[2y^2 - \frac{2}{3}y^3\right]_0^{0.3}$$

$$= 5\left(2 \times 0.3^2 - \frac{2}{3} \times 0.3^3\right)$$

$$= 0.81 \, ms^{-1}$$

3a) $\dot{m}_{in} - \dot{m}_{out} = \dot{m}_{tank}$

$$\dot{m}_{tank} = 1.2 \times 0.3 - 210 \times 1.8 \times \pi \left(\frac{3 \times 10^{-2}}{2}\right)^2$$

$$= 0.09280754481$$

$$\approx 0.093 \, kg \, s^{-1}$$

b) $$\frac{d\rho}{dt} = \frac{dm}{dt} \div V$$

$$= 0.093 \div 0.6$$

$$= 0.1546792414 \, kg \, m^{-3} s^{-1}$$

$$\approx 0.155 \, kg \, m^{-3} s^{-1}$$