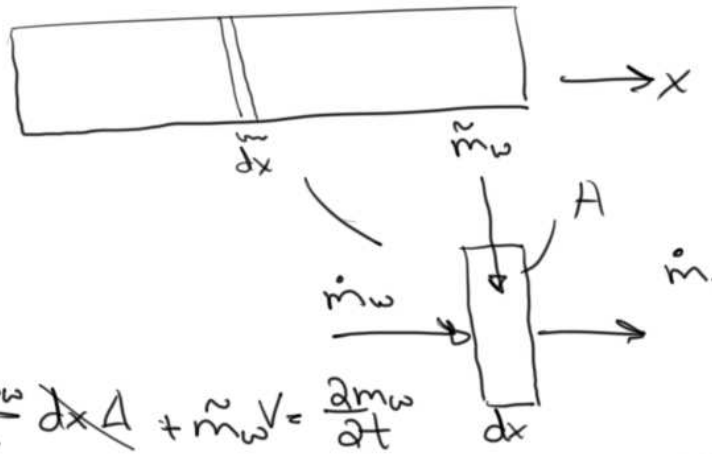
Black oil model

- Gas component in oil or flow separately
- Gas does not dissolve in water
- Water & oil don't mix

$$S_w + S_o + S_g = 1$$



$$\dot{m}_w - \dot{m}_w - \frac{\partial \dot{m}_w}{\partial x} dx A + \tilde{m}_w V = \frac{\partial m_w}{\partial t}$$

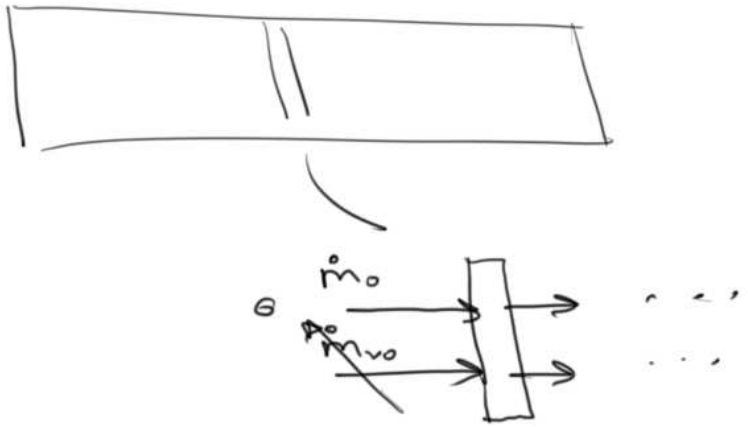
$$\dot{m}_w = \rho_w \vec{u}_w$$

$$m_w = \rho_w S_w \phi A dx$$

$$\boxed{-\frac{\partial (\rho_w u_w)}{\partial x} + \tilde{m}_w = \frac{\partial (\rho_w \phi S_w)}{\partial t}}$$

$$B_w = \frac{\text{res. volume of aqueous phase}}{\text{stock volume aqueous phase}} = \frac{V_w^{RC}}{V_w^{SC}} = \frac{\rho_w^{SC}}{\rho_w^{RC}}$$

$$\boxed{-\frac{\partial}{\partial x}\left(\frac{u_w}{B_w}\right) + \tilde{q}_w = \frac{\partial}{\partial t}\left(\frac{\phi S_w}{B_w}\right)} \qquad (1)$$



$$-\frac{\partial}{\partial x}\left(\rho_o u_o\right) + \tilde{m}_o = \frac{\partial(\rho_o \phi S_o)}{\partial t}$$

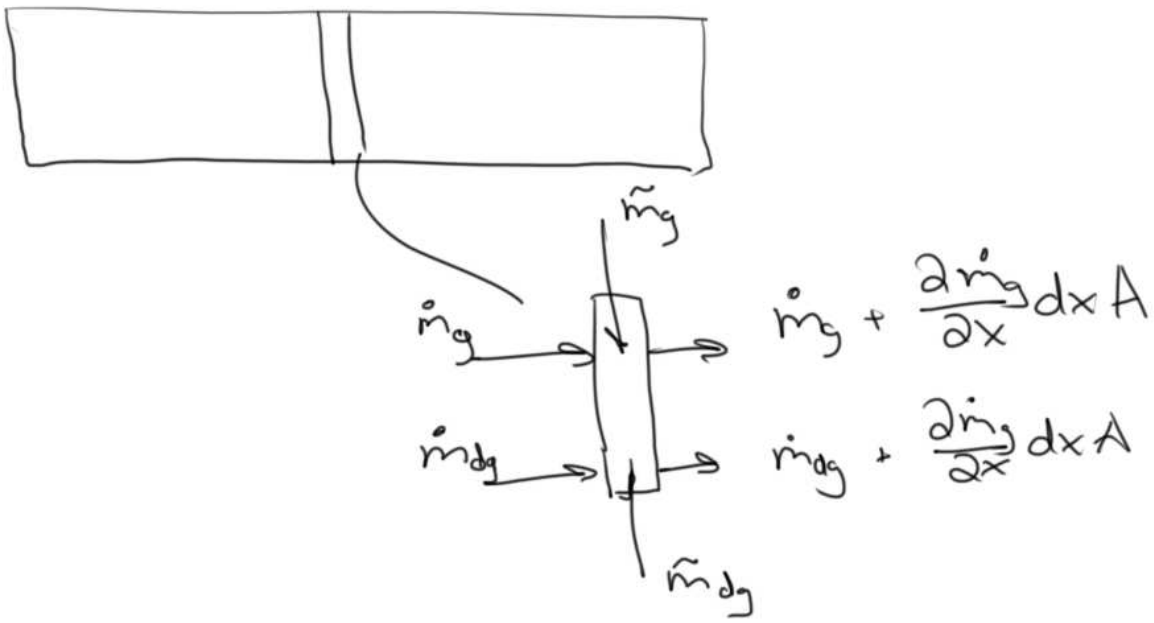
$$B_o = \frac{\text{res. volume of oleic phase (oil + dissolved gas)}}{\text{stock tank oleic phase (oil only)}} = \frac{V_o^{RC}}{V_o^{SC}}$$

$$\frac{\rho_{ol}^{RC} V_{ol}^{RC}}{V_{ol}^{RC}} = \frac{\rho_o^{SC} V_o^{SC}}{V_{ol}^{RC}} + \frac{\rho_g^{SC} V_{dg}^{SC}}{V_{ol}^{RC}} \cdot \frac{V_o^{SC}}{V_o^{SC}}$$

(R_s; $\frac{V_o^{SC}}{V_o^{SC}} = \frac{1}{B_o}$)

$$= \underbrace{\frac{\rho_o^{SC}}{B_o}}_{\rho_o^{RC}} + \underbrace{\frac{R_s \rho_g^{SC}}{B_o}}_{\rho_{dg}^{RC}}$$

$$\boxed{-\frac{\partial}{\partial x}\left(\frac{\vec{u}_o}{B_o}\right) + \tilde{q}^o = \frac{\partial}{\partial t}\left(\frac{\phi S_o}{B_o}\right)} \qquad (2)$$



$$-\frac{\partial}{\partial x}\left(\rho_g u_g + \rho_{dg} u_o\right) + \tilde{m}_g + \tilde{m}_{dg} = \frac{\partial}{\partial t}\left(\rho_g \phi S_g + \rho_{dg} \phi S_o\right)$$

$$B_g = \frac{\text{res. volume of gaseous phase (gas + volatile oil)}}{\text{stock volume gaseous phase (gas only)}}$$

$$\frac{\rho_g^{RC} V_g^{RC}}{V_g^{RC}} = \frac{\rho_g^{SC} V_g^{SC}}{V_g^{RC}} + \frac{\rho_o^{SC} V_{vo}^{SC}}{V_g^{RC}} + \frac{V_g^{SC}}{V_g^{RC}} = \frac{1}{B_g}$$

R_v

$$= \frac{\rho_g^{SC}}{B_g} + \frac{R_v \rho_o^{SC}}{B_g}$$

$R_v = 0$

ρ_g^{RC}

$$\boxed{-\frac{\partial}{\partial x}\left(\frac{u_g}{B_g} + R_s \frac{u_o}{B_o}\right) + \tilde{q}_g + R_s \tilde{q}_o = \frac{\partial}{\partial t}\left[\phi\left(\frac{1}{B_g} S_g + \frac{R_s}{B_o} S_o\right)\right]} \quad (3)$$