Rate Equation (PSS : $p_R(t)$) of a Surface Product

$$q_p = \underbrace{\frac{\alpha\, kh}{\ln\left(\frac{r_e}{r_w}\right) - \frac{3}{4} + s}}_{\text{"J"}} \cdot \int_{p_{wf}}^{p_R} \underbrace{\lambda_p(p')}_{\text{Phase Mobility}}\, dp'$$

q_p: Product "o" "g"

$$\lambda_p = \frac{k_{rp}}{\mu_p B_p}$$

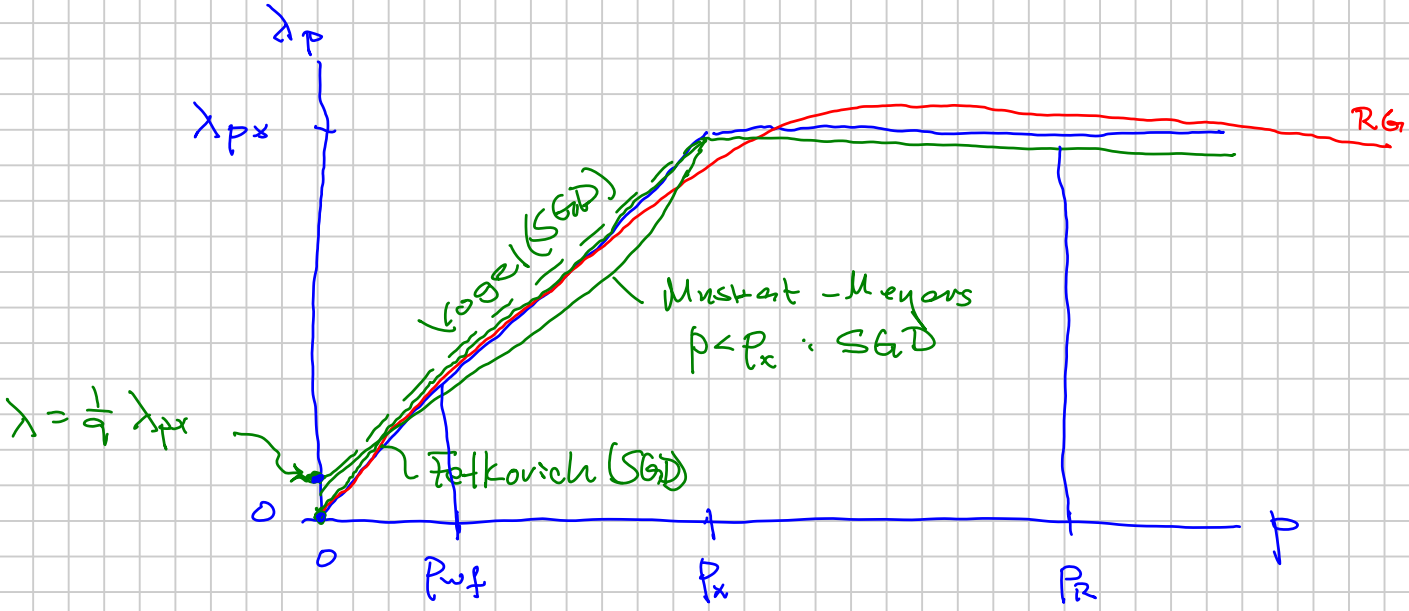
λ_p: reservoir phase

B_p: Conversion from R phase to surface product

$$s = s' + D q_p$$

Gas $p_x \sim 200$-bar

Oils $p_x = p_b$



$p_x < p_{wf} < p_R$:

$$q_p = J_p (p_R - p_{wf})\, \lambda_{px}$$ Straight-Line IPR

$p_{wf} < p_R < p_x$:

$$q_p = \underbrace{\frac{J_p}{2p_x}}_{J'} \left(p_R^2 - p_{wf}^2\right) \lambda_{px}$$

$p_{wf} < p_x < p_R$

$$q_p = J \lambda_{px} (p_R - p_x) + \frac{J \lambda_{px}}{2p_x} \left(p_x^2 - p_{wf}^2\right)$$

Need: J: Rock, Flow Geometry, Skin

λ_{px}: Mobility

$p_R \quad p_{wf} \quad p_x$

$\Delta p = p_R - p_{wf}$ "Drawdown"

Dimensionless Quantities:

$$p_d \equiv \frac{p_{wf}}{p_R} \qquad q_d \equiv \frac{q_p}{[q_p(p_{wf}=0)]} = \frac{q_p}{q_{pmax}}$$

Theoretical Absolute Open Flow Potential

$p_{wf} \to 0$ AOFP

$$\lambda_p(p_{wf}=0) = \frac{1}{q} \lambda_{px}$$

Vogel (SGD):

$$q_d = \frac{q_o}{q_{omax}} \cong 1 - 0.2\, p_d - 0.8\, p_d^2$$

$$1 - V p_d - (1-V) p_d^2 \quad 0 < V < 1$$

Fetkovich

$$q_d \cong 1 - p_d^2$$

$s = s' + D q_p$ ⇒ Whitson 1984 ?