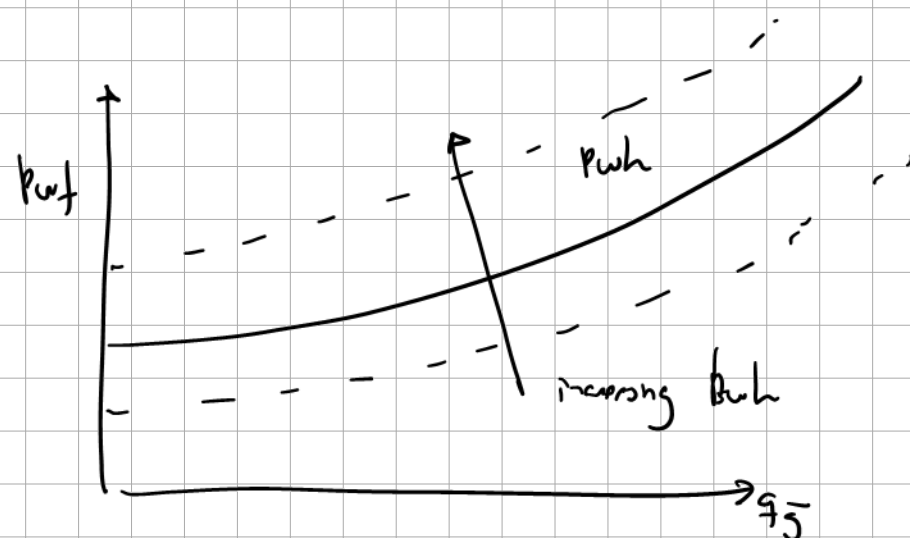
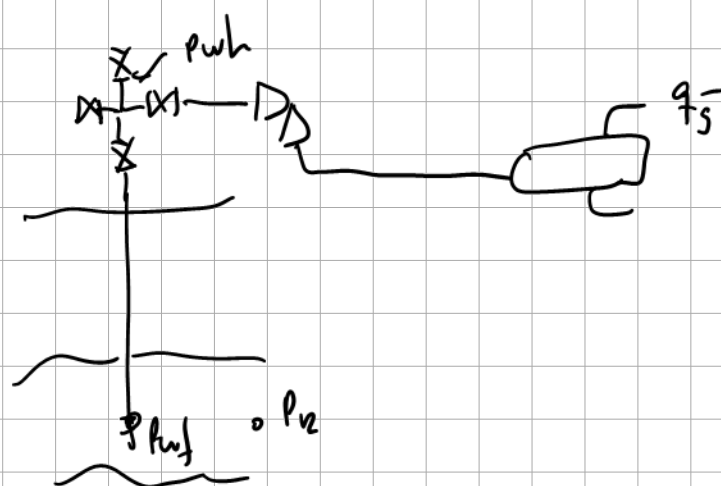




$$q_g = C_T \cdot \left(\frac{p_{wf}^2}{e^S} - p_{wlh}^2 \right)^{0.5}$$

tubing coefficient, tubing elevation coefficient

for same p_{wf} , p_{wlh} :

• $C_T \uparrow$ $q_g \uparrow$
• $S \uparrow$ $q_g \downarrow$

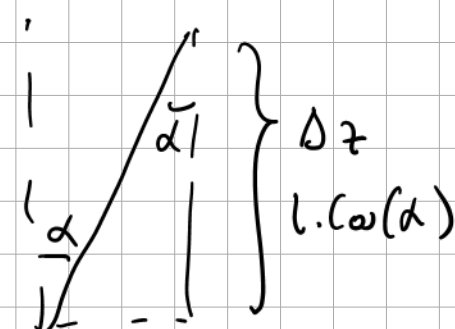
$$u_g = \frac{q_g}{A} = \frac{\dot{m}_g}{\rho_g \cdot A}$$

$$u_g^2 = \left(\frac{\dot{m}_g}{\rho_g A} \right)^2$$

$$\rho_g = \frac{p}{Z R T} \rightarrow \frac{\rho_o}{M_w}$$

$$-\frac{dp}{dl} = \underbrace{\frac{p \cdot M_g}{Z \cdot R \cdot T}}_{f(p)} \cdot g \cdot \cos(\alpha) + \frac{8 \cdot f_M \cdot \dot{m}^2}{\pi^2 \cdot D^5} \cdot \frac{Z \cdot R \cdot T}{p \cdot M_g}$$

$f(v, \rho, \mu)$



$$S = 2 \cdot L \cdot C_a = 2 \cdot \frac{M_g}{Z_{av} \cdot R \cdot T_{av}} \cdot L \cdot g \cdot \cos(\alpha)$$

$$q_{sc} = \left(\frac{\pi}{4} \right) \cdot \left(\frac{R}{M_{air}} \right)^{0.5} \cdot \left(\frac{T_{sc}}{p_{sc}} \right) \cdot \left(\frac{D^5}{f_M \cdot L \cdot \gamma_g \cdot Z_{av} \cdot T_{av}} \right)^{0.5} \cdot \left[(p_{wlf}^2 - p_t^2 \cdot e^S) \cdot \left(\frac{S}{e^S - 1} \right) \right]^{0.5}$$

By defining the tubing constant C_T :

$$C_T = \left(\frac{\pi}{4} \right) \cdot \left(\frac{R}{M_{air}} \right)^{0.5} \cdot \left(\frac{T_{sc}}{p_{sc}} \right) \cdot \left(\frac{D^5}{f_M \cdot L \cdot \gamma_g \cdot Z_{av} \cdot T_{av}} \right)^{0.5} \cdot \left(\frac{S \cdot e^S}{e^S - 1} \right)^{0.5}$$

Eq. A-24

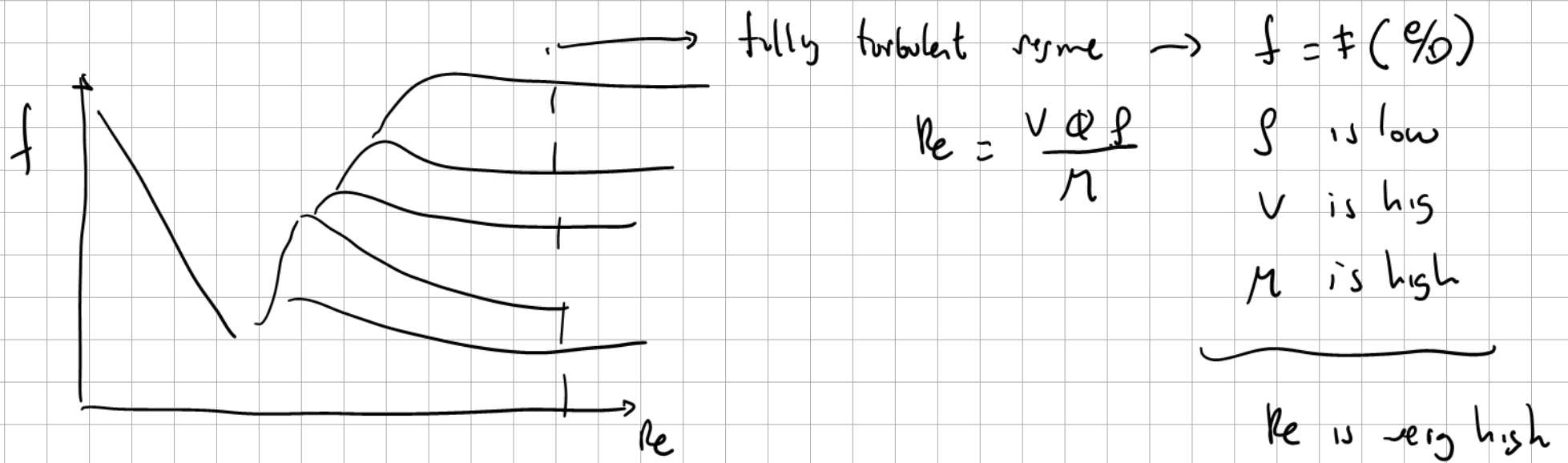
This yields:

$$q_{sc} = C_T \cdot \left[\left(\frac{p_{wlf}^2}{e^S} - p_t^2 \right) \right]^{0.5}$$

Eq. A-25

to calculate C_T , S , a ^{seed} p_{wf} , p_{wlh} , T_{wf} , T_{wlh} are required!
 Z_{av} , T_{av}

which the effect of seed is modest



$$e = f(\phi) \quad \text{Smith (1950)}$$

$$\hookrightarrow f = F(\phi)$$

DETERMINING FRICTION FACTORS FOR MEASURING PRODUCTIVITY OF GAS WELLS

R. V. SMITH, U. S. BUREAU OF MINES, BARTLESVILLE, OKLAHOMA

$$f_M = \frac{0.01748}{D^{0.224} \cdot \left(|1 \text{ m}| \cdot \left| \frac{39.37 \text{ in}}{1 \text{ m}} \right| \right)^{0.224}} = \frac{0.0077}{D^{0.224}}$$