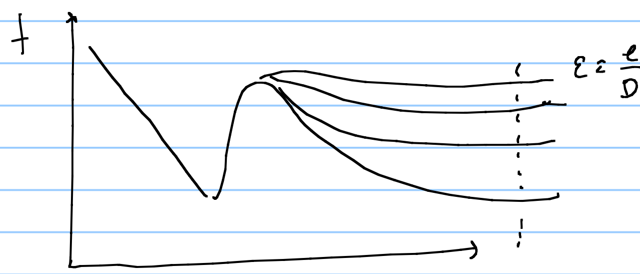
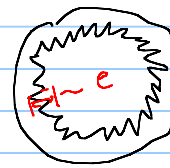
Comments about tubing equation

$T_{av} \rightarrow \dfrac{T_{wf} + T_{wh}}{2}$ An estimate of T_{wh} is needed to compute G_T

$Z_{av} \rightsquigarrow \dfrac{Z_{wf} + Z_{wh}}{2}$

f_m friction factor





$Re = \dfrac{v \rho D}{\mu}$

μ_g is << μ_L

Re_g >>

always in fully turbulent regime

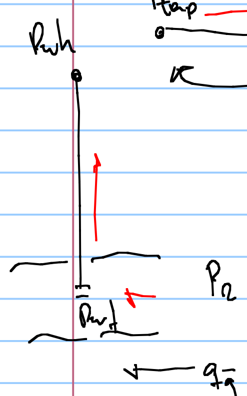
$v = f(q_{local})$ for gas $v \uparrow \uparrow$ ρ is low compared to liquid

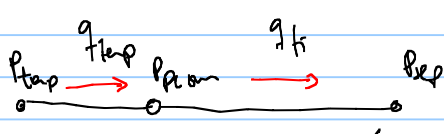
q_{local} $f(\rho)$

liquid v - $[0.5 - 4]$ m/s

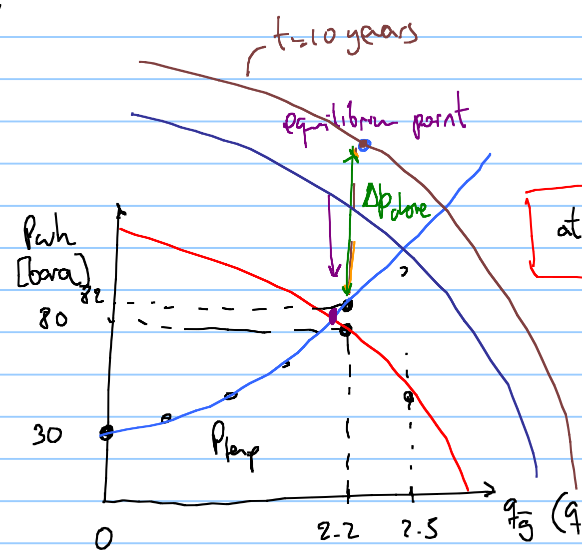
gas v - $[5 - 40]$ m/s

$f_m = f(\varepsilon)$ however $e = f(t, D)$ due to manufacturing



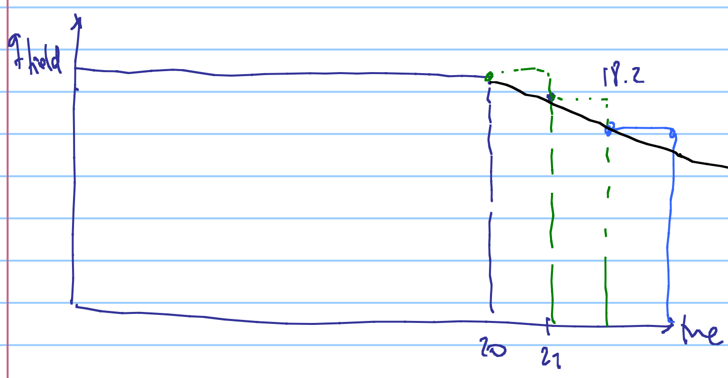


$q_{field} = 3\, q_{temp} = 9\, q_{well}$



$\boxed{\text{at time 21 years}}$

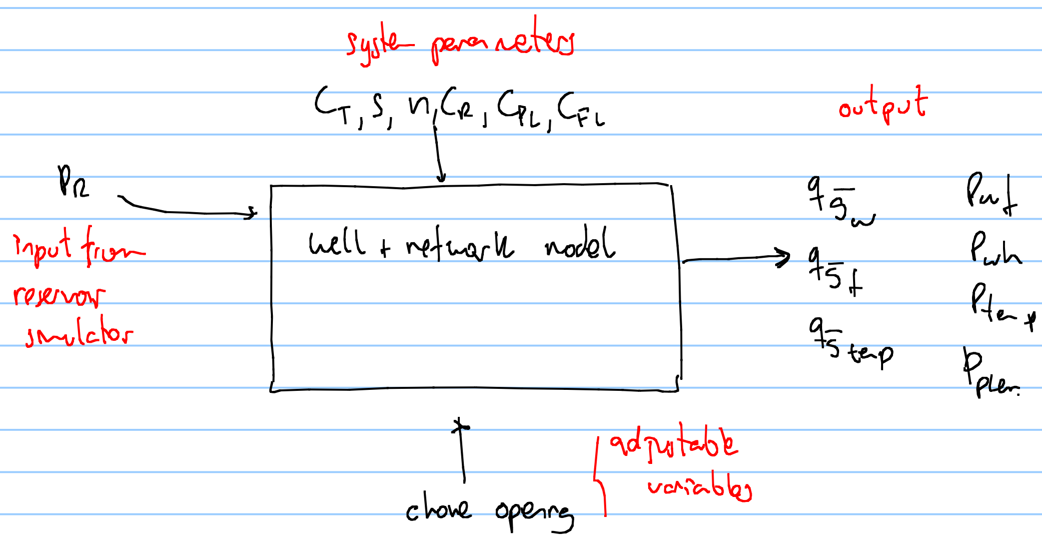
$P_R = 115$ bara

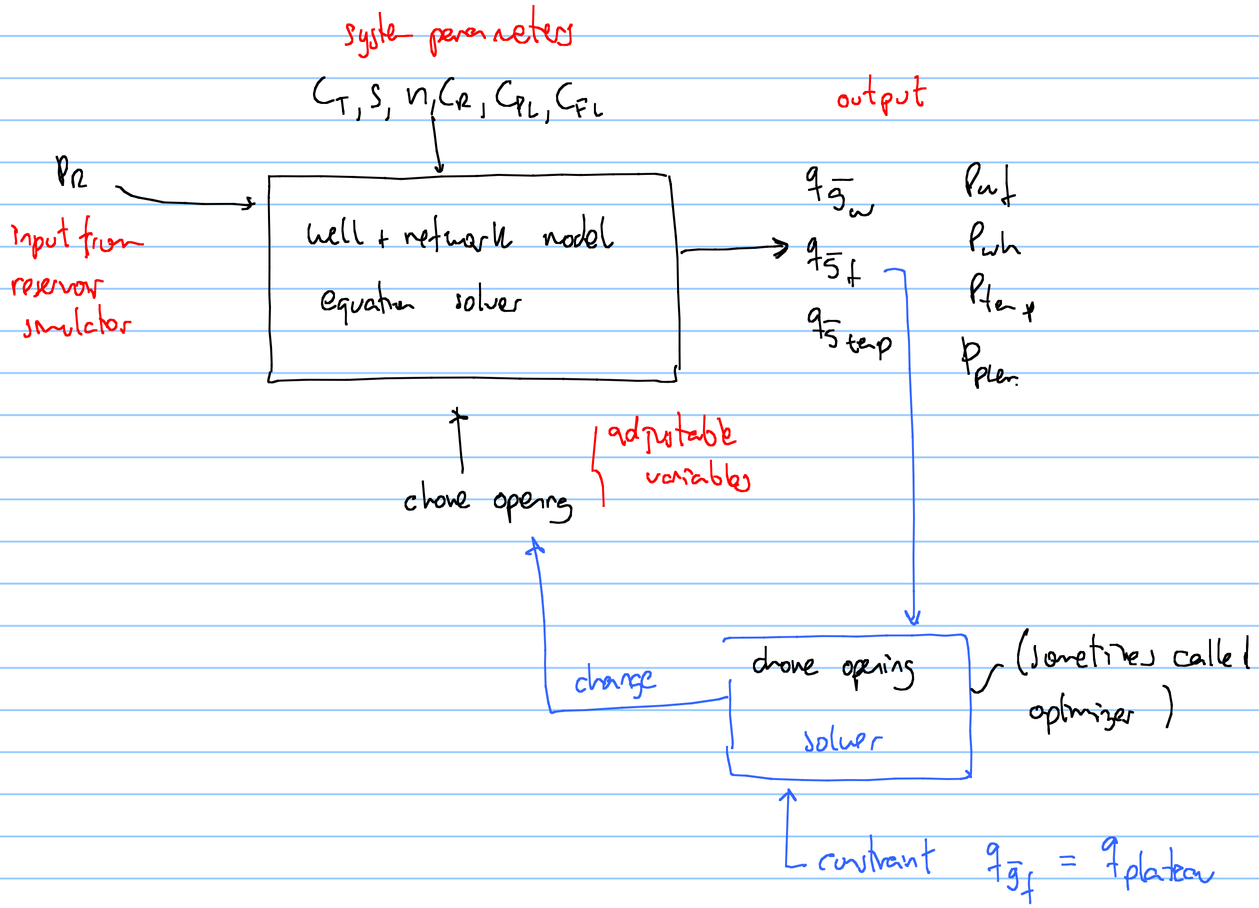


In reality the well+network simulator works differently, as a system of equations solver

for example

		EQUATIONS	UNKNOWNS
IPR	$q_{\bar{g}_w} = C_R \left(P_R^2 - P_{wf}^2\right)^n$	1	2
TPR	$q_{\bar{g}_w} = C_T \left(\frac{P_{wf}^2}{e^S} - P_{wh}^2\right)^{0.5}$	2	3
FPR	$q_{\bar{g}_T} = C_{FL} \left(P_{Temp}^2 - P_{PLEM}^2\right)^{0.5}$	3	6
PPR	$q_{\bar{g}_f} = C_{PL} \left(P_{PLEM}^2 - P_{sep}^2\right)^{0.5}$	4	7
choke	$q_{\bar{g}_f} = f\left(P_{wh}, P_{temp}, \text{opening}\right)$	5	7 (if opening is given)
	$q_{\bar{g}_w} = q_f / N_w$	6	7
	$q_{\bar{g}_t} = q_f / N_{temp}$	7	7
		7	= 7





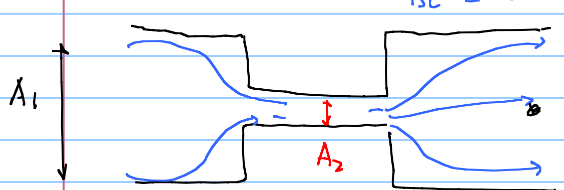
choke equation for dry gas: (page 166)

"opening" tuning factor $R = \frac{R_U}{MW_g}$ $k = \frac{C_P}{C_V}$

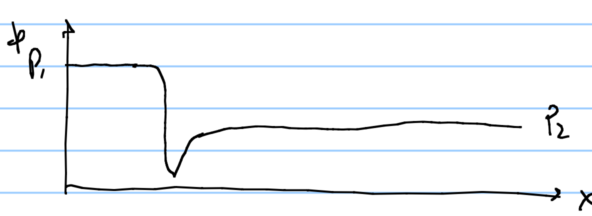
$$q_{\bar{g}} = \frac{p_1 \cdot T_{sc} \cdot A_2 \cdot C_d}{p_{sc}} \cdot \sqrt{2 \cdot \frac{R}{Z_1 \cdot T_1 \cdot M_w} \cdot \frac{k}{k-1} \cdot \left(y^{\frac{2}{k}} - y^{\frac{k+1}{k}}\right)}$$

$P_{sc} = 1.01325$ bara
$T_{sc} = 15.56\ °C$

$y = \frac{P_2 \text{ (downstream)}}{P_1 \text{ (upstream)}}$



if $y > y_c \simeq (0.6)$, there is critical flow at the throat



if $y > y_c$ $\quad q_{\bar{g}} = q_{\bar{g}_c} =$

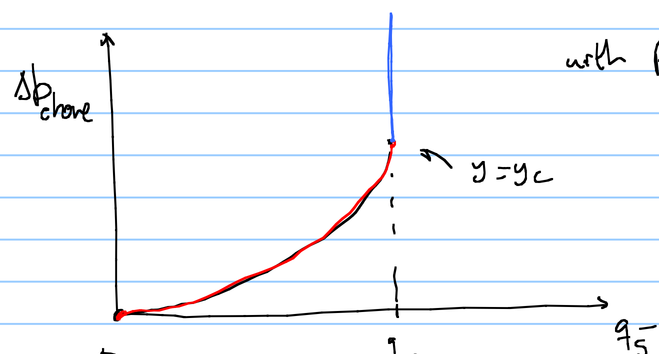
$$q_{\bar{g}} = \frac{p_1 \cdot T_{sc} \cdot A_2 \cdot C_d}{p_{sc}} \cdot \sqrt{2 \cdot \frac{R}{Z_1 \cdot T_1 \cdot M_w} \cdot \frac{k}{k-1} \cdot \left(y_c^{\frac{2}{k}} - y_c^{\frac{k+1}{k}}\right)}$$

in blue

if $y < y_c$

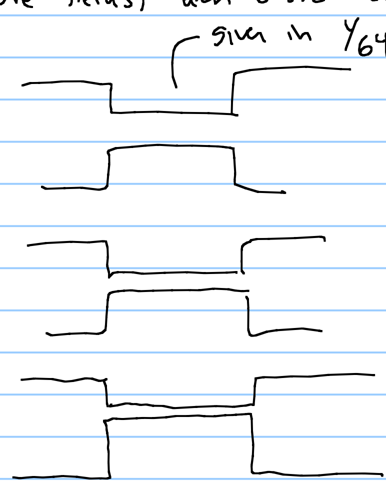
$$q_{\bar{g}} = \frac{p_1 \cdot T_{sc} \cdot A_2 \cdot C_d}{p_{sc}} \cdot \sqrt{2 \cdot \frac{R}{Z_1 \cdot T_1 \cdot M_w} \cdot \frac{k}{k-1} \cdot \left(y^{\frac{2}{k}} - y^{\frac{k+1}{k}}\right)}$$

in red

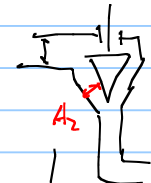


$q_{\bar{g}_c}$ (flow is "choked", critical flow)

in onshore fields, bean choke are often used



offshore often adjustable chokes are used
needle choke



adjustable throat area