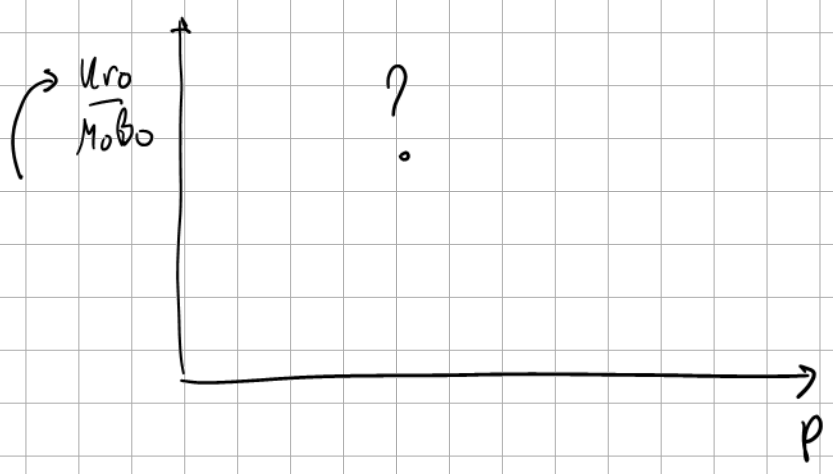


(1941) Evinger and Muskat

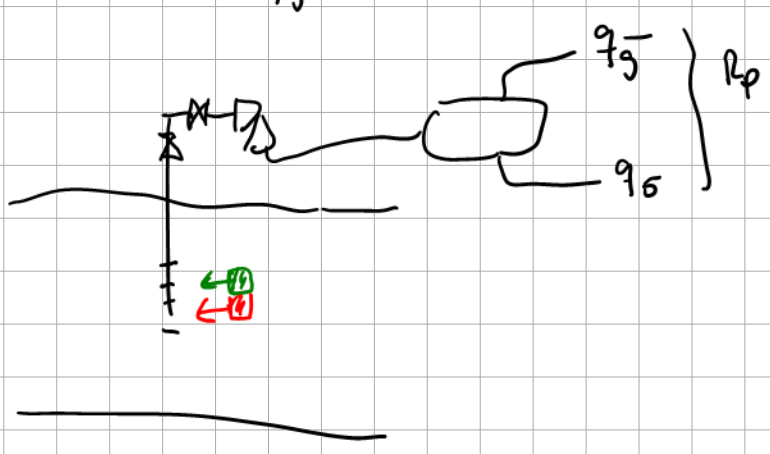
Calculation of Theoretical Productivity Factor

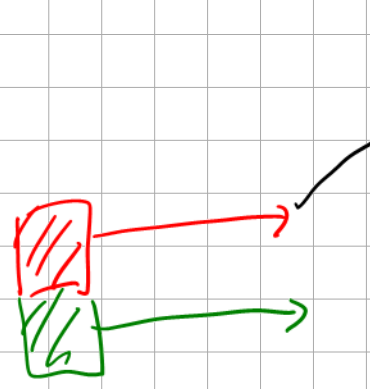
BY H. H. EVINGER* AND M. MUSKAT*

(New York Meeting, February 1941)

$k_{ro} = f(p)$

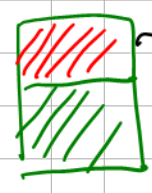
$$GOR = R_p = \frac{q_{\bar{g}}}{q_{\bar{o}}} = \frac{q_{\bar{g}}}{q_{\bar{o}}} = \frac{q_{\bar{g}g} + q_{\bar{g}o}}{q_{\bar{o}o}} = \frac{q_{\bar{g}g}}{q_{\bar{o}o}} + \frac{q_{\bar{g}o}}{q_{\bar{o}o}} = \frac{q_{\bar{g}g}}{q_{\bar{o}o}} + R_s(p)$$





$q_{\bar{g}} = q_{\bar{g}g} + q_{\bar{g}o}$

$q_{\bar{o}} = q_{\bar{o}g} + q_{\bar{o}o}$



very small

$q_{\bar{g}g} << q_{\bar{o}o}$

$q_{\bar{o}} = q_{\bar{o}o}$

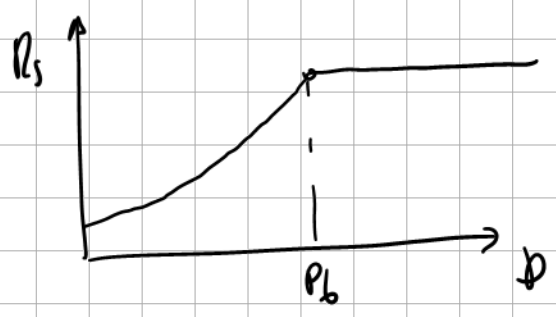
$$\frac{q_{\bar{g}g}}{q_{\bar{o}o}} = \frac{q_g}{B_g}\frac{B_o}{q_o} = \frac{k_{rg}}{k_{ro}}\frac{\mu_o B_o}{\mu_g B_g}$$

$$R_s = \frac{q_{\bar{g}o}}{q_{\bar{o}o}} \qquad R_s(p) \text{ solution gas oil ratio}$$

$$\frac{q_g}{q_o} = \frac{k_{rg}}{\mu_g}\frac{\mu_o}{k_{ro}}$$

$$v_g = \frac{k_{rg}}{\mu_g} k \frac{dp}{dx}$$

$$v_o = \frac{k_{ro}}{\mu_o} k \frac{dp}{dx}$$



$$\frac{v_o}{v_{\bar{o}}} = b_o = \frac{q_o}{q_{\bar{o}o}}$$

$$\frac{v_g}{v_{\bar{g}}} = b_g = \frac{q_g}{q_{\bar{g}g}}$$

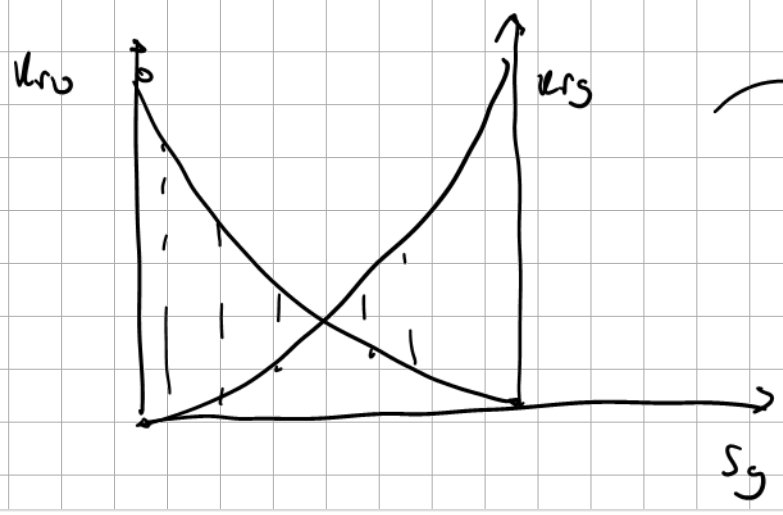
$$R_p = \frac{k_{rg}}{k_{ro}}\frac{\mu_o B_o}{\mu_g B_g} + R_s(p)$$

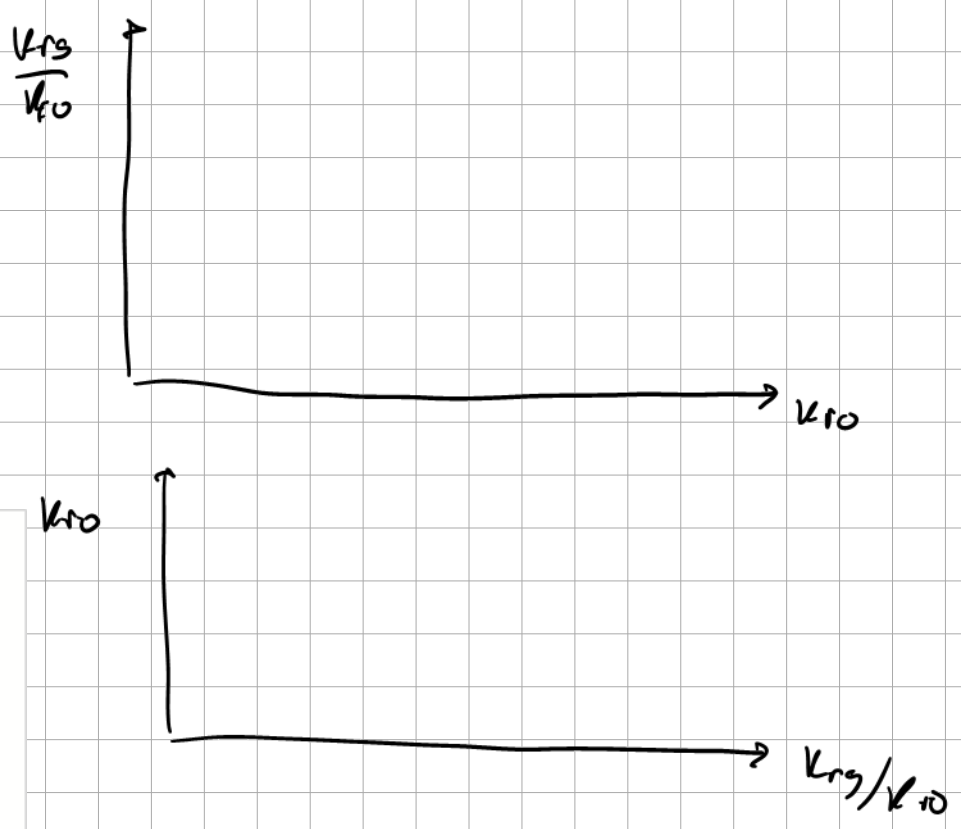
$f(p)$ $f(p)$ $f(p)$

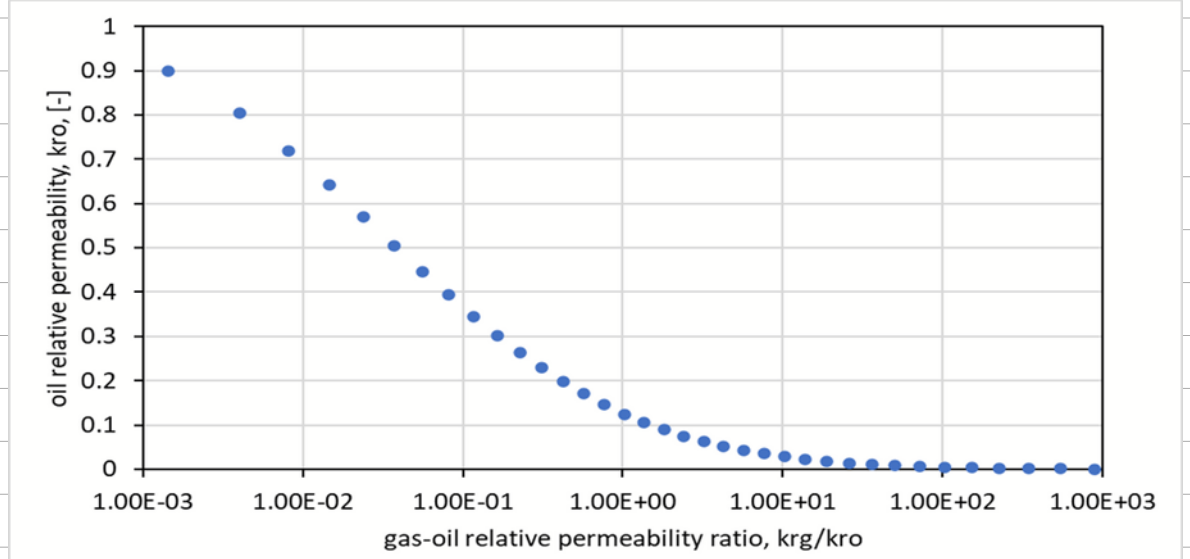
measured

$$\frac{k_{rg}}{k_{ro}} = \frac{\mu_g B_g}{\mu_o B_o}\left(R_p - R_s\right) \qquad (1)$$

but we need k_{ro}, NOT $\frac{k_{rg}}{k_{ro}}$



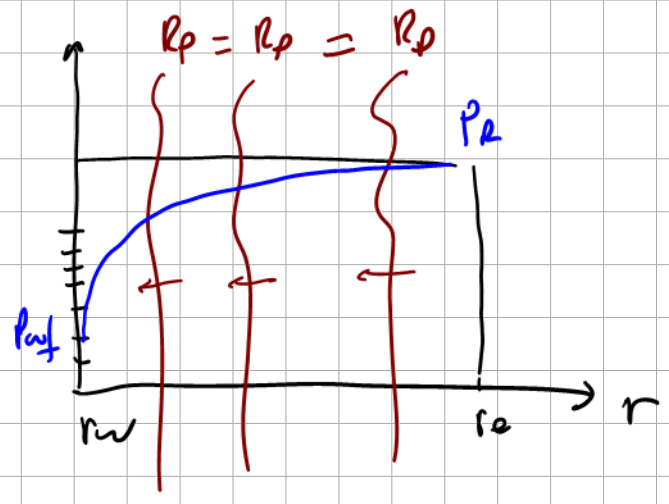




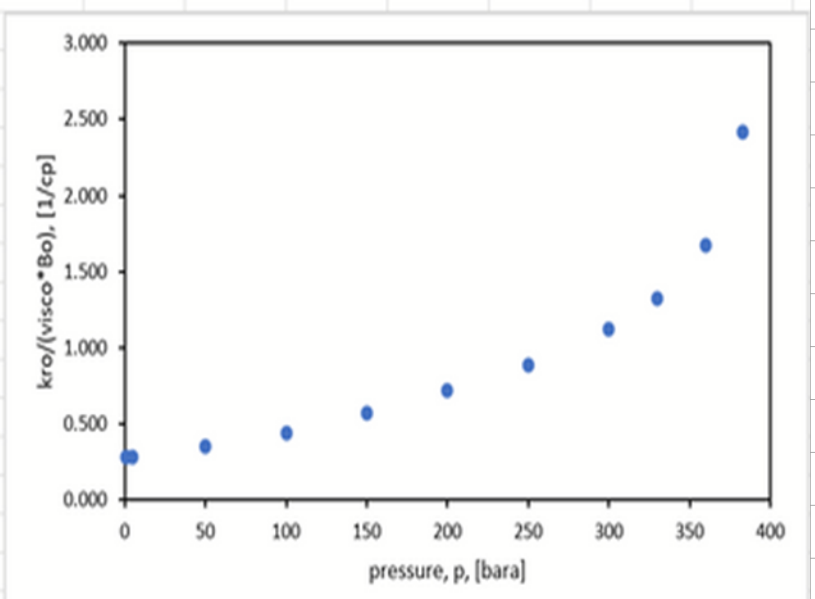
1) from (1) at $p \rightsquigarrow \frac{k_{rg}}{k_{ro}}$

2) from (2) with $\frac{k_{rg}}{k_{ro}} \rightsquigarrow k_{ro}$

3) k_{ro} f(p)



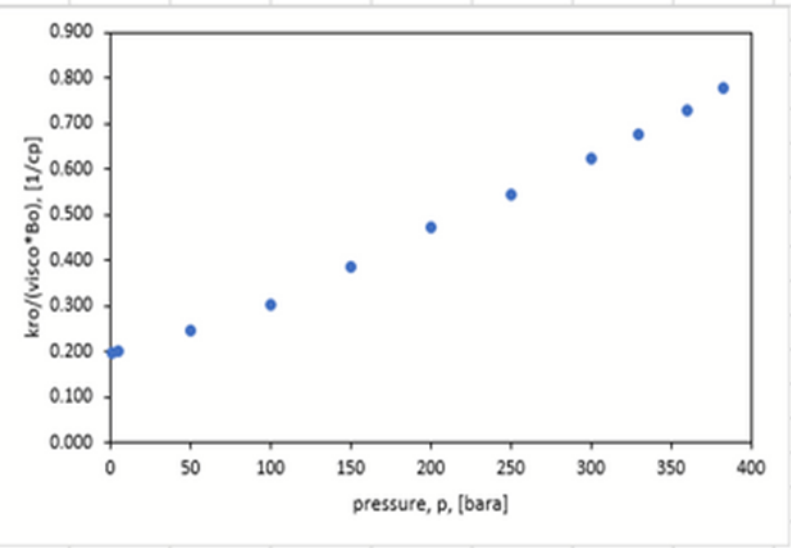
Rp	[Sm3/Sm3]	300								
COLUMN		4	6	3	5	2				
p		Rs	viscg	Bg	Visco	Bo	krg/kro	kro	kro/(visco*Bo)	So
[bara]		[Sm3/Sm3]	[cp]	[m3/Sm3]	[cp]	[m3/Sm3]	[-]	[-]	[1/cp]	[-]
	1	0.5	1.12E-02	2.66E-02	1.4	1.2	5.54E-02	4.49E-01	0.277	0.60
	5	2.6	1.14E-02	2.59E-02	1.4	1.2	5.50E-02	4.50E-01	0.282	0.60
	50	25.5	1.32E-02	1.81E-02	1.1	1.2	4.96E-02	4.67E-01	0.352	0.60
	100	48.8	1.58E-02	1.22E-02	0.9	1.2	4.46E-02	4.82E-01	0.443	0.60
	150	76.4	1.82E-02	8.20E-03	0.7	1.3	3.81E-02	5.03E-01	0.573	0.61
	200	107.2	2.14E-02	6.25E-03	0.5	1.4	3.65E-02	5.09E-01	0.722	0.61
	250	143.9	2.51E-02	5.29E-03	0.4	1.5	3.59E-02	5.12E-01	0.888	0.61
	300	187.9	2.90E-02	4.69E-03	0.3	1.6	3.23E-02	5.29E-01	1.121	0.62
	330	220.4	3.15E-02	4.45E-03	0.3	1.7	2.65E-02	5.57E-01	1.322	0.62
	360	258.3	3.41E-02	4.26E-03	0.2	1.8	1.61E-02	6.29E-01	1.672	0.64
	383	292.6	3.60E-02	4.14E-03	0.2	1.9	3.19E-03	8.34E-01	2.414	0.67



NOT LINEAR!!!

For higher GOR

Rp	[Sm3/Sm3]	800								
COLUMN		4	6	3	5	2				
p		Rs	viscg	Bg	Visco	Bo	krg/kro	kro	kro/(visco*Bo)	So
[bara]		[Sm3/Sm3]	[cp]	[m3/Sm3]	[cp]	[m3/Sm3]	[-]	[-]	[1/cp]	[-]
	1	0.5	1.12E-02	2.66E-02	1.4	1.2	1.48E-01	3.17E-01	0.196	0.56
	5	2.6	1.14E-02	2.59E-02	1.4	1.2	1.47E-01	3.17E-01	0.199	0.56
	50	25.5	1.32E-02	1.81E-02	1.1	1.2	1.40E-01	3.24E-01	0.244	0.56
	100	48.8	1.58E-02	1.22E-02	0.9	1.2	1.33E-01	3.30E-01	0.304	0.56
	150	76.4	1.82E-02	8.20E-03	0.7	1.3	1.23E-01	3.40E-01	0.387	0.56
	200	107.2	2.14E-02	6.25E-03	0.5	1.4	1.31E-01	3.32E-01	0.471	0.56
	250	143.9	2.51E-02	5.29E-03	0.4	1.5	1.51E-01	3.14E-01	0.545	0.56
	300	187.9	2.90E-02	4.69E-03	0.3	1.6	1.77E-01	2.95E-01	0.624	0.55
	330	220.4	3.15E-02	4.45E-03	0.3	1.7	1.93E-01	2.85E-01	0.675	0.54
	360	258.3	3.41E-02	4.26E-03	0.2	1.8	2.09E-01	2.75E-01	0.730	0.54
	383	292.6	3.60E-02	4.14E-03	0.2	1.9	2.19E-01	2.69E-01	0.778	0.54



LINEAR??