كلية الهندسة – جامعة مصراته

القسم: الهندسة النفطية
الزمن: ساعتان ونصف
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الامتحان النهائي

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أجب عن جميع الأسئلة الآتية

Q1/ i) What is the Defining Enhanced Oil Recovery (EOR)? ***3Mark***

ii) What is the Effects of Microbial EOR: ***3 Mark***

iii) Heat at an amount of 15×10^6 Btu/hr is injected as wet steam into a formation 77 ft thick for a period of 450 days followed by cold water injection for another 450 days. ***Calculate the vertical heat loss to adjacent strata.*** Using WILLMAN.ET.AL Curve

Thermal diffusivity = 0.94 ft^2/dat.

6Mark

Q2/ i) Describe cyclic steam injection and explain when and why the process results in higher oil rates and also high recoveries.

3Mark

ii)Assuming the formation temperature 100°F , steam quality is 65% and steam injection, the wet steam enthalpy is 1000 Btu/Ibm and water enthalpy at 100°F 69.7 Btu/Ibm, and steam injection rate is 960 bll/daysteam loss 0.45 and steam temperature 515 °F , heat capacity of the rock is 34 Btu/ft^3.°F , formation t thickness 65 ft . Where C= 350 Ibm/bll

Calculate: the heated radius. ***6Mark***

Q3/ i) What is the Thermal recovery process? ***3Mark***

ii) Steam generators are used to inject 1380bbl/day wet steam having 70 percent quality at 1200psia sand-face pressure into a formation 65ft thick. Assuming radial and uniform propagation of heat, ***Calculate the oil displaced by stem drive and the cumulative heated area if the injection period in five (5) years.***

The reservoir rock characteristics are as follows:

ϕ = 25% So = 65% Sor = 17% $T_{initial\ Res.\ Tem.}\cong162.24°F$

Ms = 32Btu/ft^3.°F D = 0.72 ft^2/day K = 0.95 Btu/ft . hr.°F

h_{water} = enthalph of water @ initial res. Temp = 1001 Btu/Ib_m

10Mark

Q4) i) What is the problems of carbon dioxide in the enhanced oil recover ? ***3Mark***

ii) Calculate the final oil recovery factors at a water oil ratio 1 , 5 , 25 and 100, expected through conventional water injection and polymer water flooding .

plot WOR Vs. recovery factor.

Irreducible water saturation = 25% Relative permeability for water= 0.20

Relative permeability for oil = 0.58 Water viscosity = 1 cp

Oil Viscosity = 7 cp Permeability variation = 0.60

Formation Volume factor for oil = 1.05 RBLL/STB Resistance factor = 6

10Mark

Q5) i) What is the Mechanism: In-situ combustion ? ***3 Mark***

ii) Calculate the final oil recovery factors at a water oil ratio 1 , 5 , 25 and 100, expected through conventional water injection using Johnson's curves.

At Swi and Sor and Swc

primary Recovery = 10% Water viscosity = 1 cp

Oil Viscosity = 7 cp Permeability variation = 0.30

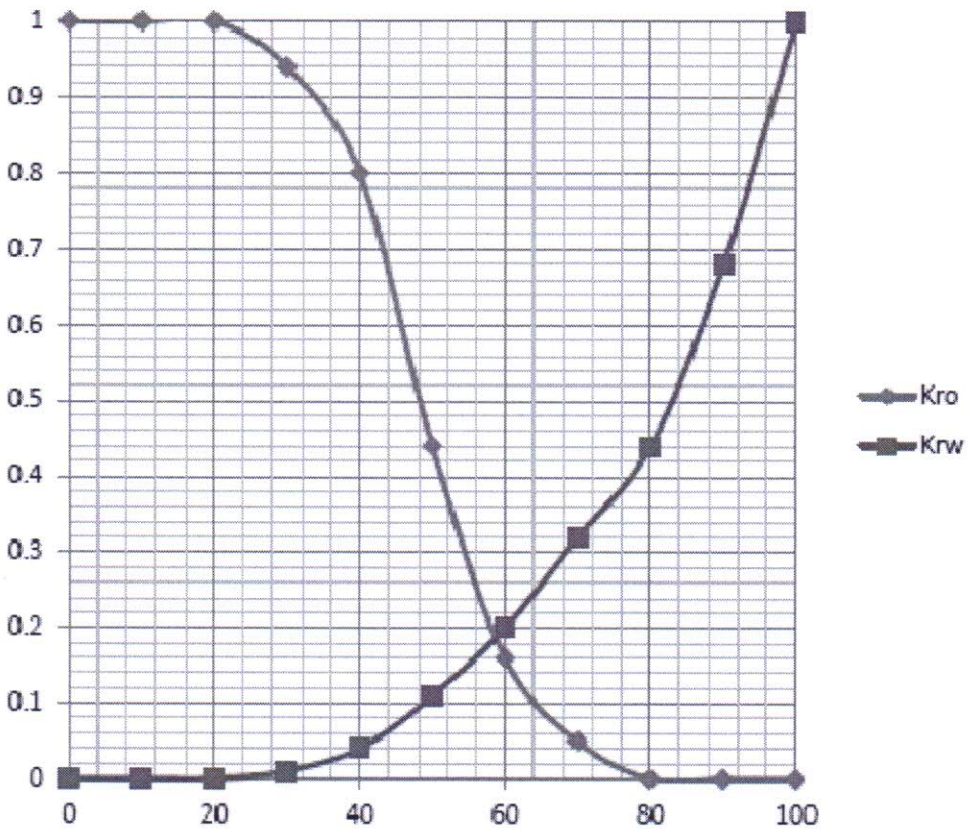
Formation Volume factor for water = 1.05 RBLL/STB Resistance factor = 6

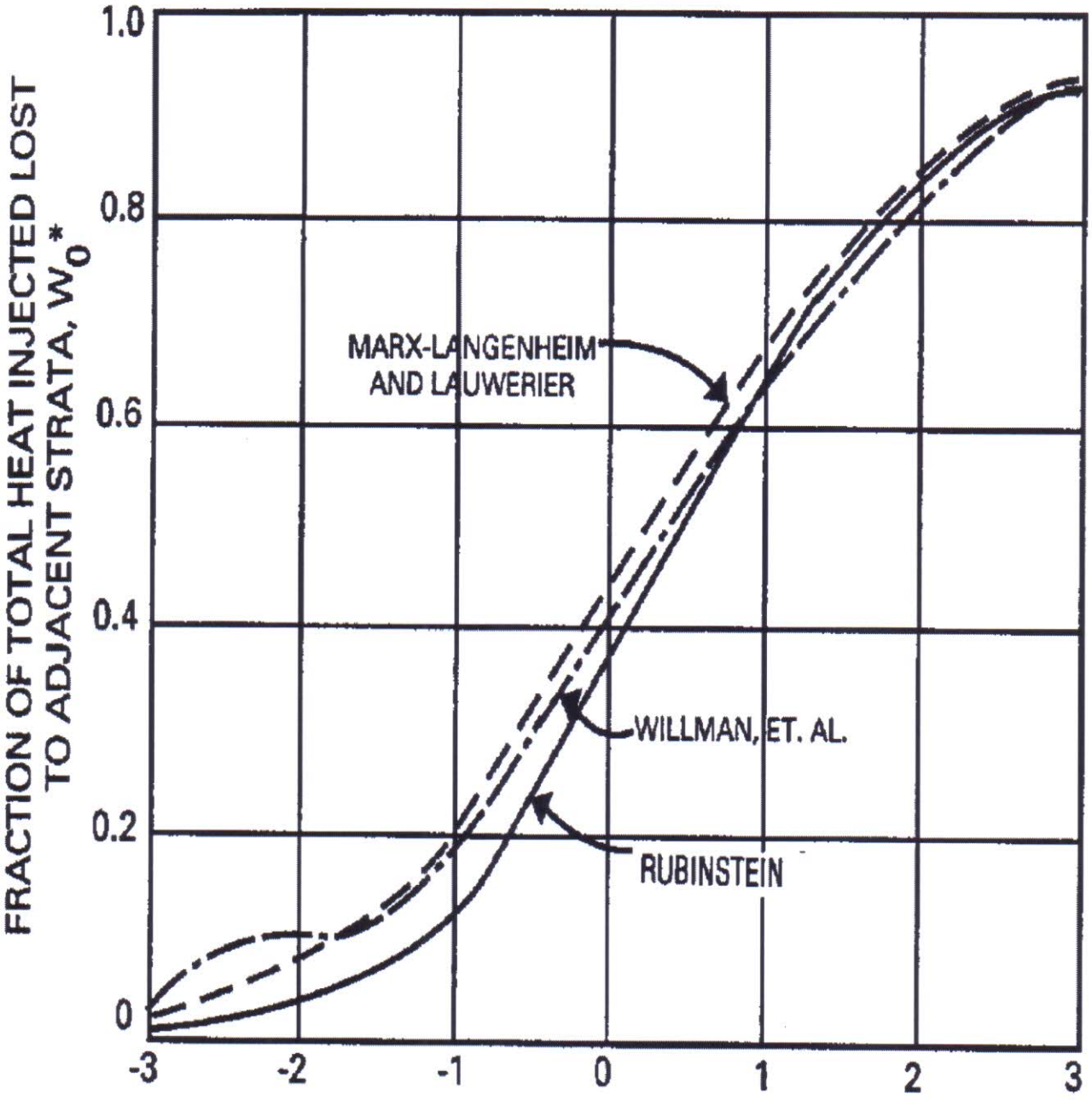
Formation Volume factor for oil= 1.15 RBLL/STB

10 Mark

انتهت الأسئلة

$t_D = \dfrac{4D \times t}{h^2}$	$(W_o)_t = \dfrac{t}{t_o}\left[(W_o^*)_t - \left(\dfrac{t - t_o}{t}\right)(W_o^*)_{t-t_o}\right]$
$r_h = \sqrt{\dfrac{Q_f}{\pi \times M_s(T_i - T) \times h}}$ ft	$x = \left(\dfrac{2K}{M_s h\sqrt{D}}\right)t^{0.5}$
$D = \dfrac{K}{\rho_e C_e}$	$V_o = 4.273\left[\dfrac{H_o \phi(S_o - S_{or})}{M_s \Delta T}\right] \times (e^{x^2}\,\mathrm{erfc}\,x)$
$A(t) = \left(\dfrac{H_o M_s hD}{4K^2 \Delta T}\right)\left(e^{x^2}\,\mathrm{erfc}\,x + \dfrac{x}{\sqrt{\pi}} - 1\right)$	$\dfrac{A(t) \times h}{43{,}560} \times 7758(\phi)(S_o - S_{or})$




FRACTION OF TOTAL HEAT INJECTED LOST TO ADJACENT STRATA, W_0*
1.0
0.8
0.6
0.4
0.2
0
-3
-2
-1
0
1
2
3
MARX-LANGENHEIM AND LAUWERIER
WILLMAN, ET. AL.
RUBINSTEIN
$LOG_{10}\ t_D = LOG_{10}\left(\frac{4Dt}{h^2}\right)$

Properties of Saturated Steam

(Abstracted from Keenan and Keyes, THERMODYNAMIC PROPERTIES OF STEAM, by permission of John Wiley & Sons, Inc.)

	Col. 1 Gauge Pressure	Col. 2 Absolute Pressure (psia)	Col. 3 Steam Temp. (°F)	Col. 4 Heat of Sat. Liquid (Btu/lb)	Col. 5 Latent Heat (Btu/lb)	Col. 6 Total Heat of Steam (Btu/lb)	Col. 7 Specific Volume of Sat. Liquid (cu ft/lb)	Col. 8 Specific Volume of Sat. Steam (cu ft/lb)
Inches of Vacuum	29.743	0.08854	32.00	0.00	1075.8	1075.8	0.096022	3306.00
	29.515	0.2	53.14	21.21	1063.8	1085.0	0.016027	1526.00
	27.886	1.0	101.74	69.70	1036.3	1106.0	0.016136	333.60
	19.742	5.0	162.24	130.13	1001.0	1131.	0.016407	73.52
	9.562	10.0	193.21	161.17	982.1	1143.3	0.016590	38.42
	7.536	11.0	197.75	165.73	979.3	1145.0	0.016620	35.14
	5.490	12.0	201.96	169.96	976.6	1146.6	0.016647	32.40
	3.454	13.0	205.88	173.91	974.2	1148.1	0.016674	30.06
	1.418	14.0	209.56	177.61	971.9	1149.5	0.016699	28.04
PSIG	0.0	14.696	212.00	180.07	970.3	1150.4	0.016715	26.80
	1.3	16.0	216.32	184.42	967.6	1152.0	0.016746	24.75
	2.3	17.0	219.44	187.56	965.5	1153.1	0.016768	23.39
	5.3	20.0	227.96	196.16	960.1	1156.3	0.016830	20.09
	10.3	25.0	240.07	208.42	952.1	1160.6	0.016922	16.30
	15.3	30.0	250.33	218.82	945.3	1164.1	0.017004	13.75
	20.3	35.0	259.28	227.91	939.2	1167.1	0.017078	11.90
	25.3	40.0	267.25	236.03	933.7	1169.7	0.017146	10.50
	30.3	45.0	274.44	243.36	928.6	1172.0	0.017209	9.40
	40.3	55.0	287.07	256.30	919.6	1175.9	0.017325	7.79
	50.3	65.0	297.97	267.50	911.6	1179.1	0.017429	6.66
	60.3	75.0	307.60	277.43	904.5	1181.9	0.017524	5.82
	70.3	85.0	316.25	286.39	897.8	1184.2	0.017613	5.17
	80.3	95.0	324.12	294.56	891.7	1186.2	0.017696	4.65
	90.3	105.0	331.36	302.10	886.0	1188.1	0.017775	4.23
	100.0	114.7	337.90	308.80	880.0	1188.8	0.017850	3.88
	110.3	125.0	344.33	315.68	875.4	1191.1	0.017922	3.59
	120.3	135.0	350.21	321.85	870.6	1192.4	0.017991	3.33
	125.3	140.0	353.02	324.82	868.2	1193.0	0.018024	3.22
	130.3	145.0	355.76	327.70	865.8	1193.5	0.018057	3.11
	140.3	155.0	360.50	333.24	861.3	1194.6	0.018121	2.92
	150.3	165.0	365.99	338.53	857.1	1195.6	0.018183	2.75
	160.3	175.0	370.75	343.57	852.8	1196.5	0.018244	2.60
	180.3	195.0	379.67	353.10	844.9	1198.0	0.018360	2.34
	200.3	215.0	387.89	361.91	837.4	1199.3	0.018470	2.13
	225.3	240.0	397.37	372.12	828.5	1200.6	0.018602	1.92
	250.3	265.0	406.11	381.60	820.1	1201.7	0.018728	1.74
		300.0	417.33	393.84	809.0	1202.8	0.018896	1.54
		400.0	444.59	424.00	780.5	1204.5	0.019340	1.16
		450.0	456.28	437.20	767.4	1204.6	0.019547	1.03
		500.0	467.01	449.40	755.0	1204.4	0.019748	0.93
		600.0	486.21	471.60	731.6	1203.2	0.02013	0.77
		900.0	531.98	526.60	668.8	1195.4	0.02123	0.50
		1200.0	567.22	571.70	611.7	1183.4	0.02232	0.36
		1500.0	596.23	611.60	556.3	1167.9	0.02346	0.28
		1700.0	613.15	636.30	519.6	1155.9	0.02428	0.24
		2000.0	635.82	671.70	463.4	1135.1	0.02565	0.19
		2500.0	668.13	730.60	360.5	1091.1	0.02860	0.13
		2700.0	679.55	756.20	312.1	1068.3	0.03027	0.11
		3206.2	705.40	902.70	0.0	902.7	0.05053	0.05

TABLE 4-1. Error Function Values

x	$e^{x^2}\operatorname{erfc} x$	$e^{x^2}\operatorname{erfc} x + \frac{2x}{\sqrt{\pi}} - 1$	x	$e^{x^2}\operatorname{erfc} x$	$e^{x^2}\operatorname{erfc} x + \frac{2x}{\sqrt{\pi}} - 1$	x	$e^{x^2}\operatorname{erfc} x$	$e^{x^2}\operatorname{erfc} x + \frac{2x}{\sqrt{\pi}} - 1$
0.00	1.00000	0.00000	1.00	0.42758	0.55596	4.00	0.12248	4.20019
.02	.97783	.00039	.05	.41430	.59910	.60	.11994	.31048
.04	.95642	.00155	.10	.40173	.64295	.70	.11749	.42087
.06	.93574	.00344	.15	.38983	.68746	.80	.11514	.53136
.08	.91576	.00603	.20	.37854	.73259	.90	.11288	.64194
0.10	0.89646	0.00929	1.25	0.36782	0.77830	5.00	0.11070	4.75260
.12	.87779	0.1320	.30	.35764	.82454	.20	.10659	4.97417
.14	.85974	.01771	.35	.34796	.87127	.40	.10277	5.19602
.16	.84228	.02282	.40	.33874	.91847	.60	.09921	.41814
.18	.82538	.02849	.45	.32996	.096611	.80	.09589	.64049
0.20	0.80902	0.03470	1.50	0.32159	1.01415	6.00	0.09278	5.86305
.22	.79318	.04142	.55	.31359	.06258	.20	.08986	6.08581
.24	.77784	.04865	.60	.30595	.11136	.40	.08712	.30874
.26	.76297	.05635	.65	.29865	.16048	.60	.08453	.53184
.28	.74857	.06451	.70	.29166	.20991	.80	.08210	.75508
0.30	0.73460	0.07311	1.75	0.28497	1.25964	7.00	0.07980	6.97845
.32	.72106	.08214	.80	.27856	.30964	.20	.07762	7.20195
.34	.70792	.09157	.85	.27241	.35991	.40	.07556	.42557
.36	.69517	.10139	.90	.26651	.41043	.60	.07361	.64929
.38	.68280	.11158	.95	.26084	.46118	.80	.07175	7.87311
0.40	0.67079	0.12214	2.00	0.25540	1.51215	8.00	0.06999	8.09702
.42	.65912	.13304	.05	.25016	.56334	.20	.06830	.32101
.44	.64779	.14428	.10	.24512	.61472	.40	.06670	.54508

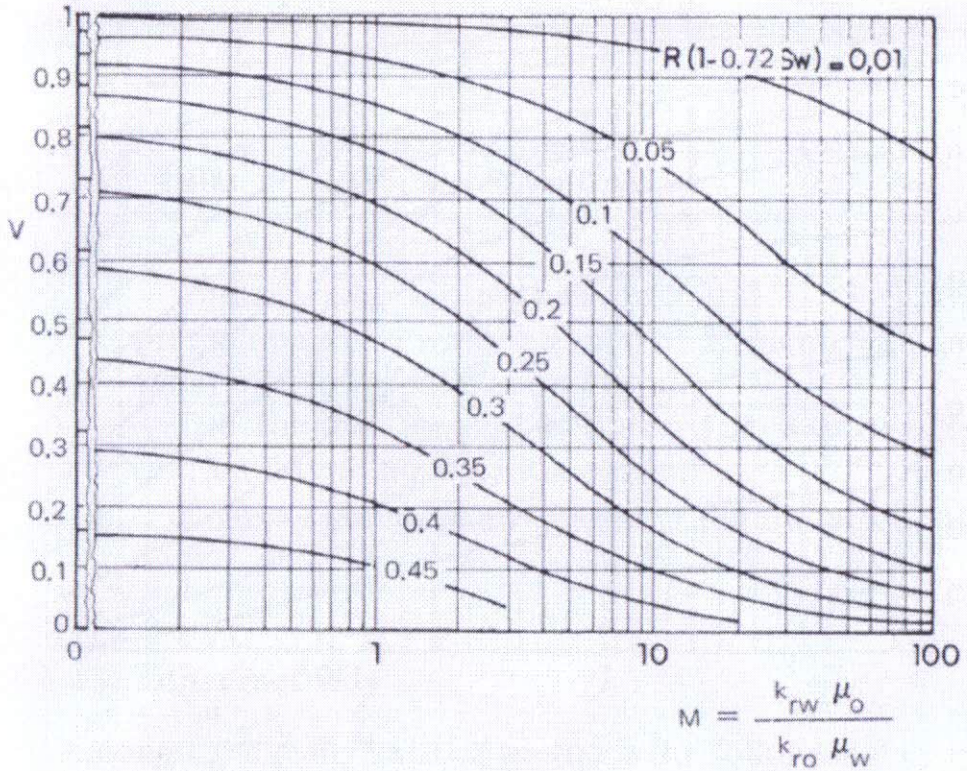


Fig. 25.122. Johnson's correlation for a producing WOR of 5.

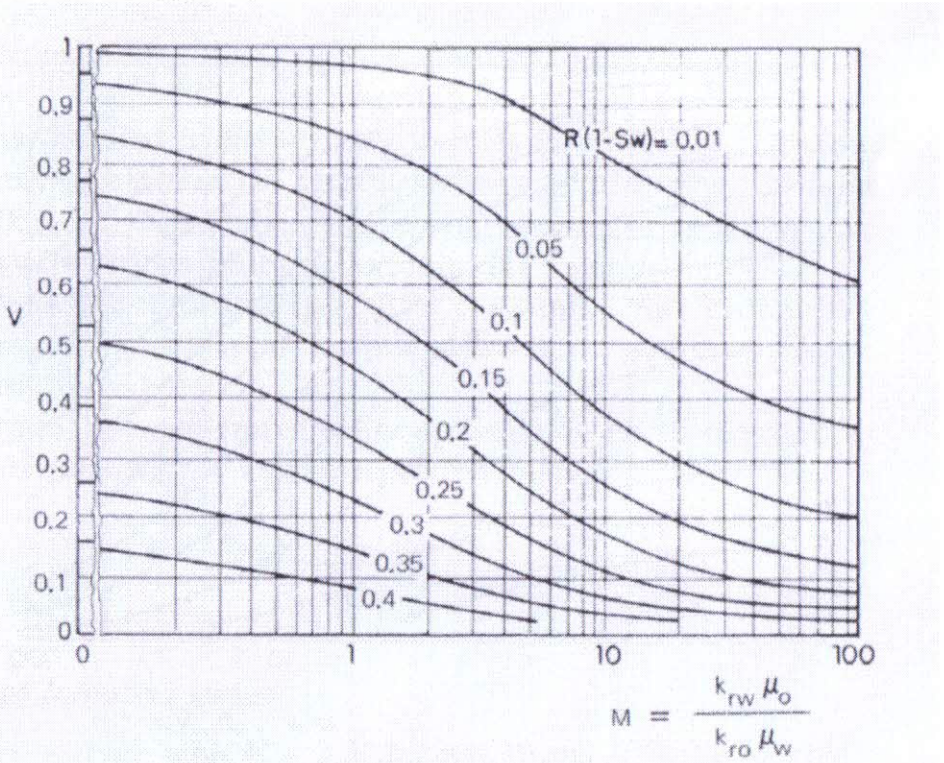


Fig. 25.121. Johnson's correlation for a producing WOR of 1.

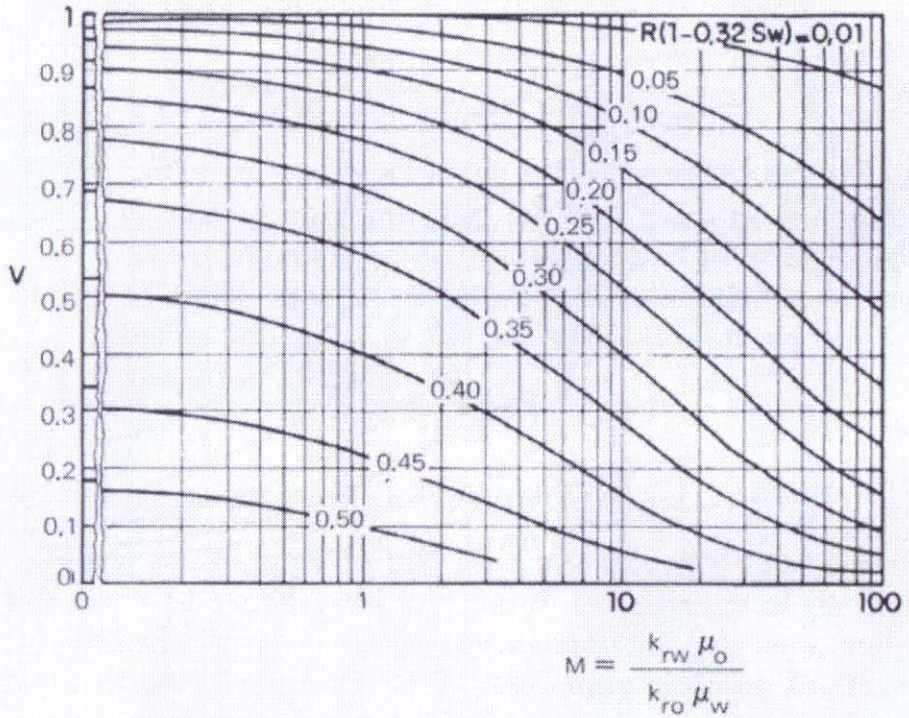


Fig. 25.123. Johnson's correlation for a producing WOR of 25.

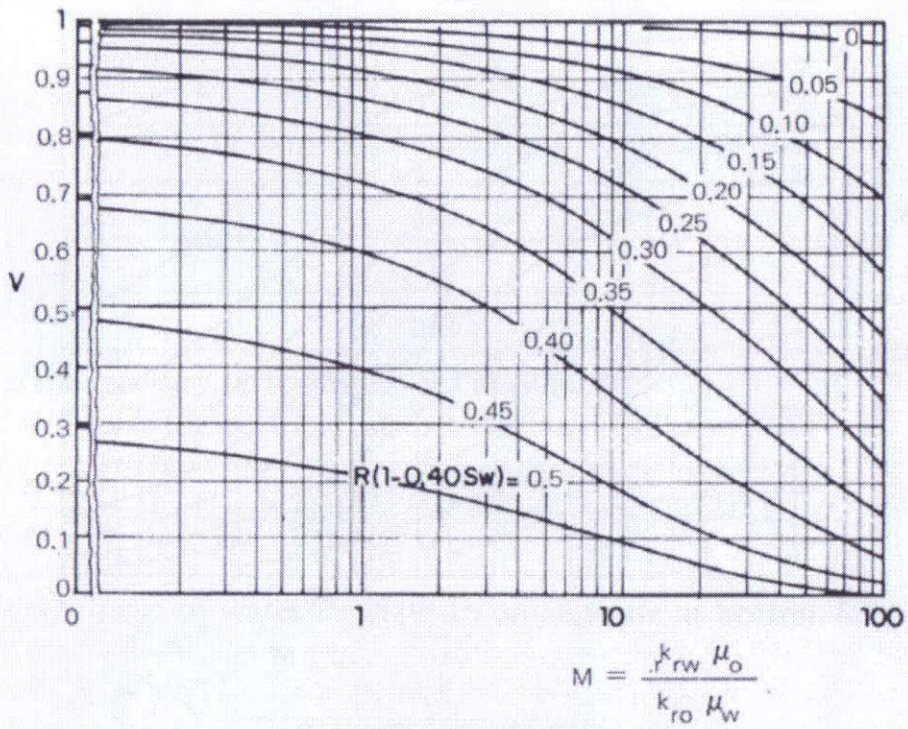


Fig. 25.124. Johnson's correlation for a producing WOR of 100.