TEST EXERCISES

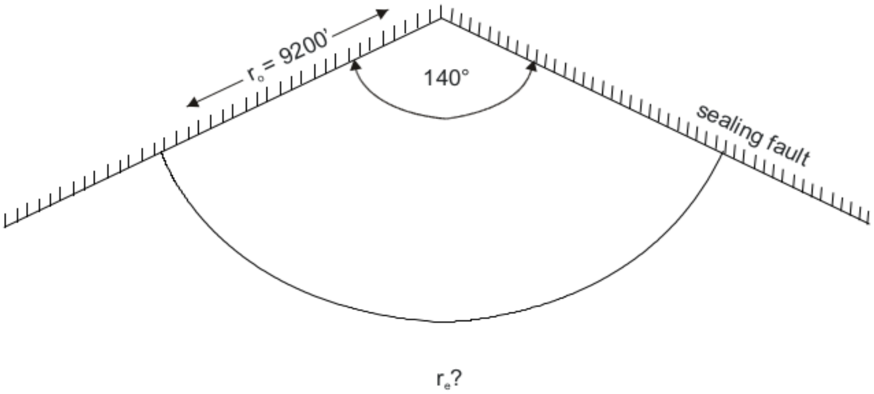
Using a computer aided approach, solve the problems below.

Instruction: You may use any programming tool/Language: Excel VBA, Python, MATLAB, C# etc.

Exercise One (From L.P. Dake Exercise 9.2)

A wedge-shaped reservoir is suspected of having a fair strong natural water drive. The geometry of the reservoir-aquifer system is shown below. The reservoir was at bubble point at the initial condition with no gas cap (m=0). Develop a computer program that will Perform history matching of the reservoir using the production and PVT data given below.

Hint: Use Klins et al paper: "A Polynomial approach to the Van Everdingen - Hurst dimensionless variables for water encroachment"



Properties common to the reservoir and aquifer

h	=	100 ft
k	=	200 mD
μ_w	=	0.55 cp
ϕ	=	0.25
c_w	=	3.0×10^{-6} /psi
c_f	=	4.0×10^{-6} / psi
B_w	=	1.0

Reservoir properties

N	=	312×10^{6} stb
S_{wc}	=	0.05

The PVT data are given in the table below:

Time (years)	Pressure at the O.W.C. (psia)	Plateau Pressure levels (psia)	Δp (psi)
0	2740 (p_i)		120
1	2500	2620	225
2	2290	2395	196
3	2109	2199	170
4	1949	2029	146
5	1818	1883	123
6	1702	1760	105
7	1608	1655	84
8	1635	1571	64
9	1480	1507	47
10	1440	1460	

Time (years)	N_p (MM/stb)	R_p (scf/stb)	B_o (rb/stb)	R_s (scf/stb)	B_g (rb/scf)
0		650 (R_{si})	1.404(B_{oi})	650 (R_{si})	.00093 (B_{gi})
1	7.88	760	1.374	592	.00098
2	18.42	845	1.349	545	.00107
3	29.15	920	1.329	507	.00117
4	40.69	975	1.316	471	.00128
5	50.14	1025	1.303	442	.00139
6	58.42	1065	1.294	418	.00150
7	65.39	1095	1.287	398	.00160
8	70.74	1120	1.280	383	.00170
9	74.54	1145	1.276	381	.00176
10	77.43	1160	1.273	364	.00182

Exercise Two

The equation given by Hall and Yarborough (Ikoku, 1984) is given below:

$$z = \frac{0.06125 P_{pr} t e^{-1.2(1-t)^2}}{y}$$

Where t = 1 / Tpr, and y = the reduced density which is obtained as the solution of the equation:

$$\mathrm{F(y)} = -0.06125 P_{pr} t e^{-1.2(1-t)^2} + \frac{y + y^2 + y^3 - y^4}{(1-y)^3} - (14.76t - 9.76t^2 + 4.58t^3)y^2 + (90.7t - 242.2t^2 + 42.4t^3)y^{(2.18+2.82t)}$$

Ppr is defined as the Pseudo Reduced Pressure; while Tpr is defined as the Pseudo Reduced Temperature.

Ppc = 677 + 15.0 γ_g - 37.5 γ_g^2; and Tpc = 168 + 325 γ_g - 12.5 γ_g^2, where γ_g is the specific gravity.

For Natural gas with specific gravity of 0.7, at a pressure of 2000 psia and a temperature of 180 deg Fahrenheit, use the equations above to calculate the z-factor, considering the presence of the non-hydrocarbon components: N_2 = 0.5%, CO_2 = 2% and H_2S = 0.1%.

REFERENCES

1. L.P Dake “Fundamentals of Reservoir Engineering” pp. 310 – 314, 1978.

2. Chi. U. Ikoku “Natural Gas Production Engineering” Wiley pp. 46 – 47, 1984.