PRODUCTION DECLINE CURVE ANALYSIS

Introduction

Production decline analysis is a traditional means of identifying well production problems and predicting well performance and life based on real production data. It uses empirical decline models that have little fundamental justifications. These models include the following:

. Exponential decline (constant fractional decline)

. Harmonic decline

. Hyperbolic decline

Although the hyperbolic decline model is more general, the other two models are degenerations of the hyperbolic decline model. These three models are related through the following relative decline rate equation (Arps, 1945):

$1/q(dq/dt) = -b(q^d)$

where b and d are empirical constants to be determined based on production data. When

$d = 0$, degenerates to an exponential decline model, and when $d = 1$, yields a harmonic decline model. When $0 < d < 1$, derives a hyperbolic decline model. The decline models are applicable to both oil and gas wells.

Model Identification

Production data can be plotted in different ways to identify a representative decline model. If the plot of log(q) versus t shows a straight line, the decline data follow an exponential decline model. If the plot of q versus Np shows a straight line, an exponential decline model should be adopted. If the plot of log(q) versus log(t) shows a straight line, the decline data follow a harmonic decline model. If the plot of Np versus log(q) shows a straight line, the harmonic decline model should be used. If no straight line is seen in these plots, the hyperbolic decline model may be verified by plotting the relative decline rate defined.

Observation and Calculation

Here we can see that the graph of log(Qo) v/s T is a straight line, so we can conclude that it is an exponential decline model.

Now we determine the decline rate (b) by the formula

$$b = \ln(Q1/Q2)/(T2-T1)$$

Taking two points as (Q_o,T) : (7.05,1.1) and (5.56,2.1).

Therefore, $b = \ln(7.05/5.56)/(2.1-1.1)$

$b = 0.2374/yr$

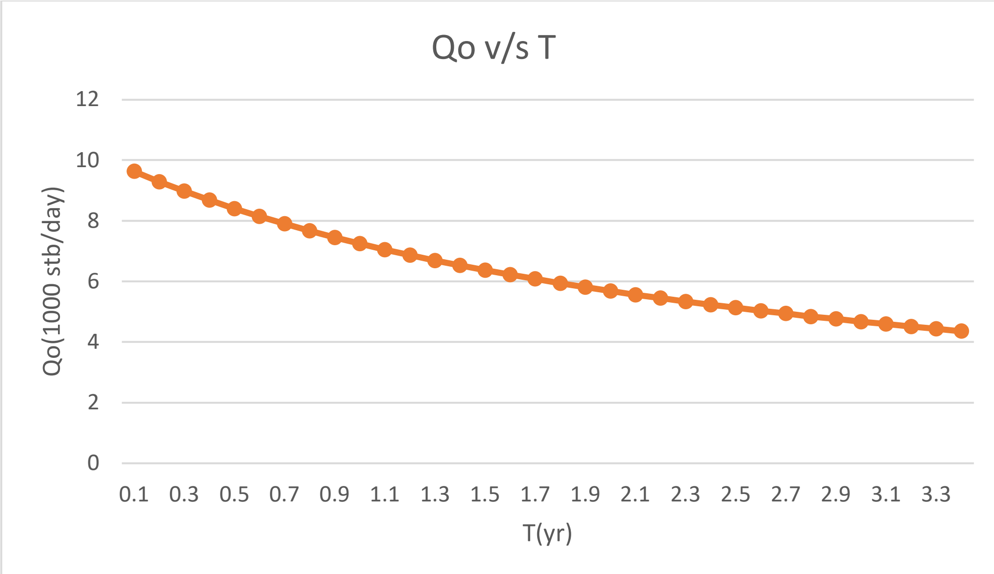
Now, finding the cumulative production, N_p using the formula

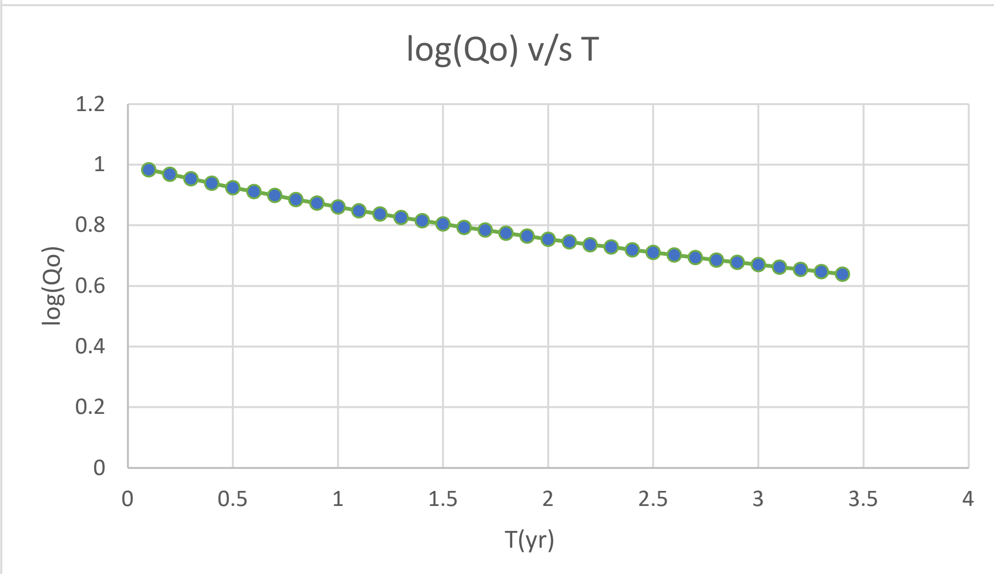
$$N_p = (Q_1-Q_2)/b$$

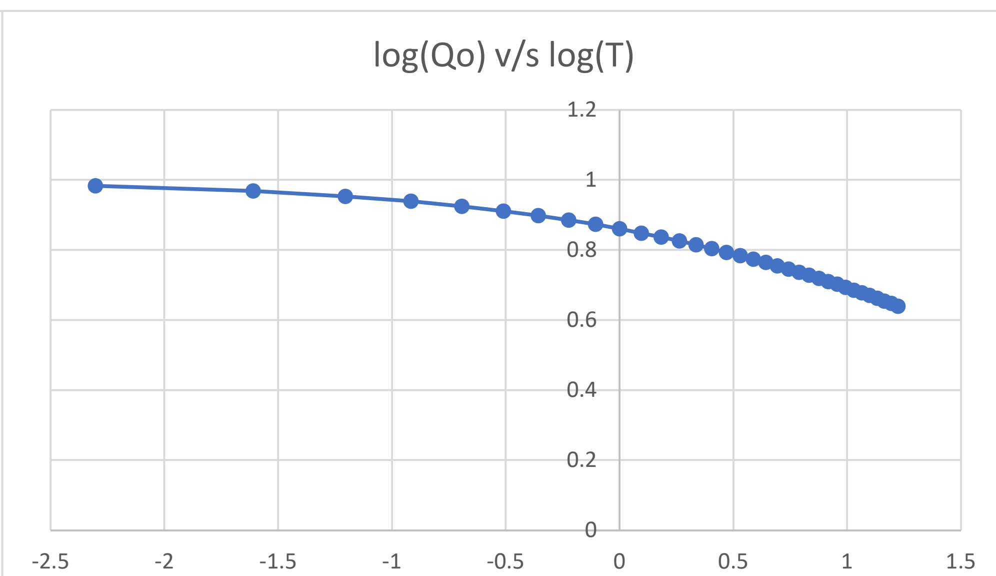
and plotting the graph of Q and N_p v/s T.

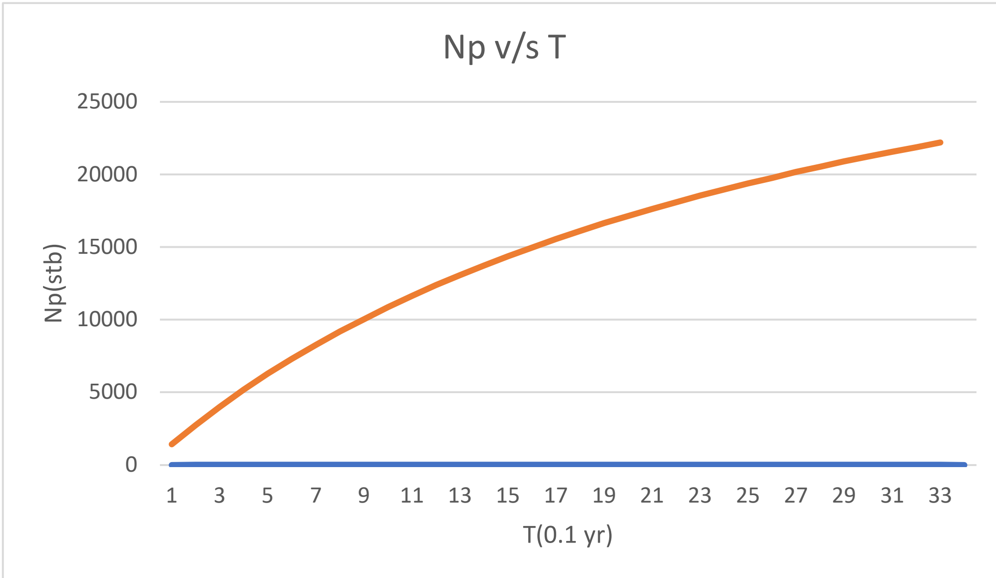
Time(yr)	Production Rate (1,000 stb/day)	Log(Time)	log(Qo)
0.1	9.63	-2.3026	0.983
0.2	9.29	-1.6094	0.968
0.3	8.98	-1.204	0.953
0.4	8.68	-0.9163	0.939
0.5	8.4	-0.6931	0.924
0.6	8.14	-0.5108	0.911
0.7	7.9	-0.3567	0.898
0.8	7.67	-0.2231	0.885
0.9	7.45	-0.1054	0.873
1	7.25	0	0.86
1.1	7.05	0.0953	0.848
1.2	6.87	0.1823	0.837
1.3	6.69	0.2624	0.826
1.4	6.53	0.3365	0.815
1.5	6.37	0.4055	0.804
1.6	6.22	0.47	0.793
1.7	6.08	0.5306	0.784
1.8	5.94	0.5878	0.774
1.9	5.81	0.642	0.764
2	5.68	0.6931	0.754
2.1	5.56	0.7419	0.745
2.2	5.45	0.7885	0.736
2.3	5.34	0.8329	0.728
2.4	5.23	0.8755	0.719
2.5	5.13	0.9163	0.71
2.6	5.03	0.9555	0.702
2.7	4.94	0.9933	0.693
2.8	4.84	1.0296	0.685
2.9	4.76	1.0647	0.678
3	4.67	1.0986	0.67
3.1	4.59	1.1314	0.662
3.2	4.51	1.1632	0.654
3.3	4.44	1.194	0.647
3.4	4.36	1.2238	0.639

Production/yr	Cummulative production, Np
1432.181971	1432.181971
1305.812974	2737.994945
1263.689975	4001.68492
1179.443976	5181.128896
1095.197978	6276.326874
1010.95198	7287.278854
968.8289806	8256.107835
926.7059815	9182.813816
842.4599832	10025.2738
842.4599832	10867.73378
758.2139848	11625.94777
758.2139848	12384.16175
673.9679865	13058.12974
673.9679865	13732.09773
631.8449874	14363.94271
589.7219882	14953.6647
589.7219882	15543.38669
547.598989	16090.98568
547.598989	16638.58467
505.4759899	17144.06066
463.3529907	17607.41365
463.3529907	18070.76664
463.3529907	18534.11963
421.2299916	18955.34962
421.2299916	19376.57961
379.1069924	19755.6866
421.2299916	20176.9166
336.9839933	20513.90059
379.1069924	20893.00758
336.9839933	21229.99158
336.9839933	21566.97557
294.8609941	21861.83656
336.9839933	22198.82056


Qo v/s T
Qo(1000 stb/day)
12
10
8
6
4
2
0
0.1 0.3 0.5 0.7 0.9 1.1 1.3 1.5 1.7 1.9 2.1 2.3 2.5 2.7 2.9 3.1 3.3
T(yr)


log(Qo) v/s T
log(Qo)
1.2
1
0.8
0.6
0.4
0.2
0
0 0.5 1 1.5 2 2.5 3 3.5 4
T(yr)


log(Qo) v/s log(T)
1.2
1
0.8
0.6
0.4
0.2
0
-2.5 -2 -1.5 -1 -0.5 0 0.5 1 1.5


Np v/s T
Np(stb)
25000
20000
15000
10000
5000
0
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33
T(0.1 yr)