
**PRODUCTION I (PP 414)**

**SUBJECT:**

# ANALYSIS OF WELL LOSS RATIO AND DECLINE CURVES

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## COURSE: PRODUCTION I (PP-414)

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### LOSS RATIO

It is the inverse of the declination:

$$a = -\frac{q}{dq/dt} = \frac{1}{k} q^{-n} = \frac{1}{k}(q_o^{-n} + nkt)$$

$$a = \frac{q_o^{-n}}{k} + nt \; ; \quad \frac{da}{dt} = n$$

This means that the first derivative of the rate of loss with respect to time is the hyperbolic constant.

The slope of the plot of a vs t, in linear regression will yield n.
The hyperbolic constant is the slope function between the values of a in relation to time.
The initial a, is the intersection function of the values of a in relation to time.
The calculated a, are found starting from the initial a and adding for each successive time the hyperbolic constant found.
The calculated q is obtained one by one, starting from an assumed initial q, close to the initial real q, with the following operation:

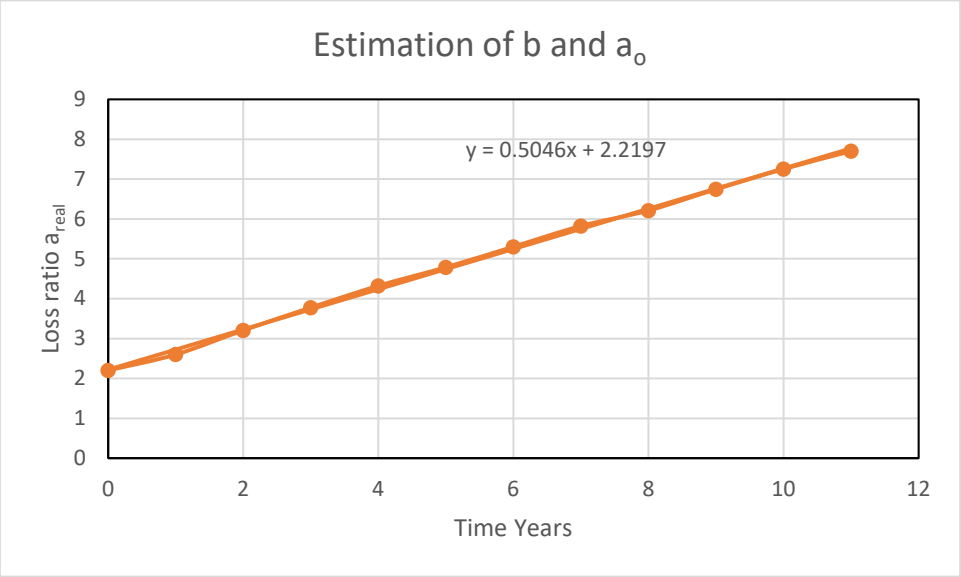
$$q_n = q_{(n-1)} * (a_{(n-1)} - 1)/a_{(n-1)} \quad \text{para n= 1, 2, 3,....., n-1, n}$$

Finally, we use the Excel solver tool, to match the sum of the real q with the calculated q.
Subsequently, the data can be extrapolated to the desired time or to the economic limit.

Example: Production data from 0 to 12 years
Extrapolate production up to 22 years.
What is the Reserve Proved Development (RPD) until the age of 22?

| t Years | q b/d | Δq | a real | a calc. | q b/d calc | | | |
|---|---|---|---|---|---|---|---|---|
| 0 | 29500 | 13400 | 2.20 | 2.22 | 29055 | Slope: 0.504585 | | |
| 1 | 16100 | 6190 | 2.60 | 2.72 | 15965 | Intersection: | 2.22 | |
| 2 | 9910 | 3090 | 3.21 | 3.23 | 10105 | t | q calc. | a calc. |
| 3 | 6820 | 1805 | 3.78 | 3.73 | 6975 | 13 | 974 | 8.78 |
| 4 | 5015 | 1160 | 4.32 | 4.24 | 5107 | 14 | 863 | 9.28 |
| 5 | 3855 | 805 | 4.79 | 4.74 | 3902 | 15 | 770 | 9.79 |
| 6 | 3050 | 575 | 5.30 | 5.25 | 3079 | 16 | 691 | 10.29 |
| 7 | 2475 | 425 | 5.82 | 5.75 | 2492 | 17 | 624 | 10.80 |
| 8 | 2050 | 330 | 6.21 | 6.26 | 2059 | 18 | 566 | 11.30 |
| 9 | 1720 | 255 | 6.75 | 6.76 | 1730 | 19 | 516 | 11.81 |
| 10 | 1465 | 202 | 7.25 | 7.27 | 1474 | 20 | 472 | 12.31 |
| 11 | 1263 | 164 | 7.70 | 7.77 | 1271 | 21 | 434 | 12.82 |
| 12 | 1099 | | | 8.27 | 1107 | 22 | 400 | |
| | 84322 | | | | 84322 | | 6311 | |

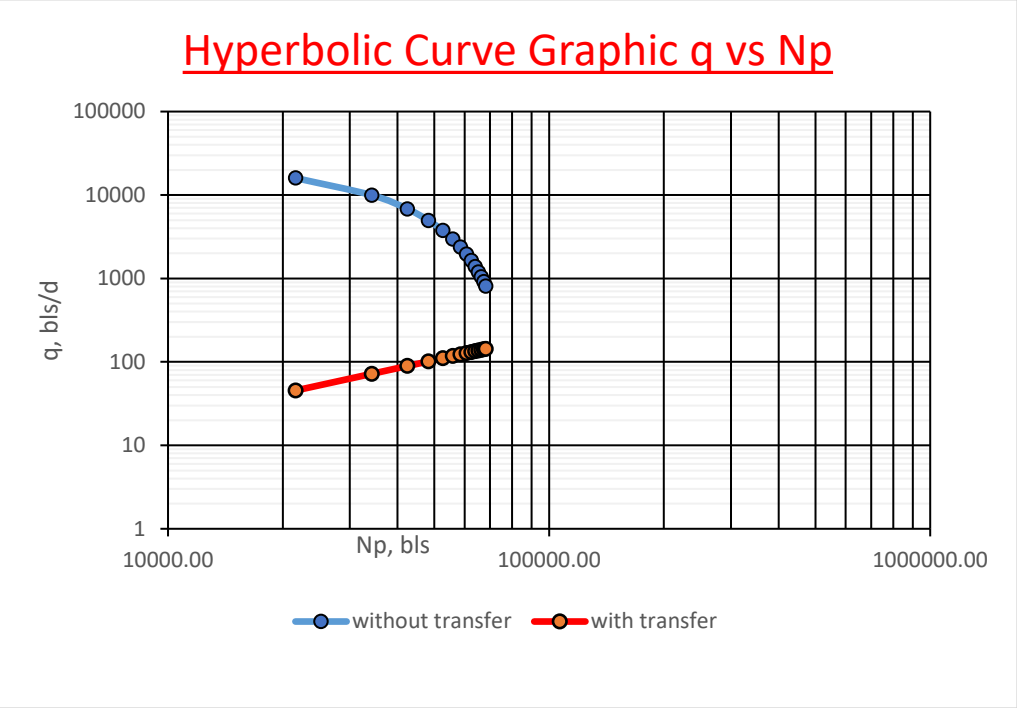
RPD = (84322+6311) *365 = 33 081,045 bls.

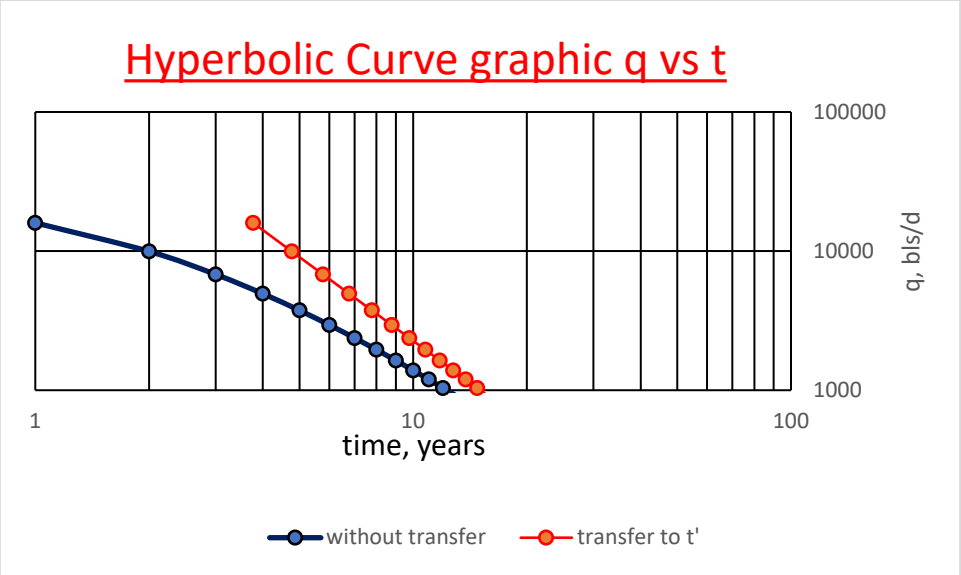


b) With the data of the previous problem, perform the transfer of axes to have a line in the graphs on logarithmic paper of q (rate) vs t (time) and q (rate) vs $N_p$ (accumulated production bls)

$D_o$= 0.72165527 n= 0.5

| time | $q_t$ | $N_p$ | t' | $q_{t'}$ |
|---|---|---|---|---|
| 0 | 29500 | | | |
| 1 | 15965 | 21612.02 | 3.77 | 45.40 |
| 2 | 9952.44 | 34269.35 | 4.77 | 71.99 |
| 3 | 6802.35 | 42497.35 | 5.77 | 89.28 |
| 4 | 4941.57 | 48295.13 | 6.77 | 101.46 |
| 5 | 3751.66 | 52600.83 | 7.77 | 110.50 |
| 6 | 2944.99 | 55924.77 | 8.77 | 117.49 |
| 7 | 2373.06 | 58568.38 | 9.77 | 123.04 |
| 8 | 1952.89 | 60721.12 | 10.77 | 127.56 |
| 9 | 1635.18 | 62508.11 | 11.77 | 131.32 |
| 10 | 1389.14 | 64015.26 | 12.77 | 134.48 |
| 11 | 1194.72 | 65303.52 | 13.77 | 137.19 |
| 12 | 1038.43 | 66417.36 | 14.77 | 139.53 |
| 13 | 910.92 | 67389.95 | 15.77 | 141.57 |
| 14 | 805.53 | 68246.56 | 16.77 | 143.37 |






The data of the rate b / d have some variation since the solver works with discrete declination and the graphs with nominal declination.

## References

1. Del Castillo Rodríguez Luis Antonio et al.: “Analysis of Decline Curves”, Thesis Graduate, UNI Petroleum Faculty, 1963.
2. J.J. Arps et al.: “Analysis of Decline Curves”, Chapter II, Petroleum Economics, Houston Meeting, May 1944, 228-246, SPE . 945228-G-P.