Reserve Estimation Using Decline Curve Analysis for Libyan Oil Field

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Abstract

Decline curve analysis relates past performance of oil to future performance, and it used to provide a best-fit equation for series of data points by least squares method. Most of the existing decline curve analysis techniques are based on the empirical Arps equations to determine future well performance, and hyperbolic exponent. Two main techniques for the simultaneous evaluation of the three main constants of the production decline (ai), (qi), and (b). First technique is a graphical, while the second is a numerical that based on fitting the data points to an equation having a value of (b). In this work, production decline curve was analyzed for five wells producing from the reservoir under strong water drive mechanism; perform well by well, total field performance using three scenarios (all data, averaging data and screening data.The results obtained for remaining reserve were equal to 79.34MM bbl, 78,955 MM bbl, and 83,722 MM bbl using all data, averaging data, and screening data scenario respectively.

Keywords: *Decline curve, field performance, remaining reserve, scenario*

1. Introduction

Reserve evaluation is based on the interpretation of geologic and/or engineering data available at the time of the estimate. The decline curve analysis can only used to estimate the proven reserves, which can be recovered from the current development scheme. The estimation of reserves is the most important step toward taking any decisions regarding the oil property, selling, and development. It is also the most difficult aspect of reservoir engineering, especially in the early life of the reservoir. The decline curve analysis is used to evaluate the new investments and audit of previous expenditure. Averaging the data points will minimize the effect of unwanted data points on the accuracy of the results; on the other hand the screening (canceling the faulty or non representative data point) is the best way to get more reliable remaining reserve from the production decline curve analysis. Typical decline-curve analysis consists of plotting well production versus time on semi-log paper and attempting to fit these data points to straight line, which is then extrapolated into the future. The reserves are calculated based on some average production rate per unit of time extrapolated production rates. However, the complexity of the hyperbolic analysis techniques and the excuse that the late-life differences between a constant percentage a straight line on semi-log paper, and hyperbolic decline analysis often affect the present worth value very little leads the engineer to conclude that he should use the easiest method. The two basic problems in appraisal work are the determination of a wells most probable future life and estimate of its future production. Decline curve analysis is used to estimate the ultimate recovery (reserve), predicting the future production rate and the production life of a reservoir or wells. Production decline curves plots of production rate verse time or cumulative rate verse time have found more acceptances. Decline curve analysis is one of the know methods and tools used to analyze the field performance in order to better understand its behavior. Decline curve analysis greatly affected by the changes done on the reservoir , such as drilling new wells, shutting-in some wells, conversion of some well status (injection to production or voiceovers).

2. Methodology

The proper selection of the single well production data necessitates that the well conditions are recorded together with the flow rate readings. For single well production, once all data had been collected, the data point which represent “human enforced” flow rates, should be excluded. The production history should be divided to time periods each reflecting a major change in the well conditions. Then the production data for each time period is analyzed separately, in order to be helpful in evaluating the benefits or losses due to changes made in the well condition, and will also serve to evaluate any future projects for the well. Only the production data from the most recent time period will be used for the predication of future flow rate, ultimate recovery and economic recovery. Any changes in reservoir driving mechanism should be included in the definition of the different time periods. While the proper selection of production data necessitates that the reservoir conditions are recorded together with the reservoir production rates. The change in the production decline of single well should theoretically influenced the production decline of the reservoir, but in practice the changes in the individual well conditions are usually neglected. Unless a large number of the wells are experiencing the same type of change consequently, the shut in and reduced rate periods for well testing, the acidization and the reperforation of some of the wells are usually not considered. However if there a major change in the production conditions on a field scale, then these change considered in the reservoir production decline analysis. The production data which should not be include in the reservoir production decline analysis is the data related to the time interval when there was planned reduction in the field production rate (or a completed shut down of the field). This might occur in cases of marketing difficulties, surface facilities or pipeline problems, or as a result of national strategic planning. The production rate might also reduced to a void certain reservoir problems, such as excessive coning, development of pressure skins, insufficient void age ratio limited pressure support from aquifer or due to injection facilities limitations. Once the production data of these time intervals have been excluded, the major reservoir change which would create anew decline trend, and consequently would necessitate anew and separate analysis.

3. Discussion and results

The DCA was repeated under three scenarios: all data points, averaging data points and screening data points. The calculated remaining reserve becomes more reliable whenever data points are well screening and well averaging, averaging data points will minimize the effect of unwanted data on the accuracy of the results, on the other hand the screening data points is the best way to get more reliable remaining reserve from the production decline curve analysis. The pressure history of the field is almost constant, which means that the field has very strong water drive. The expected remaining reserve for period of decline is showing in Table (1). The main assumption to take the economic limit for the flow rate is 100 STB/Day and the all scenarios results obtained are shown in figures (1), (2), (3) , and Table (2). Decline type of well (N1) is a harmonic (b=1) and the remaining reserve calculated from end of period to economic limit is 2.77 MMbbl using all data, 2.89 MM bbl using averaging data and 2.45 MM bbl using screening data scenario. The results obtained of this well are shown in figures from (4) to (6), and table (3). Decline type of well (N2) is an exponential (b=0). The remaining reserve calculated from end of period to economic limit using three scenarios is 7.54MMbbl by all data, 8.22 MM bbl by averaging data, and 9.09 MM bbl by screening. All results are shown in figures (7), (8), (9) and table (4). Decline type of wells (N3 & N4) is a hyperbolic (b= 0.27), the remaining reserve for third well calculated is 2.52MMbbl using all data scenario, 2.25MM bbl using averaging data scenario, and 1.97MM bbl using screening data scenario, that shown in figures (10), (11), (12) and table (5). For well (N4) remaining reserve is 319,555bbl using all data scenario, 466,434bbl using averaging data scenario and 377,943bbl using screening data scenario figures (13), (14), (15) and table (6). Decline type of Well (N5) is exponential (b=0), and the remaining reserve calculated from end of period to economic limit is 5.67 MMbbl using all data scenario, 5.17 MM bbl using averaging data scenario and 5.20 MM bbl using screening data scenario figures (16), (17), (18) and table (7).

4. Conclusion and recommendations

Three scenarios were used to estimate the remaining reserve (all data, averaging data and screening data). The results obtained by these scenarios are 79,344,890 bbl, 78,955,908 bbl and 83,722,224 bbl respectively. The estimated recoverable reserves, can’t be recovered completely using the existing wells due to a number of wells were shut in, for a mechanical problems, and it is recommended to work-over there wells , and drill more infill wells to reduce the well spacing and maximize oil recovery. Also it is recommended, completing the estimation of decline curve analysis for other wells to compare with the results of the decline curve analysis for the reservoir.

Table (1) Remaining Reserve

Scenarios	Type of decline	Remaining reserve (BBL)
All data	Exponential	79,344,890
Averaging	Exponential	78,955,908
Screening	Exponential	83,722,224

Table (2) Results of Libyan Oil Field

Scenarios	All Data	Averaging data	screening data
B	EXP	EXP	EXP
Qi	13544.3 bpd	13356 bpd	13489.2 bpd
Ai	0.045684 /year	0.046888 /year	0.048233/year
Qe	100 bpd	100 bpd	100 bpd
R.R	79,344,890 BBL	78,955,908 BBL	83,722,224 BBL

Table (3) Results of Well N1

Scenarios	Remaining reserve	Qi	ai	B
All data	2,778,567	986 bpd	0.189769 /year	1
averaging	2,896,887	955 bpd	0.134890 /year	1
screening	2,454,667	931 bpd	0.178890 /year	1

Table (4) Results of Well N2

Scenarios	Remaining reserve	Qi	ai	B
All data	7,544,654	745 bpd	0.059483 /year	0
averaging	8,222,544	789 bpd	0.054329/ year	0
screening	9,094,211	711 bpd	0.032948 /year	0

Table (5) Results of Well N3

Scenarios	Remaining reserve	Qi	ai	B
All data	25,213,555	2764.32 bpd	0.090321 /year	0.44
averaging	22,521,997	2365.64 bpd	0.083703 /year	0.27
screening	19,766,332	2444.76 bpd	0.089788 /year	0.27

Table (6) Results of Well N4

Scenarios	Remaining reserve	Qi	ai	B
All data	319,555	312.55 bpd	0.1865443 /year	0
averaging	466,434	365.97 bpd	0.224596 /year	0
screening	377,943	477.60 bpd	0.2285499 /year	0.12

Table (7) Results of Well N5

Scenarios	Remaining reserve	Qi	ai	B
All data	5,678,232	2,796	0.056443 /year	0
averaging	5,173,927	2,618	0.095844 /year	0
screening	5,200,471	2,667	0.085005 /year	0

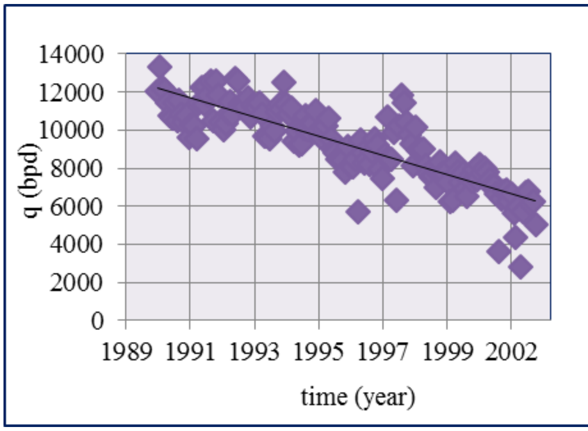

Fig. (1) All Data Scenario of field

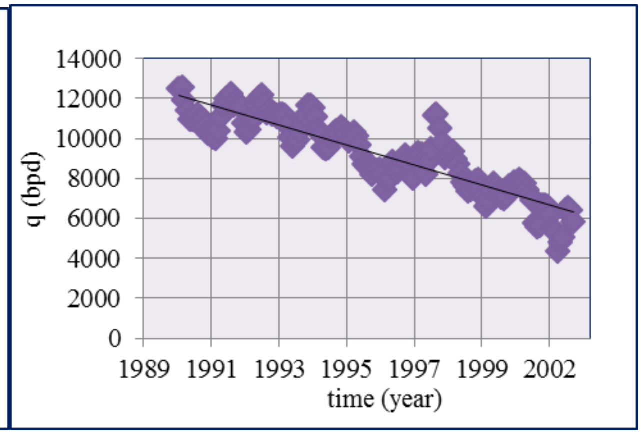

Fig. (2) Averaging Data Scenario of field

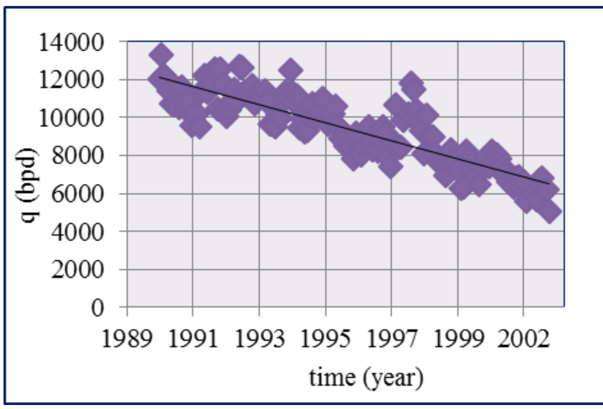

Fig. (3) Screening Data Scenario of field

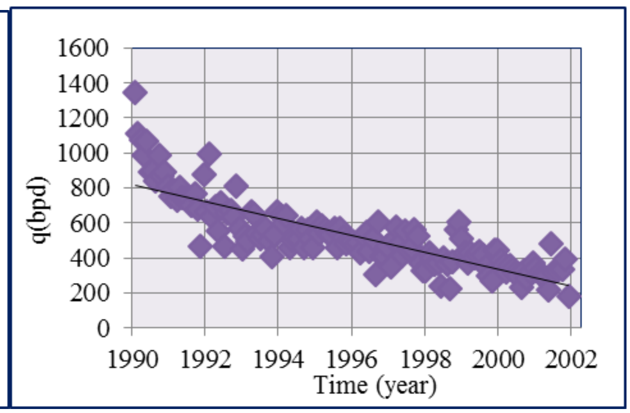

Fig. (4) All Data Scenario of Well N1

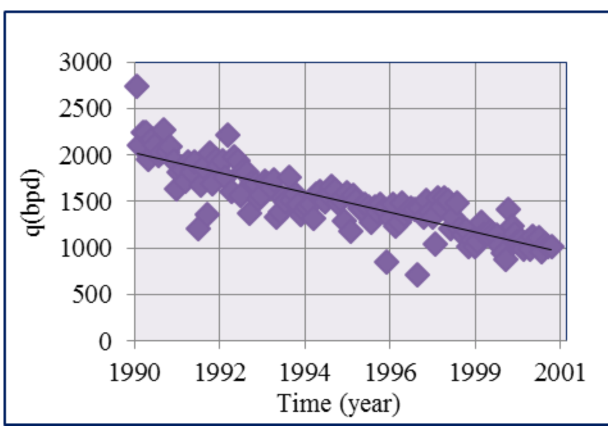

Fig. (5) Averaging Data Scenario of Well N1

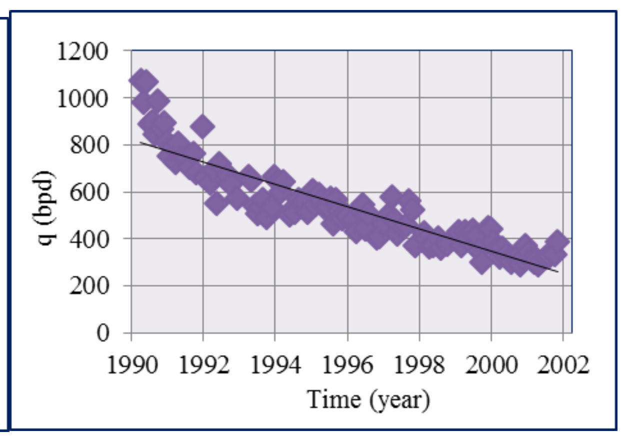

Fig. (6) Screening Data Scenario of Well N1

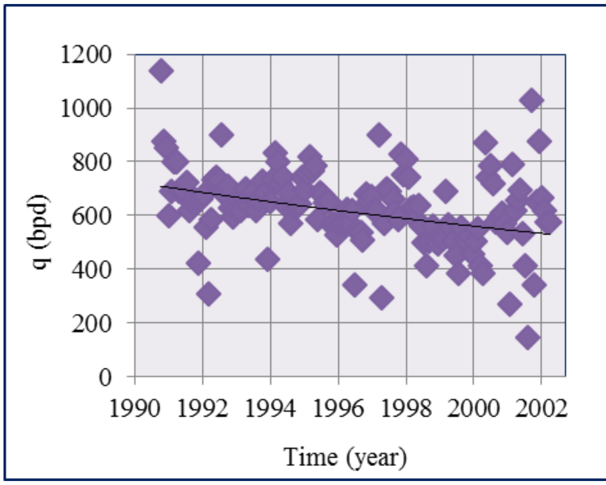

Fig. (7) All Data Scenario of Well N2

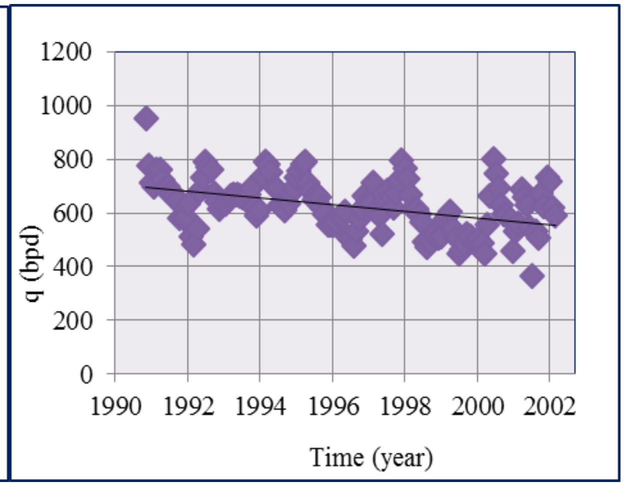

Fig. (8) Averaging Data Scenario of Well N2

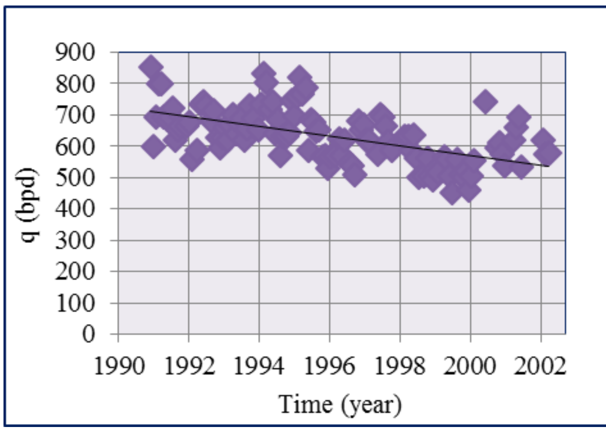

Fig. (9) Screening Data Scenario of Well N2

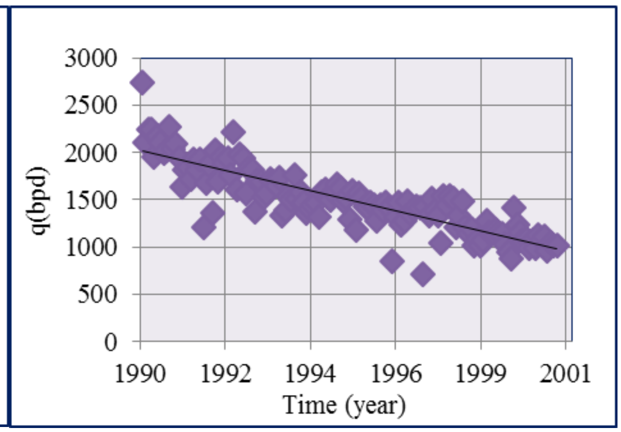

Fig. (10) All Data Scenario of Well N3

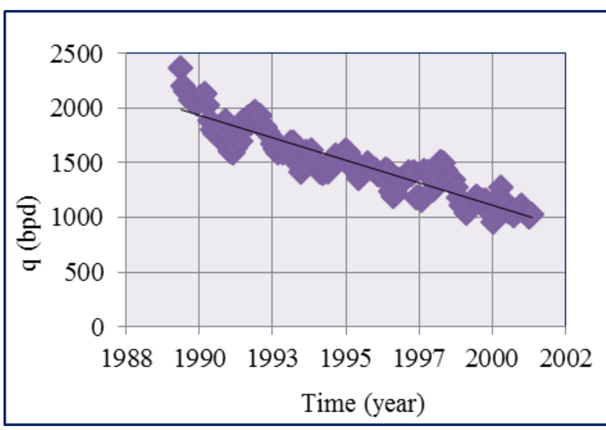

Fig. (11) Averaging Data Scenario of Well N3

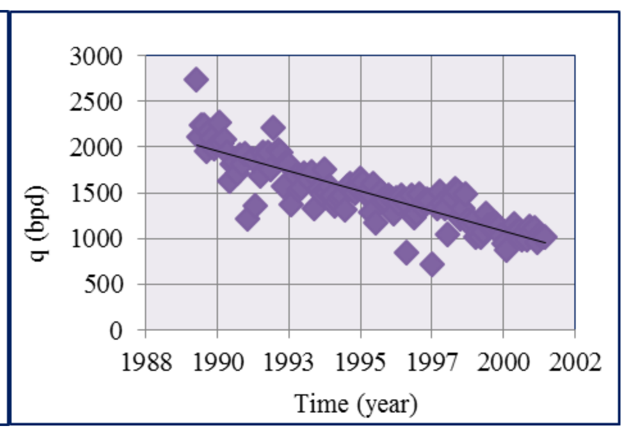

Fig. (12) Screening Data Scenario of Well N3

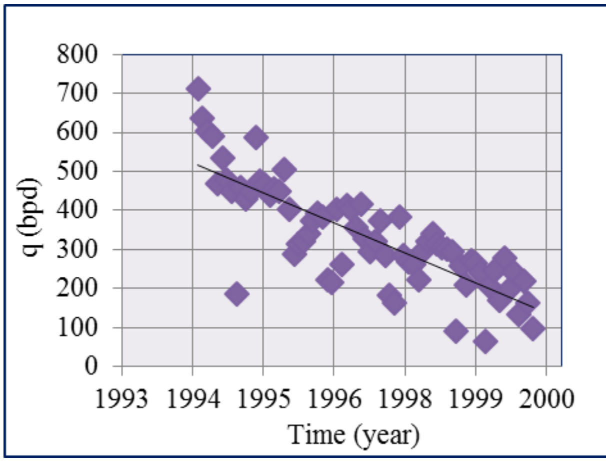

Fig. (13) All Data Scenario of Well N4

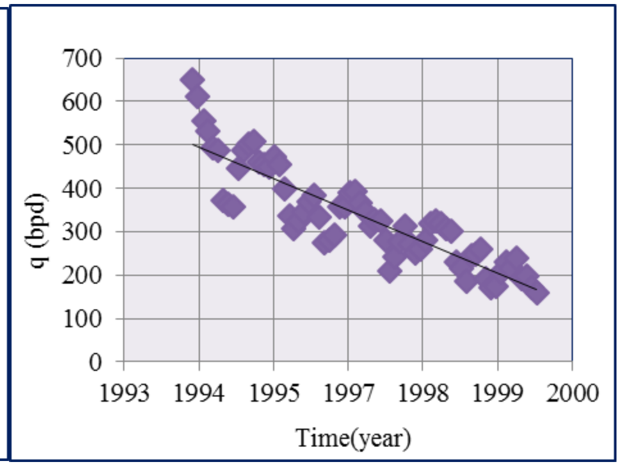

Fig. (14) Averaging Data Scenario of Well N4

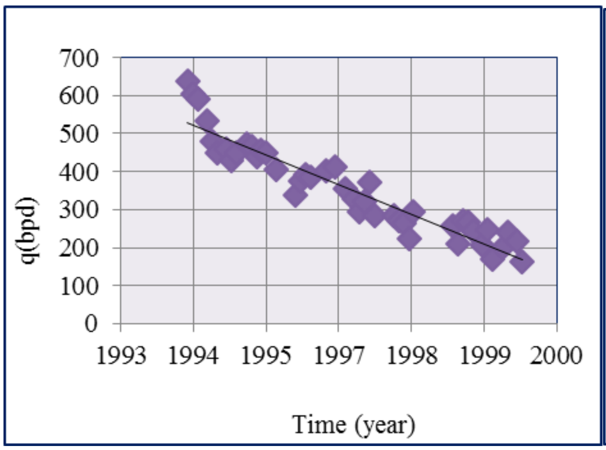

Fig. (15) Screening Data Scenario of Well N4

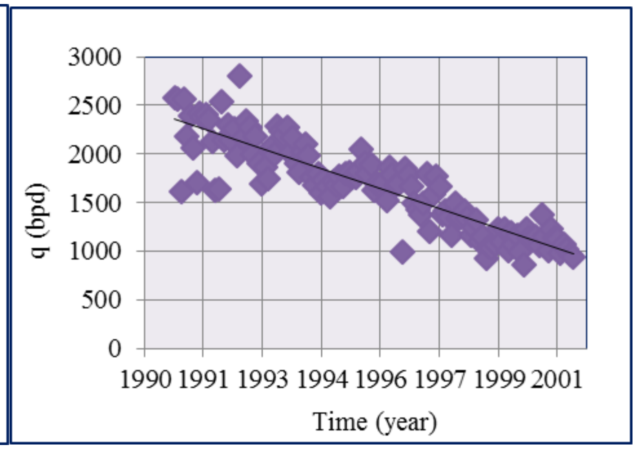

Fig. (16) All Data Scenario of Well N5

Aknoledgment

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