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Estimating the Total Recovery Loss Caused by Excessive Water Production in Al-aswad Field Using the Decline Curve Analysis (DCA)

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Abstract

Excessive water production is one of the major problems in oil industry, which comes with a lot of challenges; the biggest one is defining the total recovery drop caused by the water production. As mentioned the case study below Aswad field has high oil potential but due to highly water cut production the reserve reduced as estimated, using Excel sheet and decline curve analysis DCA method, the amount of ultimate reserve that could be extracted from the Aswad field is 37.7 MMSTB with recovery factor 39.15 %,this data from the company estimate reserve, and from this project analysis using DCA, the type of the DCA curve used has been chosen depending on the value of the decline exponent constant (b) watch is based on the production data and the behavior of nominal decline rate varies with rate and the error analysis, the value of (b) is one (Harmonic Decline Type). The ultimate reserve that could be generated under current reservoir conditions calculated as 32.88 MMSTB, this value indicates a decrease in field productivity due to high water production problems because multilayer channeling, which means that the field needs to optimize and reduce the water rate as fast as possible to reduce the losses in the recovery that would happen.

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Keywords: excessive water production, total recovery loss, decline curve analysis DCA, Al- Aswad field.

INTRODUCTION

During oil production, many problems (environmental effects, reduction of the net oil production and increases corrosion rates) were presented as a result of unwanted water production through oilfields; due to the large amount of water produced during oil production, some argue that oil industry is effectively water industry producing oil as a secondary output [1].

The production of this water together with the oil from any reservoir is a condition that is natural in all reservoirs. It is expected that water production would increase with the life of the reservoir. However, a premature increase in the production of water in any reservoir is an undesirable condition. Excess water production exists with associated cost implication on the surface facilities, artificial lift systems, corrosion and scale problems. Another effect that ensue a decrease in the recovery factory as oil is left behind the displacement front, thereby reducing the performance of the reservoir.

The economics of unwanted water production is one of the most important problems in oil and gas industry. Managing the cycle of water production, down-hole or surface separation, and disposal involve a wide range of oilfield services which are costly. These include data acquisition and diagnostics using production logging, water analysis for detecting water problems and reservoir modeling to characterize the flow. Also, there are various technologies to eliminate water problems such as down-hole separation and injection, chemical and mechanical shut-offs, and surface water separation and production facilities. All these operations from different logging like temperature and density logs to reservoir modeling for diagnosing water problems are costly for oil companies. Therefore, using a method that has low cost for diagnosing water problem is of interest to all [*2*].

Decline curve analysis (DCA) is one of the oldest and important methodologies used by production and reservoir engineers to forecast future production, calculate oil in place and estimate ultimate recovery, and it is appropriate to economic evaluation of oil and gas projects. In practice, DCA is usually performed using deterministic tools that provide a unique solution ignoring the probabilistic nature of the production data due to measurement and back allocation errors.

Fetkovich (1973) presented theoretical basis for Arps's production decline models using the pseudo steady-state flow equation. He also developed decline type curves that not only permit us to forecast well performance, but also allow us to estimate reservoir properties (i.e., flow capacity — kh) as well as oil-in-place. This classic work by Fetkovich laid the foundation for all of the work that followed regarding decline type curves [3].

McCray (1990) developed a time function that would transform production data for systems exhibiting variable rate or pressure drop performance into an equivalent system produced at a constant bottomhole pressure. In 1993, Palacio and Blasingame developed a solution for the general case of variable rate/variable pressure drop for the flow of either single-phase liquid or gas [4][5].

Perform decline curve analysis to estimate the remaining reserve and estimate the amount of unrecoverable reserve due to high reservoir water cut. Finally, proposed the optimum solution to control the water cut that produced from wells.

For the optimum treatment design, all data which consist of historical wells job, completion, production data, and reservoir data, must be available and revised thoroughly reviewed to ensure the wells were properly selected.

METHODOLOGY

The methodology of this work begins with an analysis of the performance of Aswad field by analyzing the history of production. One of the main objectives of this study was to estimate the total loss in recovery. In addition, the effect of water production on productivity in the field is assessed. The decline curve was carried out to estimate the reserve remaining and ultimate reserve to compare the results with amount of oil that could be extracted from this field.

Decline Curve Analysis

Analysis of the decline curve was conducted to measure the remaining reserve & compare it with the ultimate reserve, and then analyzed these results to study the reservoir productivity with producing water and their impact on oil production. The DCA was introduced by using, Excel sheet.

The behavior of the production data can be characterized based on the way in which the nominal decline rate varies with rate, based on the value of the decline exponent constant b.

- **Exponential** — b = 0
- **Hyperbolic** — b is a value other than 0 or 1
- **Harmonic** — b = 1

Reservoir data

Table (1): Rock and Fluid Properties using field Aswad data

Parameter	Value	Unit
Initial Pressure, (P_i)	2698	Psia
Current Pressure, (P)	2179	Psia
Saturation Pressure, ($P_{sat.}$)	1470	Psia
Original Oil in Place, (N)	96.30	MMSTB
Original Gas in Place, (G)	81.70	BSCF
Initial Oil Reserves, (N_p)	37.70	MMSTB
Gas Oil Ratio, (GOR)	1400	SCF/STB
Oil Gravity, (API)	46.70	° API
FVF @ Initial Pressure, (B_{oi})	1.561	RB/STB
Oil Viscosity, (μ_o)	0.346	Cp
Average Net Pay, (h)	49.50	Ft
Average Porosity, ($\phi_{avg.}$)	20.50	%
Average Permeability, ($k_{avg.}$)	11.68	Md
Initial Water Saturation, (S_{wi})	25.60	%

Decline Curve Analysis using Excel Sheet

Analysis of the decline curve was applied on production data of Aswad field.

Decline Period: for time from 28th of February 1987 to 31th of August 2008.

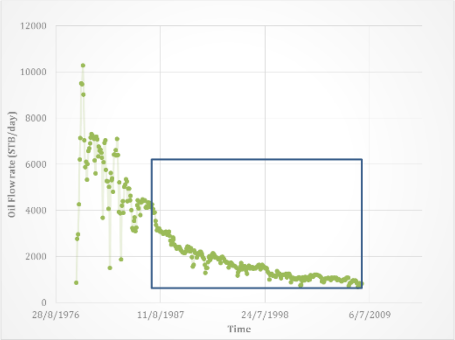

Figure (1): Aswad Oil Production History and Detection Decline Period.

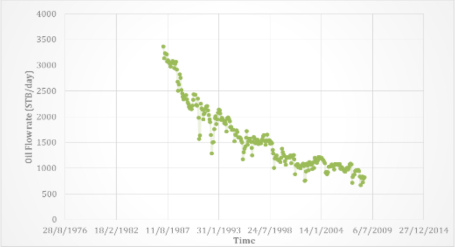

Figure (2) shows the declined period for Aswad field after study the field performance.

The decline estimated by equation of harmonic decline:
Then calculate ai and qi

$$a_i = \left(\frac{q_i \sum \frac{1}{q_k} - n}{\sum t_k} \right) \qquad q_i = \left(\frac{n\sum t_k^2 - \sum t_k \sum t_k}{\sum t_k^2 \sum \frac{1}{q_k} - \sum t_k \sum \frac{t_k}{q_k}} \right)$$

for Harmonic Decline equations, when the value of "b" is 1

$$q = q_i \times e^{(-a_i t)} \qquad N_{pe} = \left(\frac{q_i - q_e}{a_i} \right)$$

Table 1 shows the error analysis to detect the (b) value to investigate the decline type, and the analysis shows the b value is one (Harmonic Decline Type).

Table (1): Error Analysis for selected Period

B	E^2
0	1.032E+07
0.1	9.826E+06
0.2	9.335E+06
0.3	8.849E+06
0.4	8.367E+06
0.5	7.892E+06
0.6	7.427E+06
0.7	6.981E+06
0.8	6.566E+06
0.9	6.205E+06
1	5.935E+06

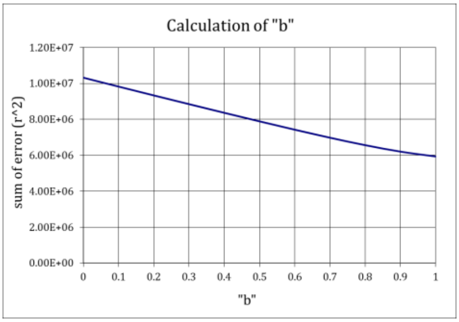

Figure (3): Aswad Decline Error Analysis

The results that obtained from the analysis summarized as the decline type was harmonic with b value is one, initial decline rate 3213 STB/day with decline factor 0.0102 year $^{-1}$

Production prediction depended on decline analysis applied to predict the oil production future rate, as shown in Figure 4.

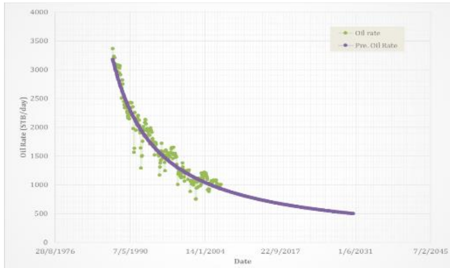

Figure (Error! No text of specified style in document.**): Aswad Production Forecasting (Excel Sheet)**

Aswad Decline Curve Analysis Results using Excel Sheet

Table (2): Summary of DCA results

Field Name	**Aswad**	
Period	From	To
	28/02/1987	31/08/2008
Decline Type	Harmonic	
b =	1.00	
q_i =	3213.57	Bpd
a_i =	0.0102	/ year
Assumed q_e	500	Bpd
Remaining Reserves	17.62	MMSTB
Produced Reserves @ q_e	15.01	MMSTB
Total Reserves	32.63	MMSTB
Recovery factor @ q_e	45.99	%
Abandoned data	31/12/2030	Years

RESULTS AND DISCUSSION

The amount of ultimate reserve that could produce from the Aswad field 37.7 MMSTB with recovery factor 39.15 % this results from company reserve estimation reserve, and from this project analysis using DCA the ultimate reserve that could produce under current reservoir conditions calculated as 32.88 MMSTB this value shows the reduction of productivity of field due to water problems because multilayer channeling so the field needs to optimize and reduce the water rate. Moreover, the proposed solution to optimize the water production as next section.

CONCLUSION

Aswad field is water flooded due to high water cut that produced from reservoir that supported by water injection from early period of the field. Aswad field has high oil potential but due to highly water cut production the reserve reduced as calculated using Excel sheet, DCA method and the type of the DCA has been detected according to the value of the decline exponent constant (b) which is one (Harmonic Decline Type) , and the amount calculated as 32.88 MMSTB, this value shows the reduction of productivity of the field.

RECOMMENDATIONS

i. Perform simulation study and study the proposed solution that achieved from this project and applied this solution to reduce the water production.
ii. Study the Cost and economic feasibility designing the optimization methods to use in this situation.
iii. Quick intervention by either the solution proposed or the one of the oil enhanced method or water control will completion.
iv. The multi-use of the software programs in order to reduce the time spied and the data required and increase the accuracy of the results.

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