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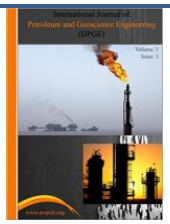

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Comparison of OIIP Estimation Using Different Methods

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A b s t r a c t

Keywords:

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Decline curve,
Material balance,
Reserve estimation.

There are many techniques applied to estimate oil initial in places, such as Volumetric Method, which uses the static properties of the reservoir, and Material Balance Method, which is based on the analysis of the production and pressure history data. Another technique for estimating oil initial in place is the use of a long duration draw-down test in the drainage area of the well, but it is limited to small hydrocarbon accumulations. The aims of this study were to determine the IOIP and to estimate the recoverable reserves using different methods and applications. The remaining reserve was estimated by decline curve analysis using total field production rates. Initial oil in place was calculated using the volumetric method, and material balance method. Comparing the results obtained, it preferable to apply volumetric method using OFM software.

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1. Introduction

Calculation of reserves is the most important step toward taking any decisions regarding the oil property; buying, selling, development, etc. It is also the most difficult aspect of reservoir engineering, especially in the early life of the reservoir, because the only available tools for the estimation of reserves are macro-analysis techniques which assume a reservoir model where the characteristics of any point in the reservoir are a linear interpolation of surrounding known points.

Consequently, it is important to assert, prior to any discussion of the techniques of reserve estimation that the certainty level of the reserve estimate can only improve with more production history and better reservoir management.

In general, as long as the cumulative production has not reached 10% of the OIIP, the uncertainty level in the reported reserves will always be high. Once 10% or more have been produced, the certainty level will depend mainly on three factors, the level of development (i.e. well density), the quality and quantity of data collected, as well as on the tool used to calculate the reserves. There are three main tools for estimating of the reserves, with different levels of sophistication. The choice will depend mainly on the data which is available.

2. Method explanation

2.1. Volumetric method

There are three different volumetric techniques for the calculation of the OIIP. These three techniques are normally termed:

- The Isopach method.
- The Hydrocarbon-Pore-Volume, HPV, method.
- The Finite Grid method

Calculate the net pay thickness, the average porosity, and, the average water saturation for each well. Also, prepare the good location map indicating the positions of the faults and the limits of the reservoir. Prepare the net pay thickness map of the reservoir, and calculate the areas calculate the volume of the oil initially in place using the following equation:

$$OIIP\ \ (STB) = \frac{V_f .\bar{\phi}.(1-\overline{S_{wi}})}{5.615\ \ B_{oi}} \qquad (1)$$

Where:

B_{oi} = oil formation volume factor at the initial reservoir pressure and temperature, bbl/STB

2.2. Material Balance Equation (MBE)

The material balance equation was first presented by Schilthuis in 1936 and many reservoir engineersing methods involve the application of the material balance equation. Since the equation is a volumetric balance, relating volumes to pressures, it is limited in its application. The equation provides a relationship with a reservoir's cumulative production and its average pressure. Practically all reservoir engineering techniques involve some application of material balance.

2.3. Decline curve analysis

Forecasting future production is the most important part of the economic analysis of exploration and production expenditures. Analysis of production decline curves represents a useful tool for reserve estimation and forecasting future production during capacity production from wells or reservoirs.

Procedure:

- Plot q Vs Time and allocate interval to be analyzed.
- Assume difference value of (b) starting from (0.0 to 1.0)
- Use the least sum of error square method to calculate (Di), and (qi) for each value of (b).

Exponential decline:

$$qi = \exp\left[\frac{\sum \ln q + Di \times \sum t}{n}\right]$$

Hyperbolic & harmonic decline

$$qi = \left[\frac{n\sum t^2 - (\sum t)^2}{\sum t^2 \sum \frac{1}{q^b} - \sum t \times \sum \frac{1}{q^b}}\right]^{\frac{1}{b}}$$

$$Di = \frac{qi^b \times \sum \frac{1}{q^b} - n}{b \sum t}$$

Where: N = number of data points

3. Results and discussion

3.1. Volumetric method by using OFM (Oil Field Manager) Software

The reserve was estimated applying OFM Software, where volumetric equation and arithmetic grid are used to calculate oil/gas original in place. Net thickness, saturation, porosity, and OIIP grid maps obtained are shown in figures from 1 to 4. Properties of the field & reserve estimated are inserted in table 1.

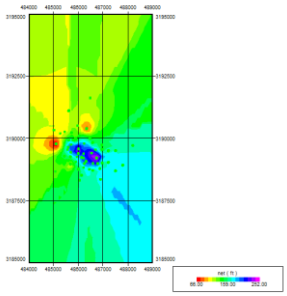

Fig. 1: Net thickness map.

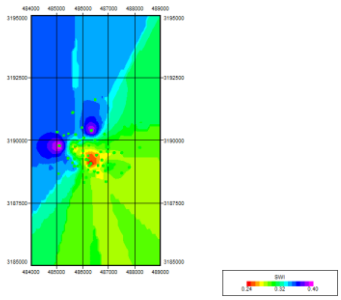

Fig. 2: Saturation grid map.

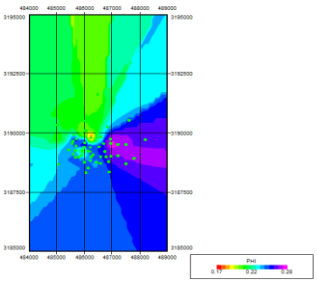

Fig. 3: Porosity grid map.

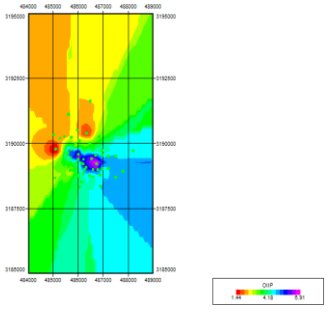

Fig. 4: OOIP grid map.

Table 1: properties and oil initial in place.

Properties	Value
Phi	0.236323
Swi	0.32481
Net thickness, ft	143
Boi, Rb/stb	1.169
OIIP, MMSTB	177.412e+06

3.2. Material Balance Equation method

Reserve estimated applying Hallelena and Odeh figure 5. Table 2 shows the results of calculated oil initial in place and water influx.

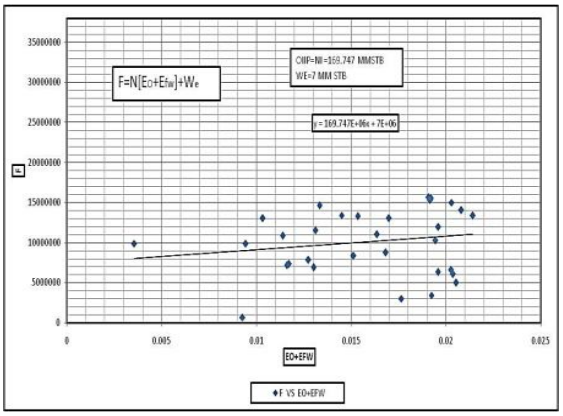

Fig. 5: OIIP applying MBE.

Table 2: reserve estimation

Properties	Value
Oil Initial In Place	169.747 MMSTB
Water influx	7MMSTB

3.3. Decline Curve Method

The DCA was repeated under three scenarios: all data points, averaging data points and screening data points. Figures 6, 7, 8 show field performance, the sum of least square vs b factor, and b factor versus the sum of absolute relative error

respectively. Table 3 shows results obtained by decline curve analysis.

Table 3: Results of decline curve analysis.

Calculation	Value	Unit
B factor	0	
A	0.0095	**1/months**
Initial flow rate	14275.54	**bbl/day**
Calculated flow rate	4479.66194	**bbl/day**
Economic rate	300	**bbl/day**
Remaining reserve	44.74526	**MMbbl**
t_a	33.8817578	**Years**

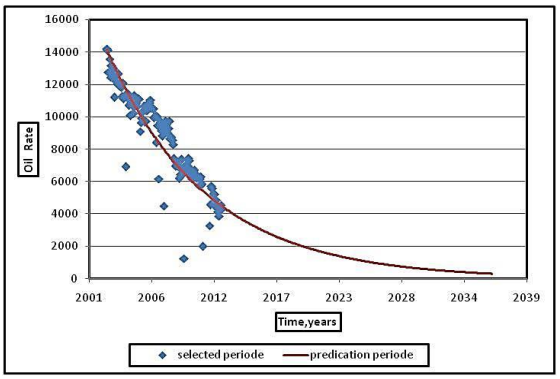

Fig. 6: Field production performance.

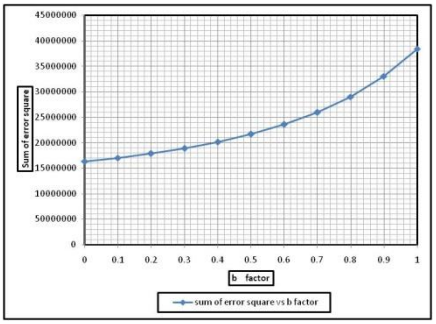

Fig. 7: "b" factor versus the sum of least square.

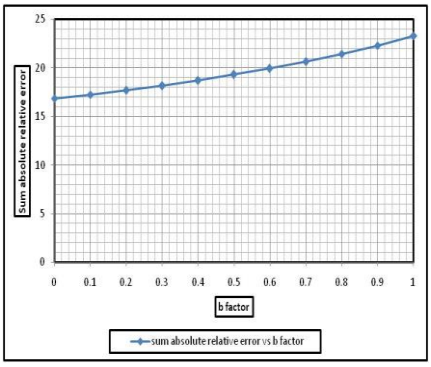

Fig. 8: "b" factor versus the sum of absolute relative error.

4. Conclusion and Recommendation

The estimated initial oil in place based on volumetric calculation is 177 MMSTB.

The estimated Initial Oil in Place based on MBE calculation is 169 MMSTB.

Decline curve analysis was performed using total field analysis, and remaining reserve estimated was 44.74526MMbbl.

It is recommended to divide the field into three pools, because of faults.

To reduce the well spacing and maximize oil recovery we recommend working over the wells and drilling more infill wells.

In material balance equation method, we must be careful while dealing with average reservoir pressure.

In order to maximize the efficiency of the reservoir, full field development plans should be applied such as:

- Run PLT in Injectors and Producers.
- Conduct SBHP survey to monitor the pressure behavior.

- Update the geological and the simulation models.

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