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Reserve Estimation of Initial Oil and Gas by using Volumetric Method in Mann Oil Field

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ABSTRACT

This research paper is focused to estimate the current production rate of the wells and to predict field remaining reserves. The remaining reserve depends on the production points that selected to represent the real well behavior, the way of dealing with the production data, and the human errors that might happen during the life of the field. Reserves estimating methods are usually categorized into three families: analogy, volumetric, and performance techniques. Reserve Estimators should utilize the particular methods, and the number of methods, which in their professional judgment are most appropriate given; (i)the geographic location, formation characteristics and nature of the property or group of properties with respect to which reserves are being estimated (ii)the amount and quality of available data and (iii)the significance of such property or group of properties in relation to the oil and gas properties with respect to which reserves are being estimated. In this research paper, the calculation of collecting data and sample by volumetric method are suggested to estimate the oil and gas production rate with time by using the geological configuration and the historical production data from CD(3700- 3800) sand in Mann Oil Field.

KEYWORDS: *production, remaining reserve, volumetric, data collecting, estimation*

1. INTRODUCTION

The general performance characteristics of hydrocarbon-producing reservoirs are largely dependent on the types of energy available for moving the hydrocarbon fluids to the wellbore. Drive mechanisms are determined by the analysis of historical production data, primarily reservoir pressure data and fluid production ratios.The total resource base of oil and gas is the entire volume formed and trapped in-place within the earth before any production. The largest portion of this total resource base is non-recoverable by current or foreseeable technology. Most of the non-recoverable volume occurs at very low concentrations throughout the earth's crust and cannot be extracted short of mining the rock or the application of some other approach that would consume more energy than it produced. Depending on the kinds and amounts of data available, and a judgment on the reliability of those data, the estimator will select one of several methods of making a proved reserves estimate. Methods based on production performance data are generally more accurate than those based strictly on inference from geological and engineering data.Data collection is a process of inspection, transforming and modeling data with the goal of discovering useful information, informing and support decision-making.

2. Background History of Mann Oil Field

The Mann Oil field is located on the northern plunging end of the 30 miles long Mann-Minbu structural trend in proved oil province of the Central Burma Basin. (approximate Latitude N 20º 9' and Longitude E 94º 51'). The length and width of the producing area is about 10 miles and 1 mile respectively. It is situated on the northern plunging end of the Minbu anticline. It is asymmetric anticlinal fold and has broad crestal portion. The dip ranges between 35 to 45 degrees at the east and 45 to 75 degrees at the west flanks. The dip of the plunge is about 8-10 degree towards north. In this structure, oil exploration has been started since 1909. Many shallow wells had been drilled along the structure in Minbu, Shwelinbin, Htaukshabin, Palanyon Ywathaya, Htontaung and Peppi areas before the SecondWorld War was estimated to be about 3 million barrels. In 1962,1965,1968 and 1975 the geological, geophysical and seismic surveys were carried out. The first well was drilled on the northern part of the Mann Oil Field on 10.2.1970

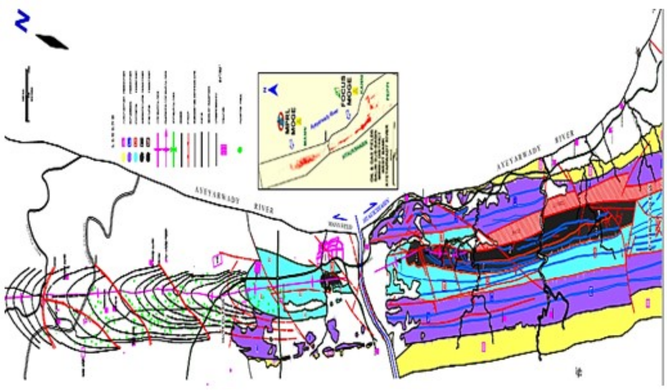

Figure.1 Geological Map of Mann - Htaukshabin Area
Source: Mann Oil Field (2017-18)

3. The Collective Data Used in Reserve Estimates

The raw data used in estimating proved reserves include the engineering and geological data for reservoir rock and its fluid content. These data are obtained from direct and indirect measurements. The data available for a given reservoir vary in kind, quality, and quantity. When a reservoir is first discovered only data from a single well are available, and prior to flow testing or actual production, proved reserves can only be inferred. As development of the reservoir proceeds, and flow tests are made or actual production commences, more and more data become available, enabling proved reserves estimates to become more accurate.

Many different kinds of data are useful in making reserves estimates. They may include: data on porosity, permeability, and fluid saturations of the reservoir rocks (obtained directly from core analysis or from various types of electrical measurements taken in a well or several wells); data on the production of fluids from a well or several wells; geologic maps of the areal extent, thickness, and continuity of the reservoir rocks (inferred from well logs, geophysical, and geological data); and reservoir pressure and temperature data. Also involved are economic data including the current price of crude oil and natural gas, and various developmental and operating costs.

3.1. Phase Diagram for Reservoir Fluids

Using two component systems have examined various aspects of phase behavior. Reservoir fluids contain hundreds of components and therefore are multicomponent systems. The phase behavior of multicomponent hydrocarbon system in the liquid-vapor region. However, is very similar to that of binary system the mathematical and experimental analysis of the phase behavior is more complex. Figure (1) gives a schematic PT and PV diagram for reservoir fluid system. System which include crude oil also contain appreciable amounts of relatively non-volatile constituents such that dew points are practically unattainable. [3],[5]

The behavior of several examples of typical crude oil and natural gas;

- Low-shrinkage oil (heavy oil, black oil)
- High-shrinkage oil (volatile oil)
- Retrograde condensate gas
- Wet gas
- Dry gas

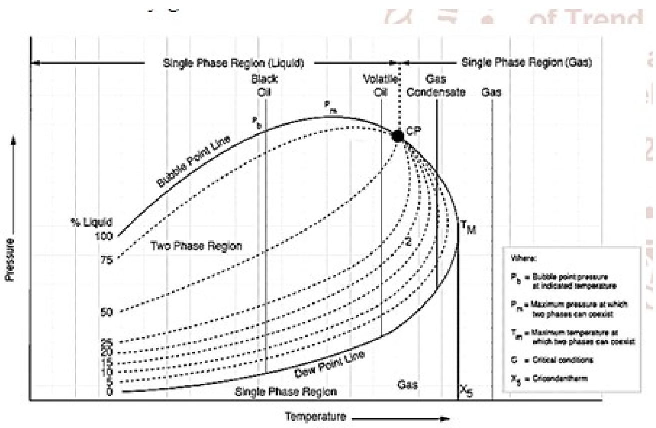

Figure.2 Sample Phase Diagram for Reservoir Fluid
Source: Fundamental of Reservoir Engineering (October 1977)

Figure (2) is a useful diagram to illustrate the behavior of the respective fluid types above. However, it should be emphasized that for each fluid type there will be different scales. The vertical lines help to distinguish the different reservoir fluid types. Isothermal behavior below the critical point designates the behavior of oil systems and the fluid is liquid in the reservoir, whereas behavior to the right of the critical point illustrates the behavior of system which are gas in the reservoir. [3]

3.2. Classification of Oil and Gas Recovery Stage

Table .1 Initial Recovery of Drive Mechanisms

Production Mechanism	Primary Recovery Range(% OOIP)
Solution-gas drive	10-25%
Gas-cap drive without/with gravity drainage	15-40% / 15-80%
Gas-reinjection without / with drainage	15-45% / 15-80%
Water drive	15-60%

Source: Petroleum Reservoir Engineering, Mc Graw-Hill,1960

Recovery stage can be defined as follows;

1. Primary recovery (Conventional Recovery)
A. Natural flow
B. Artificial lift (Pump-Gas Lift etc.)

2. Secondary recovery
A. Water-flooding, acidizing
B. Pressure maintenance (Water-gas reinjection)

3. Tertiary recovery (Enhanced Recovery)
A. Thermal
B. Solvent chemical
C. Other

3.3 Basic Petrophysical Evaluation Steps and Defined Sand Layer by Log

The gamma ray log is a simple log, run as part of almost every tool combination. Every well may have as many as five independent sets of gamma ray log data; (i) its high vertical resolution make it extremely useful for depth matching (multiple tool runs), (ii) fine scale correlation (including core matching), (iii) used to evaluate the shale content (V_{sh}), (iv) mineral analysis (spectral), (v) perforating depth control and the tracing of radioactive fluid movement. [6]

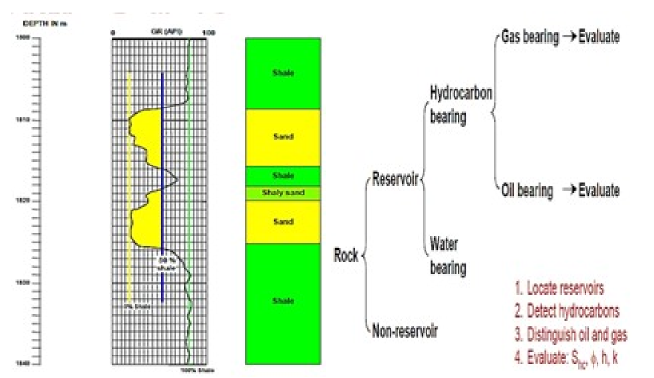

Figure.3 Simple GR Interpretation in a Sand-Shale Sequences
Source: Basic Well Log Interpretation, Shahnawaz Mustafa (2012)

3.4 Resistivity Log

Resistivity log shows the effect of the formation and the contained fluids on the passage of an electric current and similar effects in porous limestone and dolomite. The crossover effect of hydrocarbons in a reservoir and with a fresh water aquifer. [6]

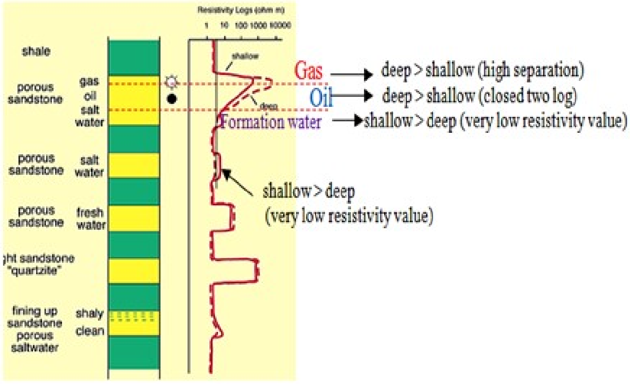

Figure.4 Simple Resistivity Log

Source: Basic Well Log Interpretation, Shahnawaz Mustafa (2012)

3.5 Definition of Sand Layer by Logging Data from Well No.2 (CD Block in Mann Oil Field)

The essential target of resistivity logging is a value of the true resistivity (Rt) of a reservoir and especially its hydrocarbon saturation.

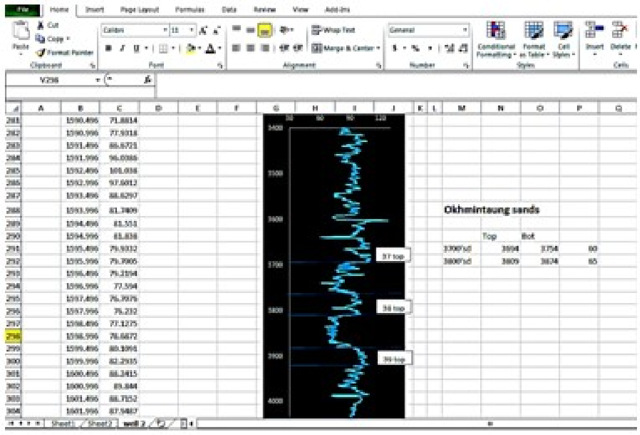

Figure.5 Log Data from Mann Oil Field Well.No.2 (3700'-3800'Sands)

Table.2 Properties of Mann Oil Field Formation

Formation	Geological age	No. of Hydrocarbon Bearing Sand	Net Pay Thickness (Ft)	Porosity (%) Range Avg	Permeability (md) Avg
Kyaukkok	Mid Miocene (26 age million years)	4(2200-Ft Sands)	100	18-36 30	717
Pyawbwe	LR Miocene (26 age million years)	8(2600-3600-Ft Sands)	145	6-35 22.5	142
Okhmin–taung	UP Oligocene (37 age million years)	3(3700-3900-Ft Sands)	107	12-35 24	113
Padaung (Upper)	Mid Oligocene (37 age million years)	3(5100-Ft to 5800-Ft Sands)	175	17-31 24.5	45
Padaung (Lower)	Mid Oligocene (37 age million years)	3(5100-5800-Ft Sand)	137	–	–

Source: Mann Oil Field (2017-2018)

3.6 Core Data Analysis of Well No.5

The basic effective requirement data for reserve estimation method can be obtained from the following Table (3) core data from Mann Oil Field Well No.5 in CD fault block.

Table.3 Core Data from Well No.5 in Mann Oil Field

Extraction Colour	Depth (ft)	Oil Saturation (%)	Water Saturation (%)	Porosity (%)	Permeability (md)
Yellow	4086	4	44	33	70
Orange	4022	10	22	34	76
Orange	4011	7	49	34	431
Pale-Yellow	3781	4	44	35	41
Colourless	3694	4	62	24	No Enough
Yellow	3688	5	18	33	No Enough
Yellow	3678	2	33	34	No Enough
Yellow	3665	4	39	41	No Enough
Orange	3650	10	53	31	88

Source: Mann Oil Field (2017-2018)

Table.4 Mann Oil Field Gas Composition

Component	Molecular weight	Mole fraction	Avg; Molecular weight
Methane	16.4	0.8604	13.800816
Ethane	30.07	0.0584	1.756088
Propane	44.09	0.0375	1.653375
Isobutane	58.12	0.0171	10.993852
n-Butane	58.12	0.0176	1.022912
Pentane	72.15	0.0074	0.53391
Carbondioxide	44.01	0.0016	0.070416
		1.0	19.831369

Source: Mann Oil Field (2017-2018)

4. Utilization on Volumetric Method

This method can be very simple, requiring only well-logs and some estimated parameter. These are reservoir area, net pay thickness, porosity, initial water saturation and oil/gas formation volume factor. Reservoir area is estimated or, in a developed field, is based on the spacing and contour mapping by using Auto-CAD. Net pay thickness is determined from well logs or core analysis. Porosity is calculated from well log or core analysis. Initial water saturation is calculated from well logs. Initial oil formation volume factor is determined from laboratory measurements of fluid samples or from correlation. [1],[4],[7]

Initial oil in place can be estimated by using these following equations;

$$N = \frac{7758 \emptyset A h (1-S_w)}{B_{oi}} \quad \text{.....equation (3.1)}$$

Where;

N= oil in place, STB
Φ= porosity at reservoir pressure, fraction (%)
A= area, acres
H= thickness, ft
S_w= water saturation, fraction
B_{oi}= oil formation volume factor, bbl/STB

Initial gas in place can be estimated by using these following equations;

$$G = \frac{43560 \emptyset A h (1-S_w)}{B_g} \quad \text{.....equation (3.2)}$$

Where;

G = gas in place, SCF
Φ = porosity at reservoir pressure, fraction (%)
A = area, acres
h = thickness, ft
S_w = water saturation, fraction
B_g = oil formation volume factor, ft^3/ SCF

4.1 Estimation of Reserves for Mann Oil Field (3700-CD Sand)

Estimation of Reserves for Mann Oil Field (3700-CD Sand) by Volumetric Method;
3700'CD subsurface contour map, Area of
Oil and Gas, A= 308 and 73 acres
Mann Oil Field Well. No.5 Porosity, Φ= 24 %
Mann Oil Field Well. Nol.5 Initial Water Saturation ,S_W= 42 %
Laboratory test Initial Oil Formation Factor, B_{oi} = 1.25 RB / STB
Laboratory test Initial Gas Formation Factor, B_{gi} = 12 Stb / Mscf

There are many different data of thickness and take form contour map, log paper and log data (.LAS).

Table5. Difference Estimation Reserve Based on Changing Thickness Data (3700'-CD)

Net Pay Thickness	h = 58 (from contour map data)	h = 60 (from log paper)	h = 61.3 (from log data)
Initial Oil in Place, N	15.43 MMSTB	15.97 MMSTB	16.31 MMSTB
Initial Gas in Place, G	2.13 MMSCF	2.21 MMSCF	2.26 MMSCF

4.2 Estimation of Reserves for Mann Oil Field (3800-CD Sand)

Estimation of Reserves for Mann Oil Field (3800-CD Sand) by Volumetric Method;
3700'CD subsurface contour map, Area of Oil and Gas,

A =412 and 20 acres

Mann Oil Field Well. No.5 Porosity, Φ = 24 %
Mann Oil Field Well. No.5 Initial Water Saturation, S = 42 %
Laboratory Test Initial Oil Formation Factor, B_{oi} =1.25RB/STB
Laboratory Test Initial Gas Formation Factor, B_{gi} =12Stb / Mscf
There are many different data of thickness and take form contour map, log paper and log data (.LAS).

Table6 Difference Estimation Reserve Based on Changing Thickness Data (3800'-CD)

Net Pay Thickness	h = 58 (from contour map data)	h = 60 (from log paper)	h = 61.3 (from log data)
Initial Oil in Place, N	20.64 MMSTB	21.36 MMSTB	21.82 MMSTB
Initial Gas in Place, G	5.8 MMSCF	6.1 MMSCF	2.26 MMSCF

5. Findings

There are many different data of thickness and take form contour map, log from 3700' CD sand and 3800' CD sand in Mann Oil field. According to reserve estimation results, when the net pay thickness obtaining from contour map, h is 58ft, the initial oil in place,N are 15.43 MMSTB , 20.64 MMSTB and the Initial Gas in Place, G are 2.13 MMSCF, 5.8 MMSCF, respectively. And then, while the net pay thickness from log paper,h is 60ft, the oil reserves are 15.97 MMSTB , 21.36 MMSTB of oil and the gas reserves are 2.21 MMSCF and 6.1 MMSCF, respectively. Moreover, the estimation reserves 16.31 MMSTB and 21.82 MMSTB of initial oil in place and the 2.26 MMSCF and 2.26 MMSCF , respectively of the initial gas in place can be estimated from the net pay thickness ,h=61.3ft.

6. Conclusions

This research paper contains the calculation of oil and gas reserves to estimate in the Mann Oil Field structure by the means of volumetric method. The mathematical calculation and graphical results can be made to predict future production rate. Reserve estimation of oil and gas by using volumetric method is highly depend on field production record, laboratory test and individual well completion design. So the reserve of (3700'-3800'-CD) in Mann Oil Field is irrelevance because of field data information are fragmentary. The total reserves are also mainly depended on economic limit. Economic limit based on gross present value and gross profits. Volumetric method is a powerful tool that helps determine the reserve, recovery factor, and drive mechanism. It can be applied to a variety of reservoir either with or without water influx.. Finally, the author concludes that the calculation by Volumetric method can recommend to estimate the oil and gas reserves when about 15% of the initial estimated reserve is produced, or when 10% of initial reservoir pressure has declined and also used to infer aquifer and gas cap behavior.

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