OIL AND GAS RESERVE ESTIMATION USING VISUAL BASIC 11.0

Emmanuel Chinedu Nnyeruka[1], Victor Onensi Abbey[2]

Eastern Mediterranean University,
TURKEY.

[1]ennyeruka@yahoo.com, [2]omasyson@gmail.com

ABSTRACT

An improper estimation of an oil and gas reservoir will have considerable inimical effect on the economical out-put of that reservoir considering the level of uncertainty that will emanate. Reducing the level of uncertainty in oil and gas reserve estimation before development has been a major point of consideration amongst oil companies, as a favorable expectancy in estimation result will to a large extent guarantee return on investment. To be assured of the economic potential of any given reservoir or field before development, volumetric or analogy estimation method is mostly carried-out to estimate the level of original oil in place (OOIP) and original gas in place (OGIP). This paper presents a new and computerized approach or version of volumetric estimation method, and it is done by imputing data for all parameters, components or factors required for calculation in volumetric estimation method into the Microsoft visual basic platform. This method is triggered by the desire to reduce time spent in oil and gas reserve estimation after seismic stage and before development, in order to speed-up production for better economic value of the product vis-a-vis cost of production. Therefore, Microsoft visual basic is used to design computation models, and data as results are generated to substantiate the reservoir estimation of oil and gas. More so, this method is less time consuming compared to time spent in numerical reservoir estimation. The complete process of this method is presented in this paper. The result can be comfortably used to make oil reserve estimation of all types of reservoir and field with different geophysical and geological properties.

Keywords: Volumetric Estimation; Microsoft Visual Basic; Original Oil in Place (OOIP); Original Gas in Place (OGIP)

INTRODUCTION

The struggle to evaluate the volume and extent of hydrocarbon in any given reservoir has been a great challenge since1800s when crude oil seepage was used as insect repellant, lamb oil etc. and was consequently considered an economic commodity. Oil reservation estimation has been the approach to ascertain the extent of oil in a given reservoir and oil field. The estimation of oil reservoir is pivotal to determine the quantity of hydrocarbons in any given reservoir or field prior, during and after development and its result directly affects the decision to justify whether it is technically and economically viable to start or continue the development of such a reservoir. Good estimation classifies reservoir as proven, probable or possible reserve. Several factors such as the reservoir type, source of reservoir energy and quality and quantity of geological, engineering and geophysical data affect the level of certainty and have to be considered when estimating an oil reserve. All estimate of reserve include a certain degree of uncertainty, primarily due to geological data available at the time of appraisal and the interpretation of this data. Generally, manual calculation using volumetric estimation, material balance method, production history analysis and analogy methods for computing petroleum reserve have been in-use for a long time.

To simplify the complexity of oil reserve estimation, a number of approaches have been applied in this line of research. In recent years, researchers have also devised other ways of

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estimating a reserve holistically, not simplifying an already known specific method. Yin et al., (2009) predicted remaining oil in a reservoir by using conceptual simulation, qualitative analysis and quantitative modeling. Hesam and Alireza, 2013 showed that neural network using Bayesian algorithm yields better reservoir estimation result compared to the usual Back propagation neural network algorithm. Tarek, (2001) and Charley et al.,(2012) also pointed-out rock and liquid expansion, solution gas drive, gas cap drive, water drive, gravity drainage drive, and combination drive as mechanisms that provide natural energy as key factors to be considered for oil recovery. However, in this study the crux of the matter is to simplify the volumetric estimation method for calculating original oil in place (OOIP) and original gas in place (OGIP). Hence, a Microsoft visual basic program is designed relying on the volumetric estimation information deduced from (Nnaemeka, 2011) and (Tarek, 2001) as collated in table 1 and table 2 below;

Table 1. Reservoir Properties for Volumetric Estimation of OOIP

Properties	*Parameters*
Area of reservoir, A	1022 acres
Height or thickness of pay zone, h	12.5 ft
Reservoir porosity, ϕ	0.275
Initial water saturation, S_{wi}	0.30
Initial oil formation volume factor, B_{oi}	1.02 bbl/stb

Source: (Nnaemeka,2011)

Table 2. Reservoir Properties for Volumetric Estimation of OGIP

Properties	*Parameters*
Area of reservoir, A	3000 acres
Height or thickness of pay zone, h	30ft
Reservoir porosity, ϕ	0.15
Initial water saturation, S_{wi}	0.20
Initial gas formation volume factor, B_{gi}	0.0054 ft^3/scf

Source: (Tarek, 2001)

Reasonable estimate of the original oil and gas in place are computed, using volumetric oil estimation method to check.

VOLUMETRIC ESTIMATION METHOD

Volumetric estimation is a geological model based on core, analysis of wireline logs and geological maps, used to determine how much oil and gas that exist can be produced vis-à-vis a proposed investment to be made. (Ray and Lisa et al. 2001)Describes volumetric estimation as the only available means to assess hydrocarbons in place prior to acquiring sufficient pressure and production information to apply material balance techniques. In determining the volume of hydrocarbon in the surface of any given reservoir; the thickness of the rock containing the oil or gas, isolated and interconnected porosity, water saturation are required using *eqn.*1 and *eqn.* 2 below to estimate the volume of both oil and gas respectively.

$$N = 7758Ah\phi(1 - S_{wi}) / B_{oi} \qquad eqn.1$$

$$G = 43560Ah\phi(1 - S_{wi}) / B_{gi} \qquad eqn.2$$

Estimation Using Visual Basic 11.0

In order to develop a Microsoft visual basic program to be used to determine the extent of oil or gas in a given reservoir using volumetric estimation method, a flow chart showing step by step process taken to design the programs are required, hence

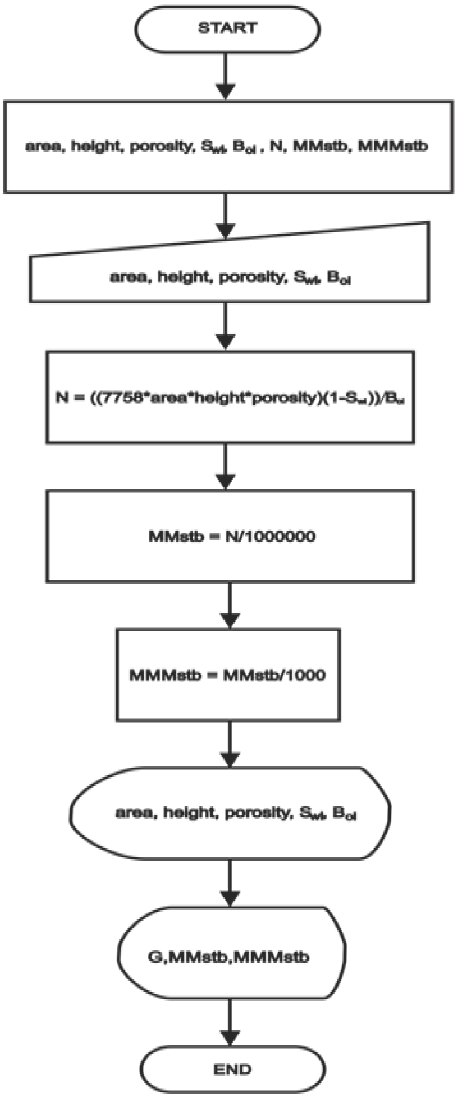

Figure 1. Flowchart Showing Steps Taken to Design Visual Basic Program for Estimation of OOIP

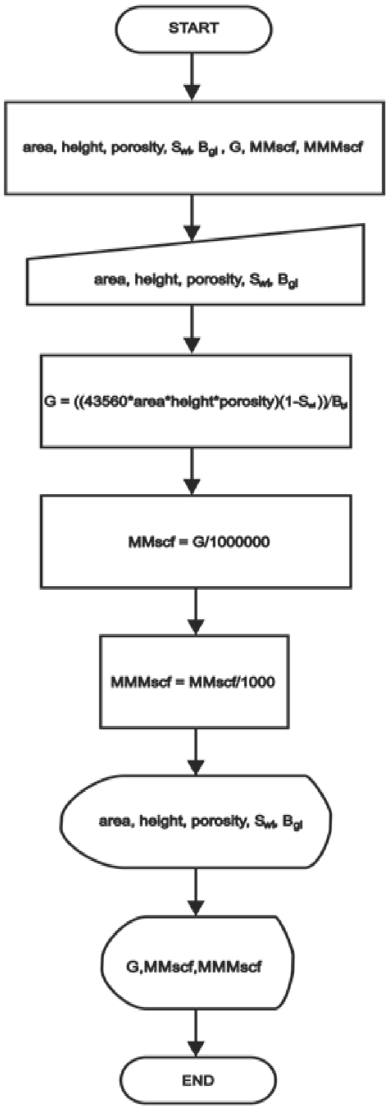

Figure 2. Flowchart Showing Steps Taken to Design Visual Basic Program for Estimation of OGIP

The Microsoft visual basic models for volumetric estimation of OOIP and OGIP are shown in Figure 3 and Figure 4 below.

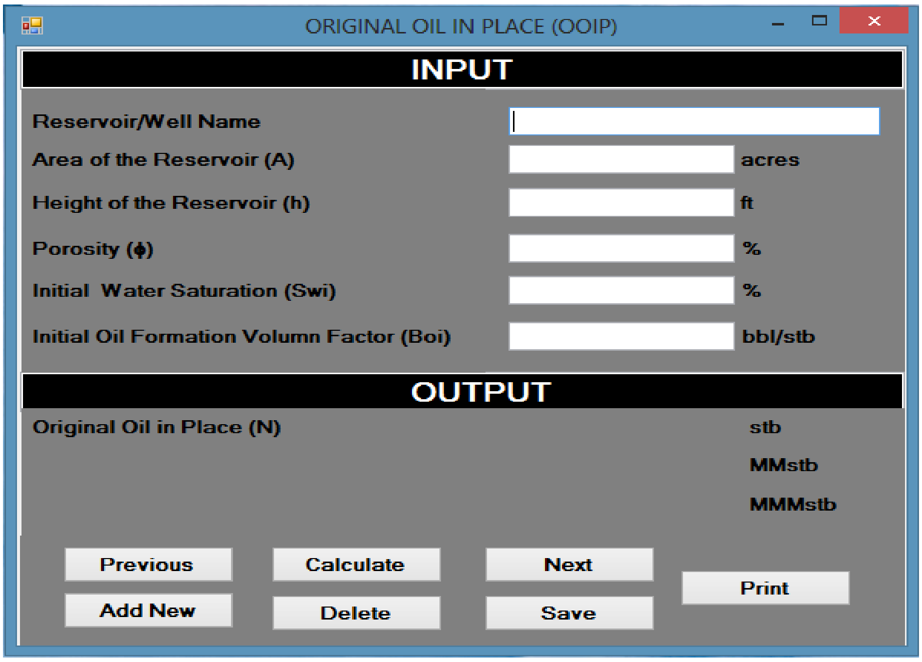

Figure 3. Visual Basic Model for Volumetric Estimation of OOIP

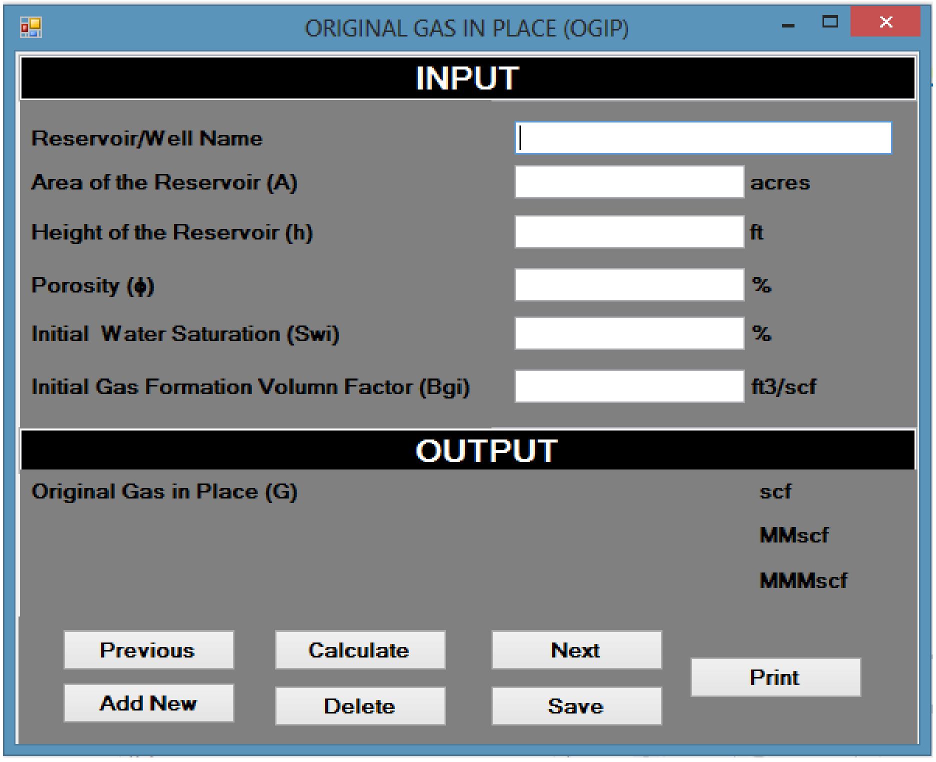

Figure 4. Visual Basic Model for Volumetric Estimation of OGIP

Before now, there had not been any exact and proven model for estimating original oil in place (OOIP) of a reservoir using parameters required for volumetric estimation method. Over the time, estimation by volumetric method had been undertaken by going through some mathematical steps and manual conversions, which more often than not have been marled or streaked by human and avoidable errors. This work unveils a simple, direct and less vigorous approach to estimating original oil in place (OOIP) of a reservoir using volumetric estimation method.

Numerical Estimation Approach for OOIP

Estimating original oil in place numerically using the well-known volumetric estimation method for a given reservoir is done by solving for ***N*** in *eqn.*1;

$$N = 7758Ah\phi(1 - S_{wi}) / B_{oi} \qquad eqn.1$$

But,

$$V_b = 7758Ah \qquad eqn.1(a)$$

Hence, substituting equation *eqn.*1(a) into *eqn.*1, we have

$$N = V_b\phi(1 - S_{wi}) / B_{oi} \qquad eqn.1(b)$$

To solve for ***N*** in *eqn.*1(b) above using the figures of reservoir properties deduced from (Nnaemeka, 2011), which are:

A= 1022 acres

h = 12.5 ft

ϕ= 0.275

S_{wi}= 0.30

B_{oi}=1.02 bbl/stb

We have;

$$V_b = 7758 \times 1022 \times 12.5 = 99.11 \text{ MMbbl}$$

Hence;

$$N = \frac{(99.11 \times 10^6 \text{ bbl})(0.275)(1 - 0.30)}{1.02 \text{ bbl/stb}}$$

$$N = 18704290.809 \text{ stb}$$

$$18.70 \text{ MMstb}$$

$$0.02 \text{ MMMstb}$$

Numerical Estimation Approach for OGIP

Similarly, estimating original gas in place numerically using the well-known volumetric estimation method for a given reservoir is done by solving for ***G*** in *eqn.*2;

$$G = 43560Ah\phi(1 - S_{wi}) / B_{gi} \qquad eqn.2$$

But,

$$V_b = 43560Ah \qquad eqn.2(a)$$

Hence, substituting equation *eqn.*2(a) into *eqn.*2, we have

$$G = V_b\phi(1 - S_{wi}) / B_{gi} \qquad eqn.2(b)$$

To solve for *G* in *eqn.*2(b) above using the figures of reservoir properties deduced from (Tarek, 2001) which are:

A= 3000 acres

h = 30ft

ϕ= 0.15

S_{wi}= 0.20

B_{gi}= 0.0054 ft^3/scf

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We have;

$$V_b = 43560 \times 3000 \times 30 = 3920.4 \text{ MMft}^3$$

Hence;

$$G = \frac{(278.78 \times 10^6 \text{ ft}^3)(0.15)(1 - 0.20)}{0.0054 \text{ ft}^3/\text{scf}}$$

$$G = 87120000000 \text{ scf}$$
$$87120.0 \text{ MMscf}$$
$$87.12 \text{ MMMscf}$$

RESULT AND DISCUSSION

Microsoft visual basic programs for estimation of OOIP and OGIP was designed as shown in Figure 1 and Figure 2, using eqn.1 and eqn.2. And same set of values deduced from (Nnaemeka, 2011) and (Tarek, 2001) was inputted into the models for a synthetic reservoir with the name "SMITH1" to determine OOIP and OGIP respectively as shown in Figure 5 and Figure 6.

After the imputation of all parameters required for calculation in volumetric estimation method into the Microsoft visual basic models, a click on the "Calculate" button in the model will automatically produce results of both Original Oil in Place and Original Gas in Place in million and in billion respectively, as in Figure 5 and Figure 6 above. The model is user friendly and multi-tasking as it avail user to toggle between different sets of imputed data and results by using the "Previous" and "Next" buttons. "Add New" button clears the input session in order for the user to type-in new sets of data, whereas the "Delete" button completely removes a given set of data from the model. The "Save" button holds calculated sets of data for printing as shown in Figure 7 and Figure 8.

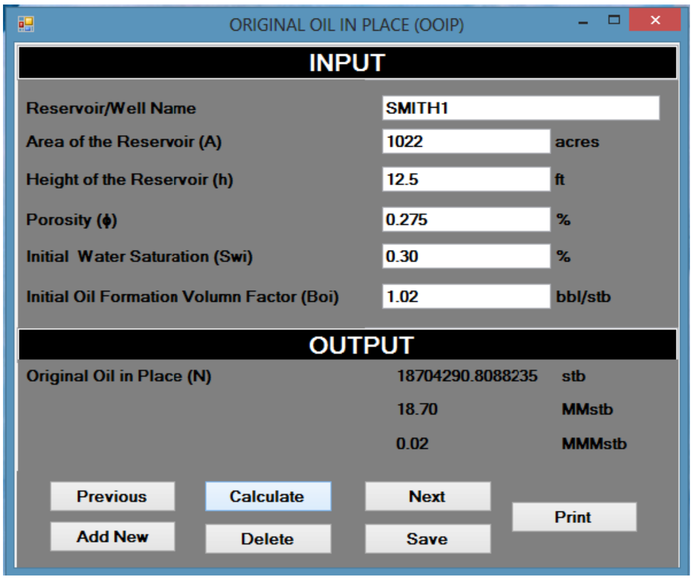

Figure 5. Visual Basic Model for Volumetric Estimation Showing Calculated of OOIP

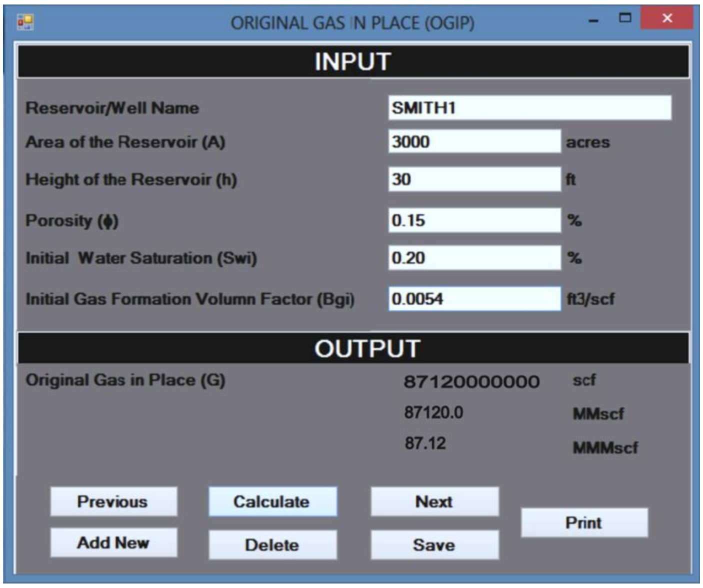

Figure 6. Visual Basic Model for Volumetric Estimation Showing Calculated of OGIP

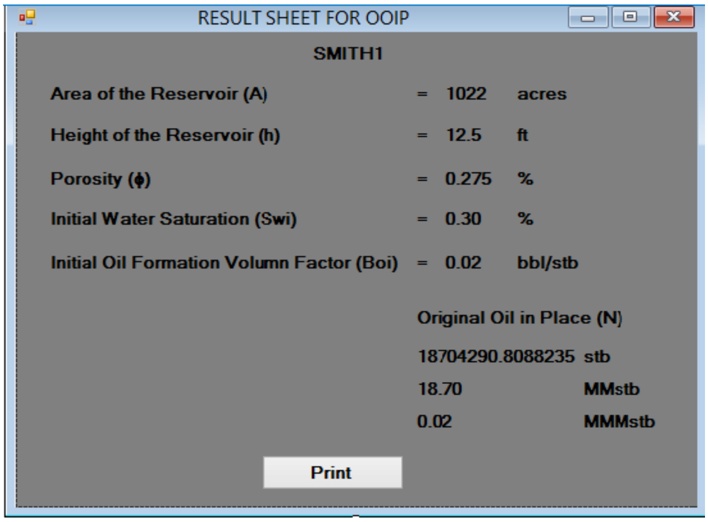

Figure 7. Visual Basic Result Sheet for Volumetric Estimation of OOIP

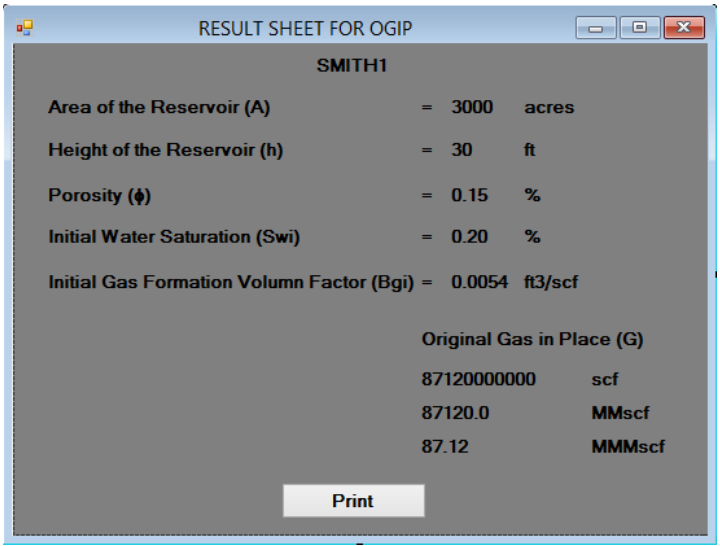

Figure 8. Visual Basic Result Sheet for Volumetric Estimation of OGIP

Importantly, this model can be used to calculate and print infinite sets of data.

CONCLUSION

To sum up, it is glaring that I obtained the same values for ***N (stb)***and ***G (scf)***from both visual basic models in Figure 5 and Figure 6 as in the well-known numerical volumetric approach. This substantiates the authenticity of the model and that it can be used to estimate original oil in place (OOIP) and original gas in place (OGIP) accurately. More so, time spent in estimating original oil in place numerically has been reduced drastically, when compared to simply imputing raw data into a visual basic platform. Furthermore, this model completely eliminates all forms of human, computational errors that could emanate as a result of computing data manually. Not only does it allow the user to make infinitely fast and accurate calculations, it also gives the user the flexibility to print infinite set of results. No doubt, the visual basic models presented in this work are straight forward approach, devoid of error and less time consuming for estimation of oil and gas reserve using the volumetric estimation method.

Nomenclature

A	reservoir area, acres
B_{gi}	initial gas formation volume factor, ft^3/scf
B_{oi}	initial oil formation volume factor, bbl/stb
G	original gas in place, scf
h	height or thickness of pay zone, feet
N	original oil in place, stb
S_{wi}	initial water saturation, fraction
$\boldsymbol{V_b}$	bulk reservoir volume
ϕ	reservoir porosity, fraction
1P	proved reserve
43560	conversion factor from acre-ft to ft^3
7758	conversion factor from acre-ftto bbl

Abbreviations

bbl	barrel
eqn.	equation
ft	feet
ft^3	cubic feet
MM	million
MMM	billion
OGIP	original gas in place
OIP	oil in place
OOIP	original oil in place
scf	standard cubic feet

stb	stock tank barrel

Subscripts

b	bulk
g	gas
i	initial
o	oil
w	water

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