DynoBal

Contents

Abstract:

Dynamic material balance equation is a method for determining the amount of oil in underground oil reservoirs (Oil in Place-OIP). This method uses a straightforward illustrative method to calculate OIP, however, calculations and illustration can be tedious. DynoBal helps users with the calculations and also with sketching charts and retrieving required data from the charts. The data will be used in the future steps to determine reservoir average pressure and OIP. This software is written in C# and uses Microsoft Excel files to input and output data for the convenience of the user.

Technical petroleum engineering concept:

In order to determine oil in place -OIP- several methods have been developed. Each of them has its own benefits and limitations and needs to be applied in the proper case. One of the earliest methods of predicting OIP is material balance equation. It uses the average pressure of the reservoir, cumulative production, and several other factors to calculate OIP. In order to obtain the average reservoir's pressure, oil production stops and reservoir pressure gradually increases and reaches its maximum level, which is average pressure at that particular time. In reservoirs with low permeability shutting wells to obtain average pressure is not practical. Pressure would take a long time to reach the average pressure thus using the conventional material balance equation is not viable.

Dynamic Material Balance Equation helps to calculate IOIP with an indirect method for the average reservoir's pressure calculation without ceasing production and shutting wells.

Here is a brief explanation of DMBE's equations and usage method (Mattar et al. 2005).

$$\boldsymbol{\bar{p}_R = p_{wf} + b_{pss} q} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad \mathbf{1}$$

$$\boldsymbol{b_{pss} = \frac{141.2 B\mu}{kh}\left[\left(ln\frac{r_e}{r_{wa}}\right) - \frac{3}{4}\right]} \ldots\ldots\ldots\ldots\ldots\ldots \quad 2$$

b_{pss} is a constant and can be calculated by illustrating $\frac{p_i - p_{wf}}{q}$ versus $\frac{N_P}{q}$. By using, flow rate, flowing pressure and b_{pss} , average pressure can be calculated simply with equation No.1.

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$$\boldsymbol{\frac{p_i - p_{wf}}{q} = \frac{qt}{c_o N q} + b_{pss} = \frac{N_P}{c_o N q} + b_{pss}} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad \mathbf{3}$$

In order to calculate, b_{pss}, consider equation No.3 . It is a line which intercepts Y axis at b_{pss} thus by illustrating $\frac{p_i - p_{wf}}{q}$ versus $\frac{N_P}{q}$, b_{pss} is calculated. It is important to consider that the early section of this chart might be curve-shaped due to transient flow regime. After establishing pseudo steady state regime, it is a line and can be used to calculate b_{pss}. After obtaining the average reservoir's pressure, conventional material balance equation uses the average reservoir's pressure data and estimate OIP.

Workflow:

The user provides an excel file containing time, flowing pressure, oil production rate, and cumulative oil production. Then software determines eq.3 and draw a graph regarding provided data. At the next step software helps the user to draw a straight line on the chart and calculates a constant, b_{pss}, which will be used in the next step. After user's confirmation on b_{pss} the software calculate average pressure and the user can save the output on an Excel file.

1. Stage one: importing data:

In this stage the user import time, flowing pressure, production rate, and cumulative produced oil until the specific time. This software has the ability to import data from excel files. In this stage initial pressure is inserted and if the users decide to skip this, the first flowing pressure is assigned as the initial pressure. Figure 1.

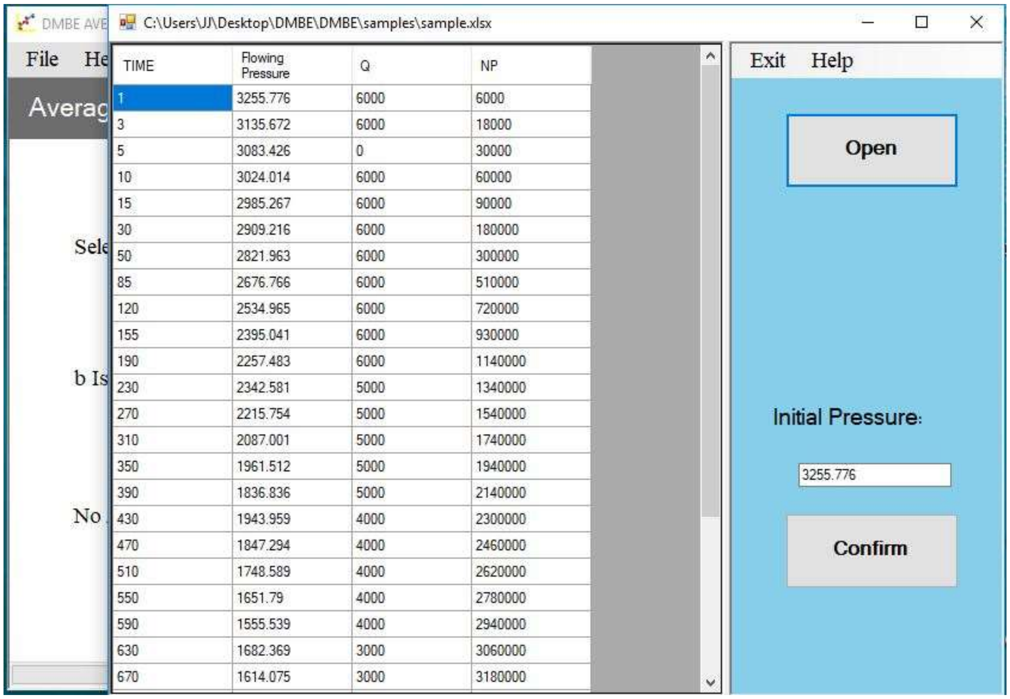


Figure 1, Import data

2. Primary calculation an Illustration, drawing the graph:

In this step, the graph that is needed to calculate reservoir constant, b, is produce and the user can use the mouse to draw the best match line for the data as it is shown in Figure 2. In this stage the primary calculation for drawing is done. After that, the reservoir constant is calculated by the software and the user can edit or confirm it.

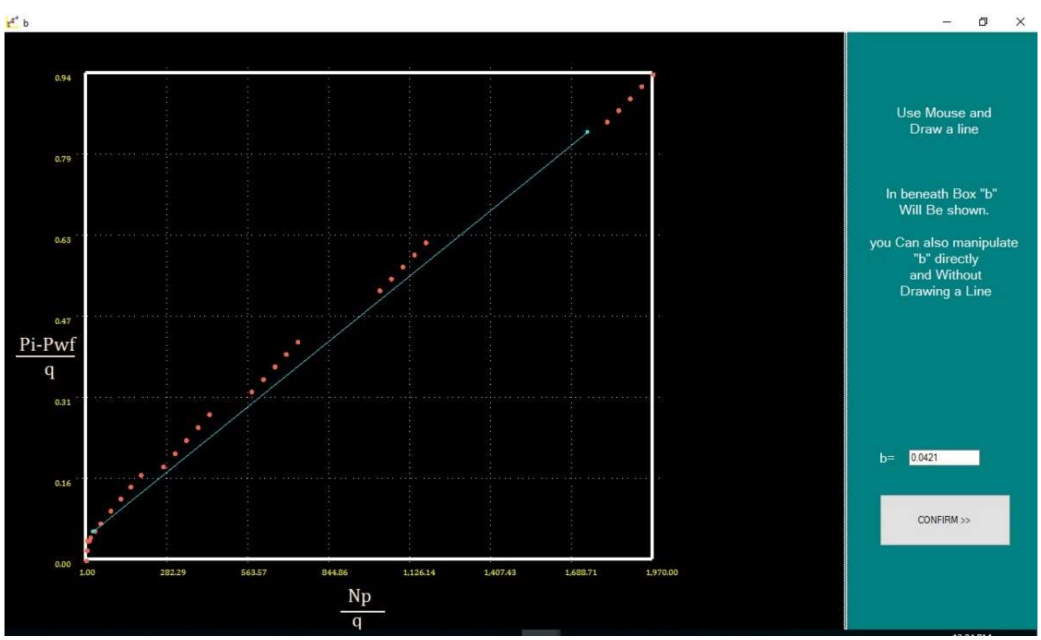
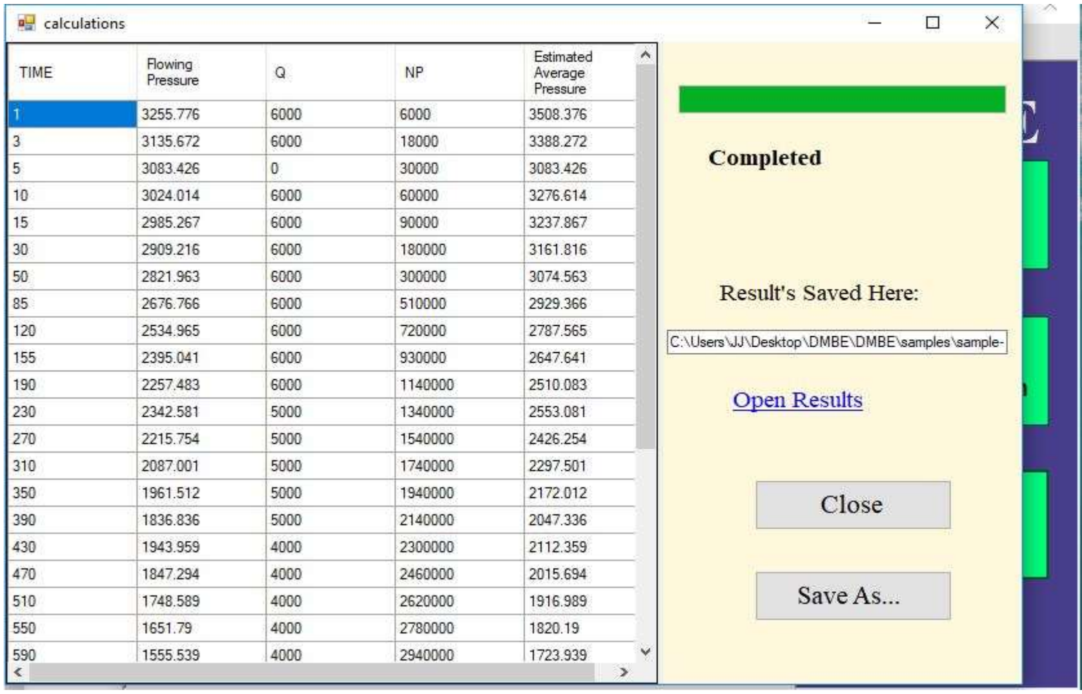


Figure 2, Reservoir constant

3. Final calculation, data output:

At this stage, Figure 3, final calculation is done the average pressures will be produced. The n the user can copy the data or save it as an excel file easily.

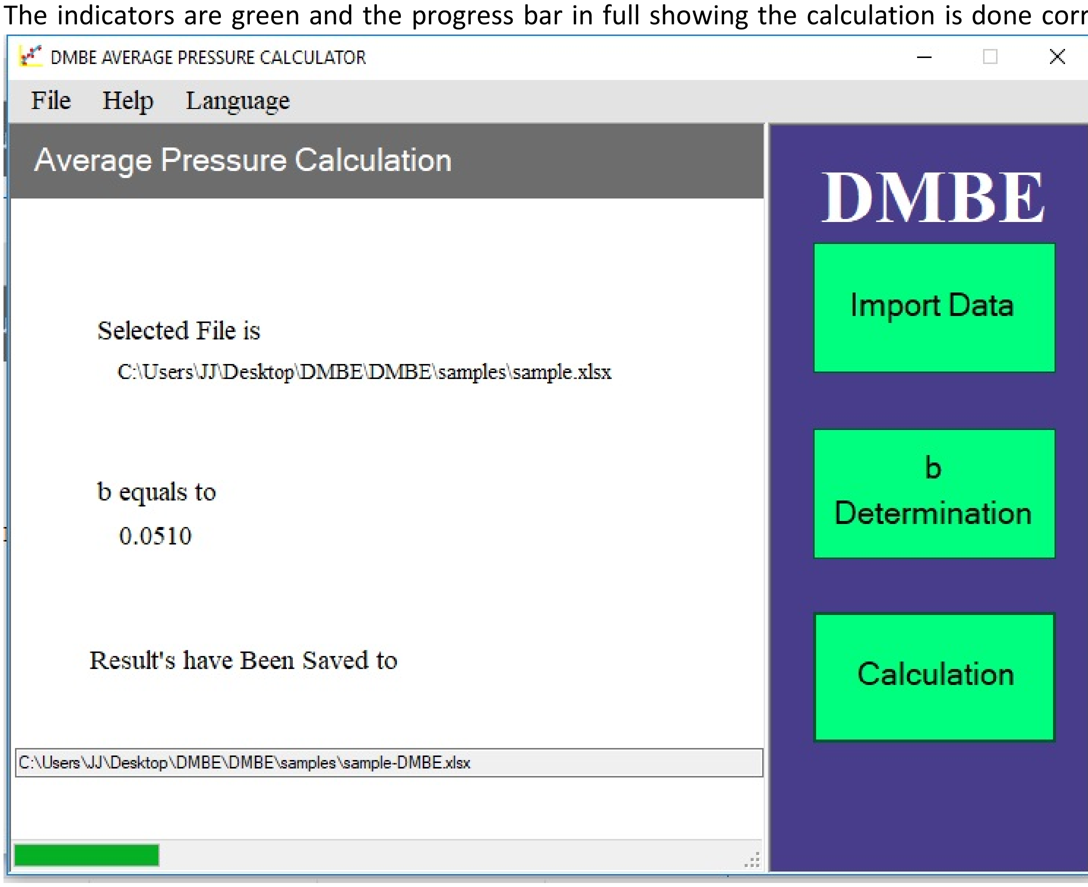


TIME	Flowing Pressure	Q	NP	Estimated Average Pressure
1	3255.776	6000	6000	3508.376
3	3135.672	6000	18000	3388.272
5	3083.426	0	30000	3083.426
10	3024.014	6000	60000	3276.614
15	2985.267	6000	90000	3237.867
30	2909.216	6000	180000	3161.816
50	2821.963	6000	300000	3074.563
85	2676.766	6000	510000	2929.366
120	2534.965	6000	720000	2787.565
155	2395.041	6000	930000	2647.641
190	2257.483	6000	1140000	2510.083
230	2342.581	5000	1340000	2553.081
270	2215.754	5000	1540000	2426.254
310	2087.001	5000	1740000	2297.501
350	1961.512	5000	1940000	2172.012
390	1836.836	5000	2140000	2047.336
430	1943.959	4000	2300000	2112.359
470	1847.294	4000	2460000	2015.694
510	1748.589	4000	2620000	1916.989
550	1651.79	4000	2780000	1820.19
590	1555.539	4000	2940000	1723.939

Figure 3, Data output

4. Summary:

In this last stage, a summary of input file name, reservoir constant and the output file is shown. The indicators are green and the progress bar in full showing the calculation is done correctly.



Key features:

- Support two languages, English and Persian.
- Very user-friendly, Uses Excel files as input and output format to make it.
- Using step by step approach and Providing feedback after each step.