Matching Well Test Data with Computer Model

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Abstract:

This project concerning with matching the well test data for one of Buzurgan wells the objective of make matching is to see if the observed data of the well test as same as the calculated one by using the mathematical model we made by using computer program.

The well test data was available for matching was consist of three build up test two of them have a record for the well head pressure and bottom hole pressure and one just contain a record for the well head pressure so after matching we can make correlation to find the bottom hole pressure for the test haven't BHP values .

By using Eclipse program we build a mathematical model for the well BU-6

The model consist of six layer (MA, MB11, MB12, MB21, MC1and MC2) and we take r=1, theta=10, we use the available data in Buzurgan field reports and then we enter the well test data and see the result of matching between the observed and the calculated one.

From the matching we see that there was good matching between the two data, the matching was for the production and the bottomhole flowing pressure and the two was matched with the observed one.

In order to make the matching very well we make change in permeability and increase its value by 20% and this change was very good to the matching of the production data and we also change the skin factor to -3.6 and that effect on the pressure matching and make it very well.

Introduction

1-1Reservoir modeling

In the oil and gas industry, reservoir modeling involves the construction of a computer model of a petroleum reservoir, for the purposes of improving estimation of reserves and making decisions regarding the development of the field.

A reservoir model represents the physical space of the reservoir by an array of discrete cells, delineated by a grid which may be regular or irregular. The array of cells is usually three-dimensional, although 1D and 2D models are sometimes used. Values for attributes such as porosity, permeability and water saturation are associated with each cell. The value of each attribute is implicitly deemed to apply uniformly throughout the volume of the reservoir represented by the cell.

Types of reservoir model

Reservoir models typically fall into two categories:

- Geological models are created by geologists and geophysicists and aim to provide a static description of the reservoir, prior to production.
- Reservoir simulation models are created by reservoir engineers and use finite difference methods to simulate the flow of fluids within the reservoir, over its production lifetime.

Sometimes a single "shared earth model" is used for both purposes. More commonly, a geological model is constructed at a relatively high (fine) resolution. A coarser grid for the reservoir simulation model is constructed, with perhaps two orders of magnitude fewer cells. Effective values of attributes for the simulation model are then derived from the geological model by a process of "up scaling". Alternatively, if no geological model exists, the attribute values for a simulation model may be determined by a process of sampling geological maps.

Uncertainty in the true values of the reservoir properties is sometimes investigated by constructing several different realizations of the sets of attribute values. The behavior of the resulting simulation models can then indicate the associated level of economic uncertainty.

The phrase "reservoir characterization" is sometimes used to refer to reservoir modeling activities up to the point when a simulation model is ready to simulate the flow of fluids.

Commercially available software is used in the construction, simulation and analysis of the reservoir models.

1-2 single well model

the single well model is a modern technique to show the effect of a well in a whole reservoir and how much it effect on the near well bores of a specific well.

Here in our project we have used a radial gridding to ensure the radial flow through the pores media near the well.

1-3 history matching

History matching is the process of building one or more sets of numerical models (representing a reservoir) which account for observed, measured data. During any kind of model calibration process such as this, it is important to note that:

- Reservoir models are models, not reality. There are inevitable errors and approximations that are found in any model of physical phenomena.
- The history matching process is undertaken for the purpose of decision making. History matching serves no purpose on its own.
- The model input is uncertain, and the uncertainty is almost always underestimated.
- The observable data always contains errors, however small.

History matching should be considered in the general context of uncertainty quantification, of which history matching is only a part. For proper decision making, the uncertainty of the outcome must be assessed. The assessment of uncertainty is always subjective. History matching should assist in creating the model of uncertainty, which is subsequently used for decision making.

1-4Well testing

Tests on oil and gas wells are performed at various stages of drilling, completion and production.

The test objectives at each stage range from simple identification of produced fluids and determination of reservoir deliverability to the characterization of complex reservoir features. Most well tests can be grouped either as productivity testing or as descriptive/reservoir testing.

Productivity well tests are conducted to;

- Identify produced fluids and determine their respective volume ratios.
- Measure reservoir pressure and temperature.
- Obtain samples suitable for PVT analysis.
- Determine well deliverability.
- Evaluate completion efficiency.
- Characterize well damage.
- Evaluate work over or stimulation treatment.

Descriptive tests seek to;

- Evaluate reservoir parameters.
- Characterize reservoir heterogeneities.
- Assess reservoir extent and geometry.
- Determine hydraulic communication between wells.

1.5 Build-Up Testing

The measurement and analysis of (usually) bottom hole pressure data acquired after a producing well is shut in. Buildup tests are the preferred means to determine well flow capacity, permeability thickness, skin effect and other information. Soon after a well is shut in, the fluid in the wellbore usually reaches a somewhat quiescent state in which bottom hole pressure rises smoothly and is easily measured. This allows interpretable test results.

Test Objectives

The primary purpose of performing a build-up test is to determine the wellbore damage (skin) and the reservoir permeability. However, during the course of a build-up, it is possible to encounter reservoir boundaries. If all the reservoir's boundaries are contacted during the build-up, the size of the reservoir can also be determined. If the well has been pressure tested before, subsequent testing allows relative material balance calculations (decline curve analysis), as well as the determination of the drive mechanism for the reservoir.

Advantages

A build-up test is one of the simplest tests to perform. The biggest advantage in performing a build-up is that it is a constant rate test: Q = 0. Simply install the equipment while the well is flowing, and then shut the well in upstream of the choke.

Literature_review

- Integrated single well modeling: improves completion design in unconventional gas play making a single well model with history matching and prediction the well production rate. -modeling study of a single well enhanced geothermal system (egs): In this work, a numerical model was built, by which the thermal outputs capacity of several single-well EGS configurations were explored and the parameters.

-Efficient history matching of reduced reservoir models. Roman Heimhuber, Sonthofen, August13,2012.
-Hamdan (2011) build 3D static geological model structure faces, and petrophysical model for mishrif formation in bazurgan depending on petrophysical properties. -ElradiAbass* & Cheng Lin Song Faculty of Petroleum Engineering, China University of Petroleum-Beijing (CUPB) 18 Fuxue Road Changping, Beijing China -Single-Well Model Interpretation: The single well model uses the Statton #1-12 well and

various modified versions of this well to build a pseudo-cross section which shows a relatively thin Morrow-Mississippian channel-fill interval (21 ft. 6.4 m.) that contains a moderately thick sand (9 ft.; 2.7 m) in the middle of the channel, flanked by a shale section that thins to a 2 ft. (0.6 m.) Morrow - Mississippian interval outside of the channel. -Mathematical models for oil reservoir simulation: - knut-andreas lie and Bradley t. mallison

Work

Our work in this project was on Bu-6 the Bazurgan sixth well, because the availability of data. At the first step we have prepared the required data for our work and inserted these data to a computer program to make the single well model we need to match the well test data.

Preparing the data

The using of computer program such as eclipse to create model requires the use of different data to be imported into the program such as:

- Well head and well tops data: - we can get it from FWR, FGR.
- Fluid properties (PHI, Sw and K): - from CPI or from core analysis reports.
- Net pay and N/G ratio:- from the data available in the special core analysis and CPIand by using either Excel or IP program.
- WOC level for each dome and even for each unit.
- Geometry data (coordinate system information, inner diameter, outer diameter, depths of top faces…. others).
- PVT data (oil, gas and water properties). By using PVT reports of Bazurgan-6 well and using PVTP software we had the data for oil, water, and gas properties.
- SCAL (Kro, Krw, Krg and Sw).

Some calculations we made to get the data we need in our work:-

Permeability estimation:-

There are three types of permeability we need it to build our model, which are (Kx, Ky and Kz,)

For the well BU-6 the reports of the core analysis only contain the horizontal permeability (Kx and Ky) and we need the vertical permeability so we search and find that in general theKv=Kh*0.1.

In the case we have several core data have Kv we can make a correlation between it and the Kh in order to get equation we can apply to predictKv for cores that has only Kh.

Net pay and N/G calculation:-

Net pay values (by using excel or by using IP program):- This isdone by applying Sw cut off on the values of Sw from CPI log data to remove the depths that has Sw values less than the cut off value.

Net to gross values: - by dividing the net pay values on the gross values (which representing the total thickness).

The final result of the calculation we made on the data we need in our work are listed in the table below

Table (1) Sample of results

Layer	PHI	Kh	Kv	net pay	gross	n/g
MB21	16.84048	64.22343	6.422343	18.86	82.6	0.229
MC1	14.17377	24.07705	2.407705	55.67	81.5	0.77
MC2	14.35333	11.30733	1.130733	5.422	33.9	0.16

3-1 Petrel work and result:-

At first we used petrel software (2013) program to build a single well model for one of Buzurgan wells (we choose BU-6).

The figure below show the final result of the single well model we made by using petrel, this figure represents the well, grids, properties scale up, and layers of Mishrif for the well BU-6.

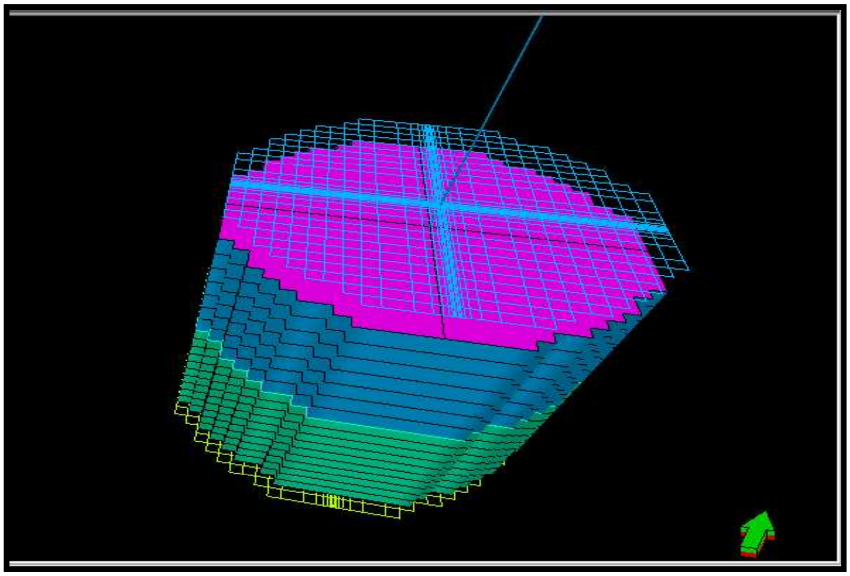

Fig.(1) single well model for BU-6

After working on this model and complete it we result that this single well model we built by using petrel RE 2013 not accurate and don't represent the actual condition of the well because the properties of it distributed on Cartesian coordinate and not radial coordinate as we see in figure (10), we can continue our work and build the dynamic model but the matching in this case will not be the actual one we want and the result will not be correct.

So we have to change the program we working on by another program which is Eclipse and start the work from the beginning.

3-2 Eclipse work and result:-

By using Eclipse software we can build single well model (static and dynamic) and we also make matching for the well test data.

We chose the well BU-6 to build our model because we find that this well have approximately all the data we need in the program and also have well test data which is the base to make matching.

The steps we need to make single well in eclipse are:

- Case definition: which we must to define the reservoir Layers in r, theta and Z direction which was equal to 1, 10, and 6 and defining reservoir phases observed in it.

- Grid section: here we have input our data of Porosity, Kh, Kv, Net thickness, reservoir geometry, and Layers dimensions.

- PVT data: here we had inserted the water, oil, and gas properties for our model. And other data such as the rocks compressibility and fluids densities. These data we have get it from Buzurgan basic files. And by using the PVTP software we have the properties correctly at difference pressures.

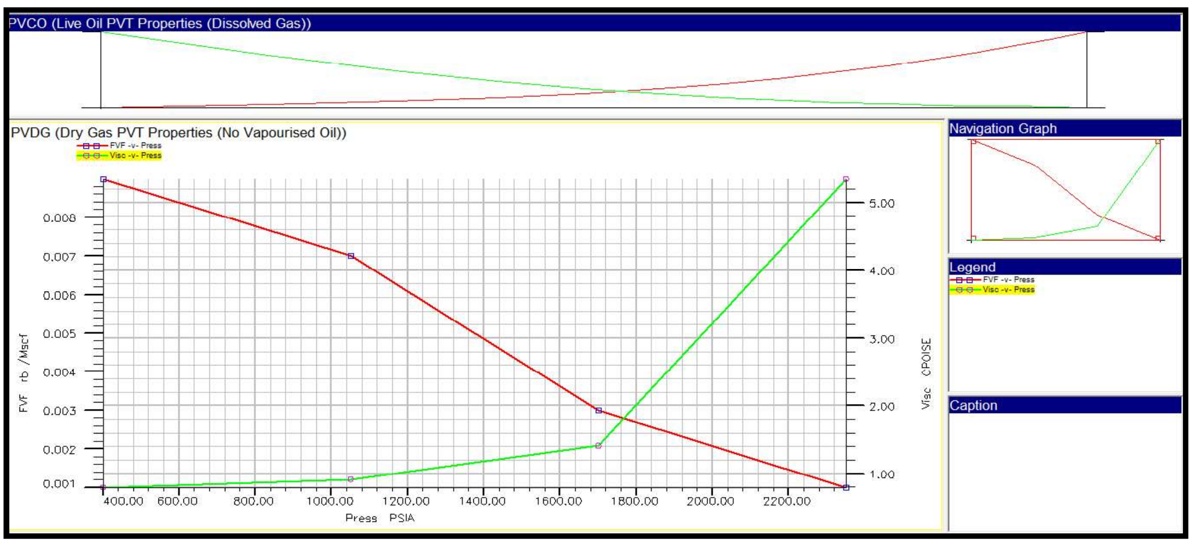

Fig. (2) Dry gas PVT properties

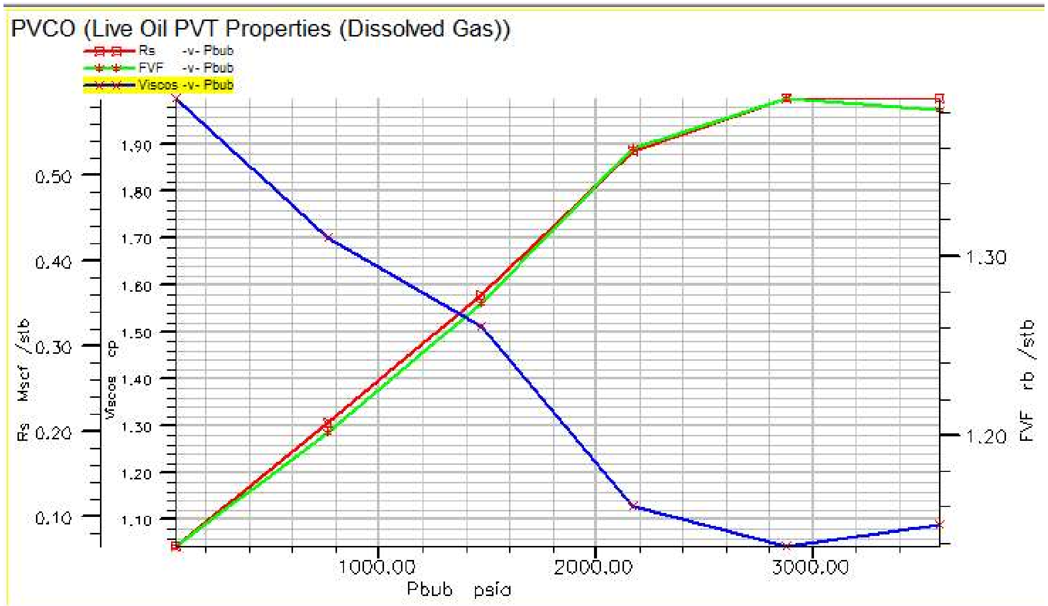

Fig.(3) live oil properties

- SCAL data for Bu-6 rocks which are Gas/ oil relative permeability, and water oil saturation functions.

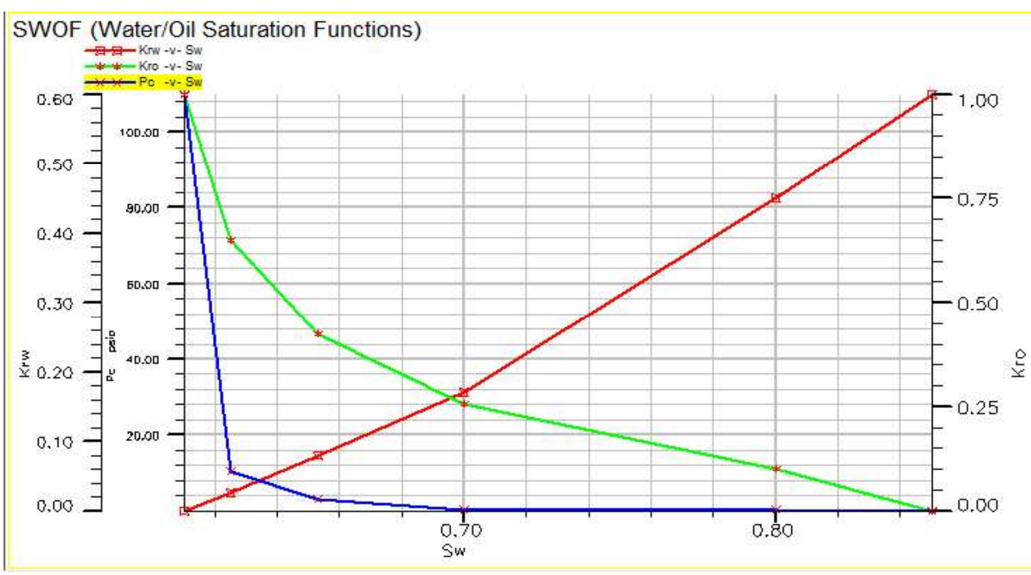

Fig.(4) water – oil relative permeability with PC cureve

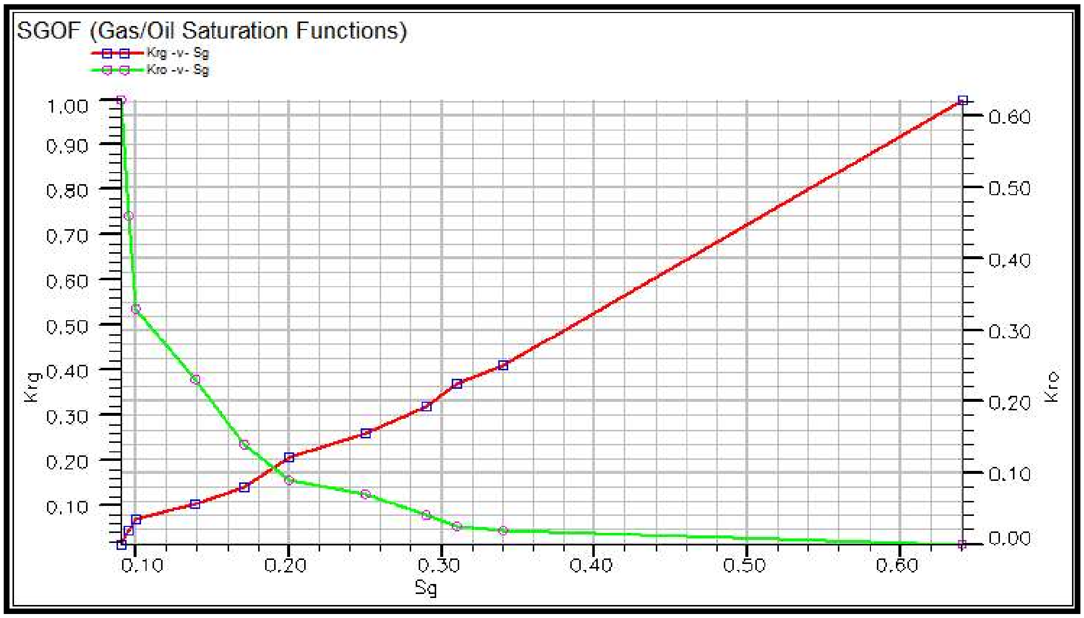

Fig. (5) Gas/ oil relative permeability function

- Initializations: consist of the initial pressure, temperature, WOC, and GOC of the well and the difference of Rswith. Depth.
- Schedule: which is consist of inserting the well connections and perforations, BHP, flow rated, and dates that we need to match the data at it.
- Summary: here we will specify the results we need in our model, and in eclipse we have specify (BHP, BHPH, WOPR, WOPRH, and WWC).

After inserting all of these data to our eclipse simulation model we will run the model by E100 which is the black oil type of eclipse, we will get the results.
The results we need to match at the first step are the production rate (flow rate) and then we will match the pressure after it.

Result and discussion

The final result from our work in Eclipse is a mathematical model for BU-6 this model characterizes by:-

- Black oil model :- with three phase fluid flow (oil, water and gas)
- Model dimensions:-
- Number of cell in X direction=
- Number of cell in Y direction=
- Number of cell in Z direction= 6
- Grid type :- radial gridding
- Geometry type:- Block centered

Now we have single well model so we can make matching by entering the available well test data which consist of three build up test two of these test contain well head, bottom hole pressure and flow rate data and the other one only contain well head pressure.

The history matching results must be done for the pressure and flow rate, there are many factors effecting on pressure and flow rate matching, The SCAL, skin factor and permeability are the most effected factors on the matching, which will be discussed in the discussion chapter.

The result from entering the well test data and make matching for production rate and pressure shown in the figures below

The first one figure(6)is for the pressure matching and as we will see the plot between Time on X-axis and WBHP "well bottom hole pressure" and WBHPH " well bottom hole pressure history" on the Y-AXIS.

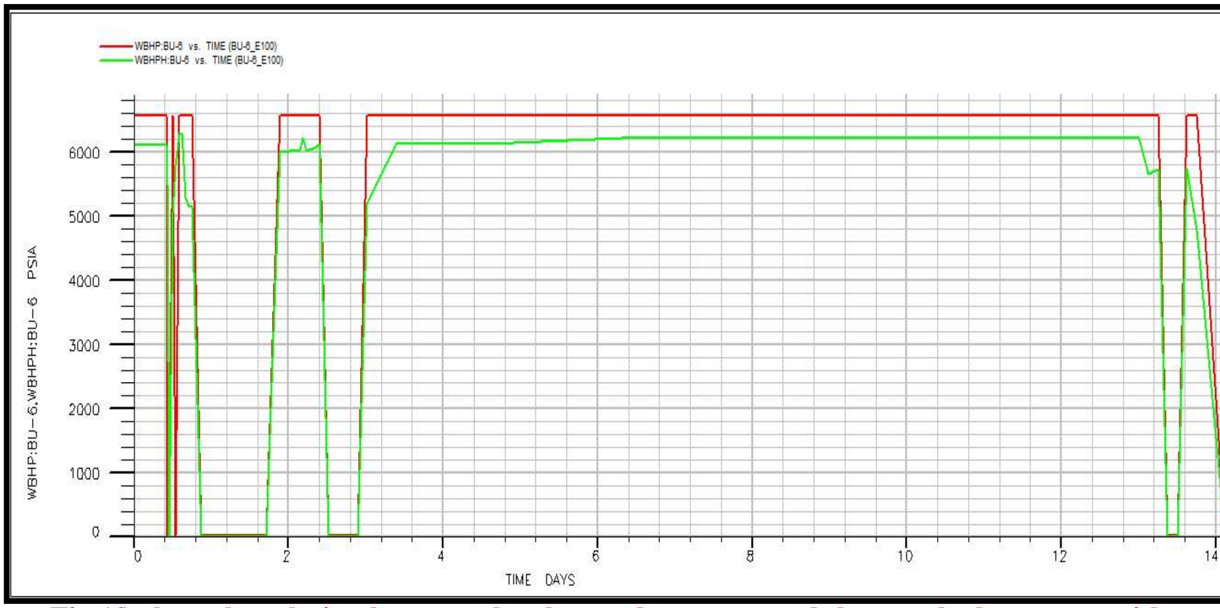

Fig.(6) show the relation between the observed pressure and the matched pressure with respect to time

The second one, figure(7) is for the flow rate matching and as we see the plot between Time on X-axis and WOPR "well oil production rate" and WOPRH " well oil production rate history" ontheY-AXIS.

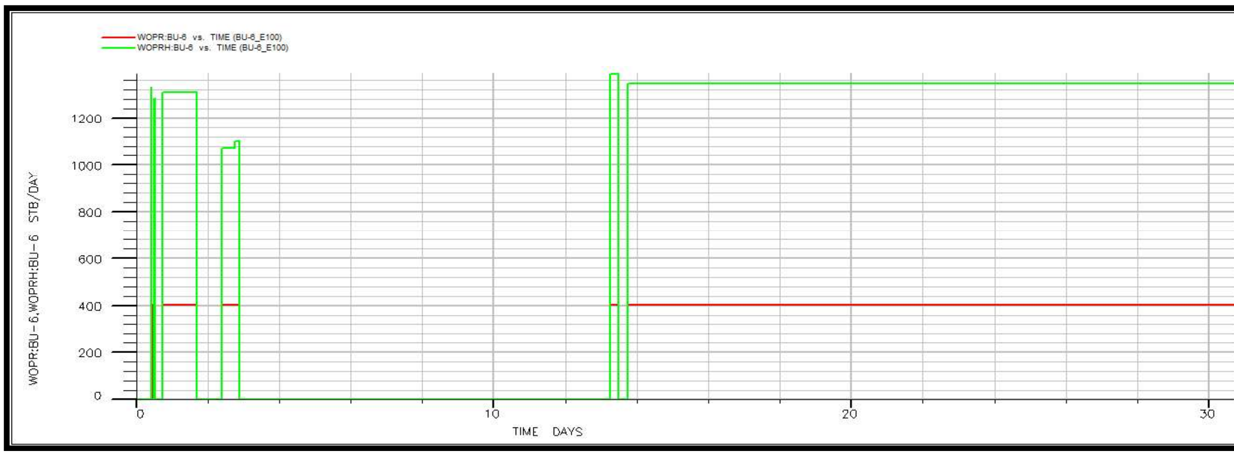

Fig.(7) show the relation between the observed flow rate and the matched flow rate with respect to time

As we see in figure (6) the WBHP and WBHPH is very close and can be considered it is somehow matched, but still needs more matching because the different between the

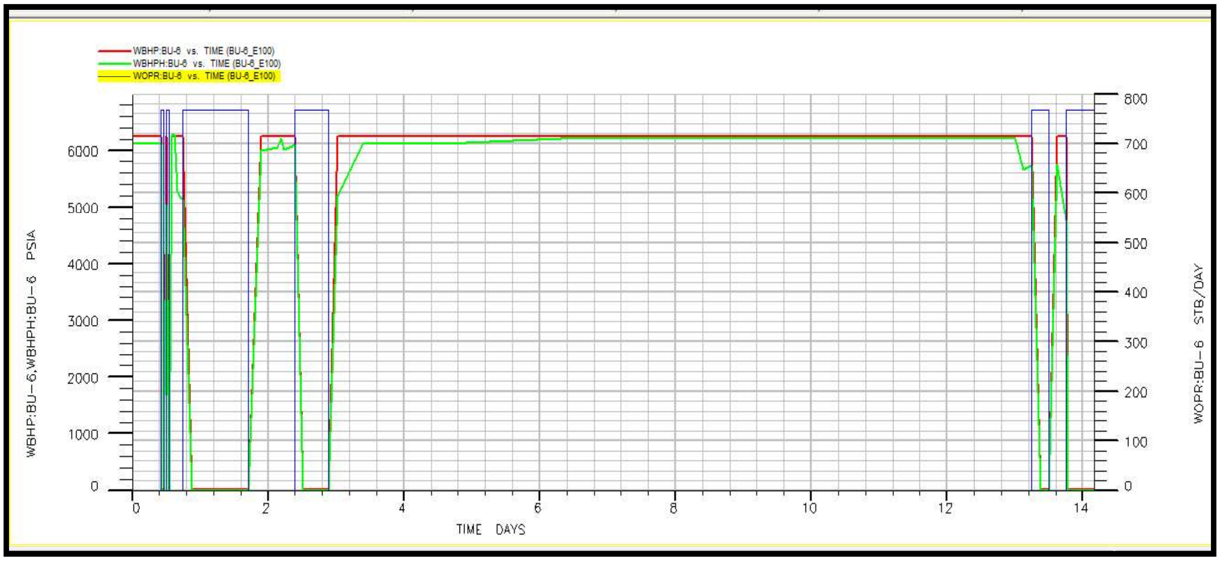

Fig.(8) shows the relation between the WBHP,WBHPH, and WOPR with Time

WBHP and the WBHPH is about 150 PSI, the flow rate is not matched as we see in figure (7) between WOPR and WOPRH because the different is about 750 STB.

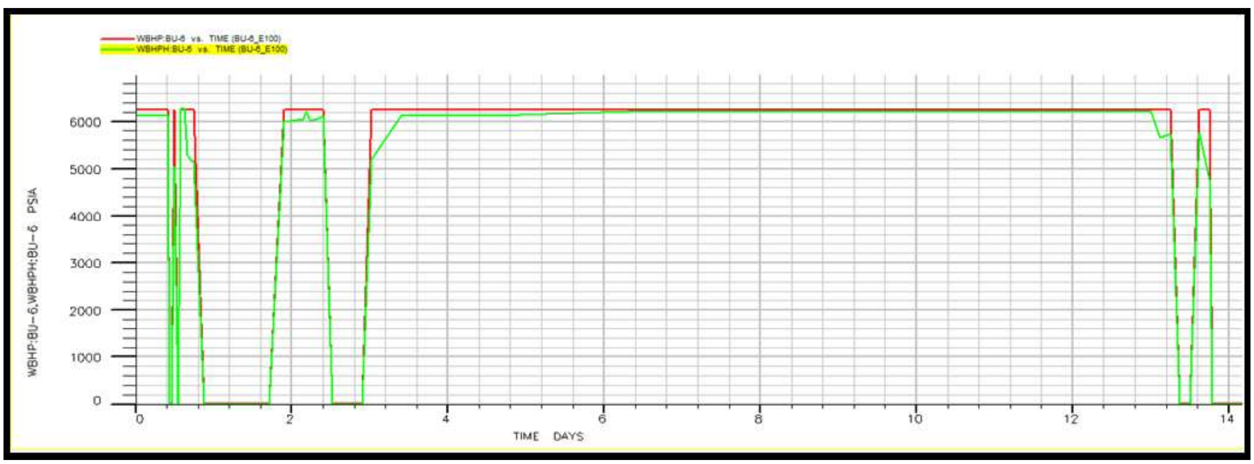

Fig.(9) pressure matching after change the skin factor to -1.7

Now by decreasing the skin factor from 1 to -1.7 we get the pressure nearly matched as shown in figure (9) and by increasing the permeability by 10 % present to increase the flow rate we get on graphs figure (10) for flow rate

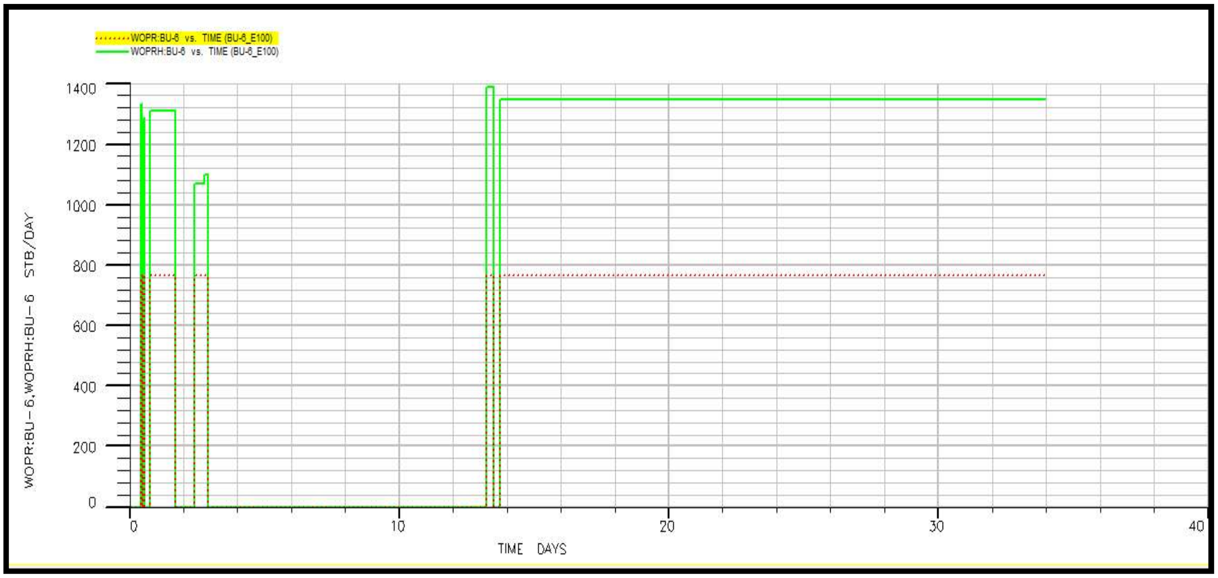

Fig.(10) flow rate matching after increase the permeability by 10%

By increasing Skin to -3.6 we get pressure matched as we see in figure (11), Flow rate still not matched and needs to increase the permeability, so we will increase the K to 20% and see the effect of increasing till the data is matched as see in figure (12).

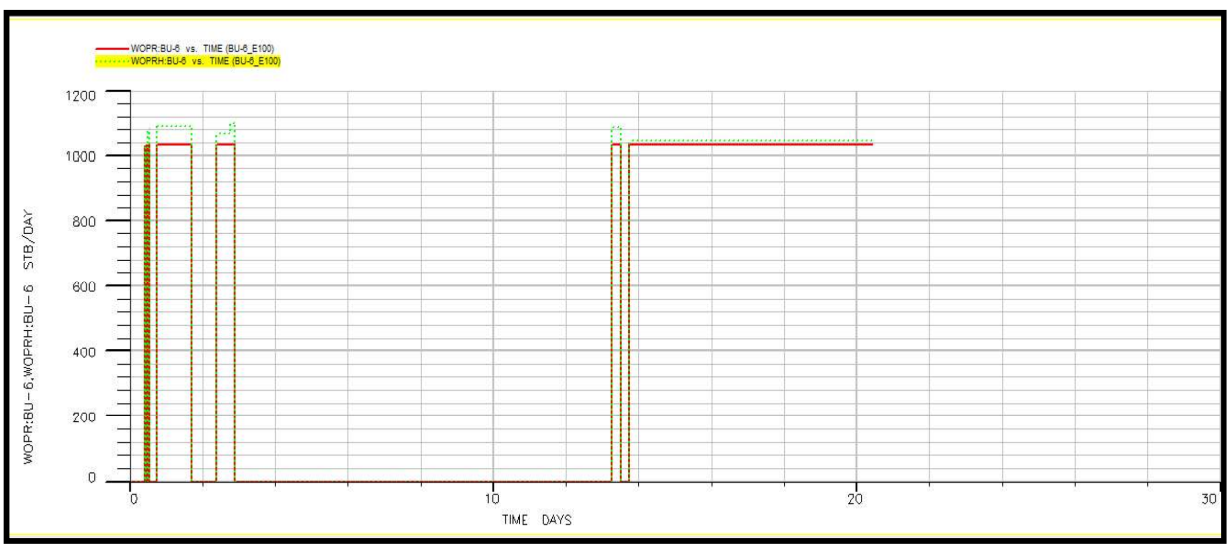

Fig. (11) Flow rate matching after increase the permeability by 20%

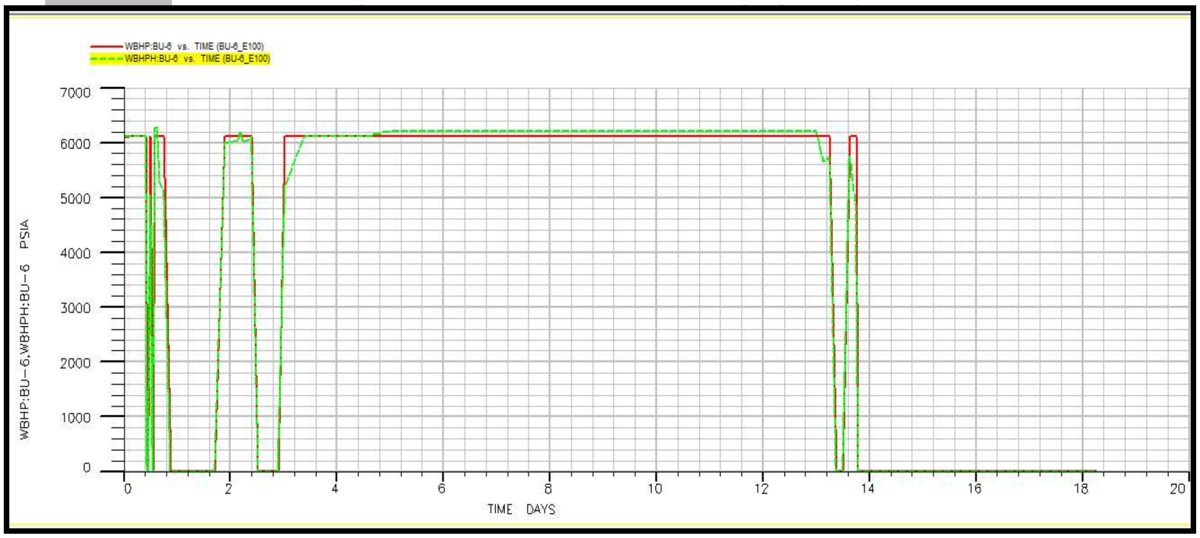

Fig. (12) Pressure matching after changes the skin factor to -3.6

By increasing Skin to -3.6 we get pressure matched and after increasing K by 20% we get the exact values matched for Q. as we see in figures (11&12), now we will discuss all there results for eclipse in the discussion chapter and will include each factor effecting on matching and show the effect of increasing and decreasing of these factors on pressure and flow rate matching.

The final graph below figure (13) representing the final Pressure (WBHP), pressure matches (WBHPH) and oil production rate (WOPR).

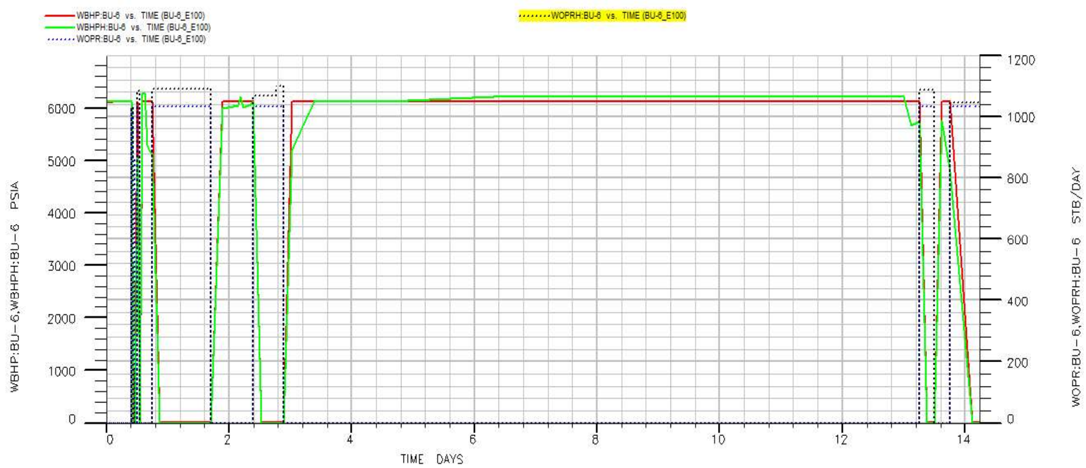

Fig.(13) show the final result of pressure and flow rate and pressure matching with time

Conclusion and recommendation

5-1Conclusion:

This report is concerned with mishrif's formation and how to build single well model by using computer program.The most important thing that we conclude from our work is that petrel software can't build single well model because petrel has rectangular gridding and not radial gridding and to build well model we have to use another program such as Eclipse (we also can use CMG but it out of our project).Eclipse was used to build the well model then we can use it to matching the well test data that already have and we also can build a development strategy to predict the performance of the well.We concluded that our input data to Eclipse must be very accurate, because any UN accuracy in the input will effect on our results. (I.e. net pay)

Recommendation:-

1- The data of buzurgan field which available to be used in our work because the chosen of the well to work on it was limited by the data we have on it because we must select the well that contain all the data that we need in the program because simulation software programs need lots of input data.

2- We must to be very accurate in porosity and permeability values because it's the most effective parameter in our work.

5-2 References

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