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Gas Lift optimization of a well using IPM Prosper.

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Abstract - *Crude oil production is a major requirement of any petroleum company. In order to avail optimum production gas lift is one of the most important and efficient widely recognized and successful technique. A proper optimization can reduce the operating cost, maximize the hydrocarbon recovery and increase the net present value which can be obtained by optimizing well parameters such as wellhead , tubing size, skin factor. All these factors have been investigated using a real field of Thrace Basin and PROSPER simulation program. Predicted results are compared and validated with measured field data to provide the best production practices. Prosper software is one of the component of IPM simulator used here to model wells using PVT data of deviation survey, geothermal gradient , downhole completion and average heat capacities. The model constructs data which is matched with the real data and thereby best well correlations are selected. Further the data helps in determining the optimum gas injection rate. Finally investigation of other parameters on the production is believed by performing sensitive analysis. The result obtained indicates (1) gas injection rate ,gas –composition , water –cut and well head pressure have an maximum effect whereas tubing roughness having minimum effect in increasing the oil production. Simulation of the field is being proved operationally and economically feasible. Results obtained have shown an impact in improving gas lift performance.*

***Key Words*: Prosper simulation, gas lift, gas injection rate, IPR , VLP, oil production rate, GLPC, Gas lift etc**

1. INTRODUCTION

When the reservoir energy is not adequate for a well to flow naturally, it is a necessary to diagnose the reservoir's energy by performing artificial lift technique and to obtain the desired production on to the surface. Gas lift is a worldwide used technique in comparative with pump-assisted lift because it has easy and simple installation. Every operator wants to minimize both capital and operating costs, maximize cumulative oil production in cost-effective manner for the field. An operator needs to take a logical look at fields production system from the subsurface to surface facilities which is true optimization for production which is a necessity. Nodal analysis is therefore the most common and the best way of preparing a well for the production of oil and gas from reservoir to achieve highest efficiency. The studies is carried basically to design and to evaluate the efficacy of gas lift as to tool for production optimization of a field with PROSPER. Investment costs also are taken into consideration for the systems. The IPM (integrated production modeling)simulation tool gives detailed assess to different production scenarios, challenges and various parameters that have an impact on production system. It also improves the gas lift performance by assisting the entire production system. It assist the production and reservoir engineers to make model for each producing well individually to contribute in overall well performance. This obtained model result are tuned with real data, by performance matching.

Gas injection is an important parameter in gas lift operation. Gas injection into a well will firstly increase the Gas-Liquid Ratio (GLR) which decrease the BHP. Therefore large production is likely to be achieved. GLR has a limit value where the flowing pressure reaches its minimal value. Above this limit the decrease in hydrostatic pressure will be obtained by increase in frictional losses. To find the optimum gas injection into the well is important because excess amount of injection will decrease production due to slippage between gas and liquid. Well reservoir data , fluid data, test point data, gas lift data completion are the input data for well model construction from which deviation survey , GLPC(gas-lift performance curve) is achieved by IPR matching VLP matching and other well test prosper data.

During the reservoir producing life, the pressure starts declining because of decline in oil production whereas the water cut ratio starts increasing. This condition drives the oil industry professionals to modernize the problems and demolish the reservoir producing life. Aritificial lift methods helps natural drive reservoir to move fluids to the surface at desired rates. In gas lift system a highly compressed gas is injection into the tubing through the gas valve which lowers the hydrostatic pressure of the tubing and boost up the differential pressure between reservoir fluid and wellbore. The purpose of this operation is to reduce the density of the fluid and to lower the hydrostatic pressure.

2. WELL PERFORMANCE

2.1. Inflow performance relationship (IPR)

It is defined as the well capacity to deliver the fluid by indicating its performance. Well which flows above the bubble point at steady condition is expressed as darcy equation.

2.2. Productivity index (PI)

It exhibits well deliverability. It is dependent on fluid and reservoir properties. If the data of the PI is available, flowrate under BHP is easily obtained.

2.3. Inflow performance relationship curve (IPR curve)

It shows the ability of the well to deliver fluid by plotting BHP and the rate of production. It requires various rate of production and drawdown pressure.

2.4. Vertical lift performance (VLP)

This is a valuable factor for designing a well. Performance of production has an affect of tubing pressure losses. This curve shows a relation between production rate and drawdown pressure. It reflects the tubing and completion string component

3. METHODOLOGY

This method is used for well model, design and to know the well performance program. The field data for the well "A1" is analyzed. PVT data, IPR data, deviation survey &equipment data are used based on simulation input. After selecting the best correlations, input data is matched with the simulated data this table shows the input data for gas lift section. This is shown in the above table.

3.1. DESCRIPTION OF A WELL "A1"

A well was drilled 30 years ago to produce oil from nubia formation in Egypt. It was drilled to depth 8000 ft and completed casing of 8 inch liner diameter. Inner casing and Inner tubing roughness is 0.0006. Formation temperature was 15oC at the surface and 2500C at reservoir depth of 8000ft.Reservoir permeability was observed to be 200 md and reservoir thickness 40 ft. The well completion is equipped with side pocket gas-lift mandrels which is installed down to the packer at the depth of 6725ft.

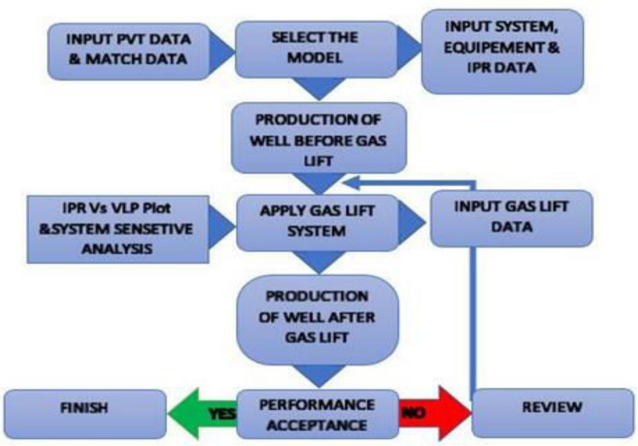

Chart -1: Lets study the following chart

Table -1: The following table shows compiled data of various parameters and their values

Parameter	Value
Solution GOR (SCF/STB)	400
Oil gravity (oAPI)	35
Gas gravity	0.833
Water salinity (ppm)	20000
Mole % H2S (%)	0
Mole % Co2 (%)	0
Mole % N2 (%)	0
Bubble point pressure(psi)	2019.25

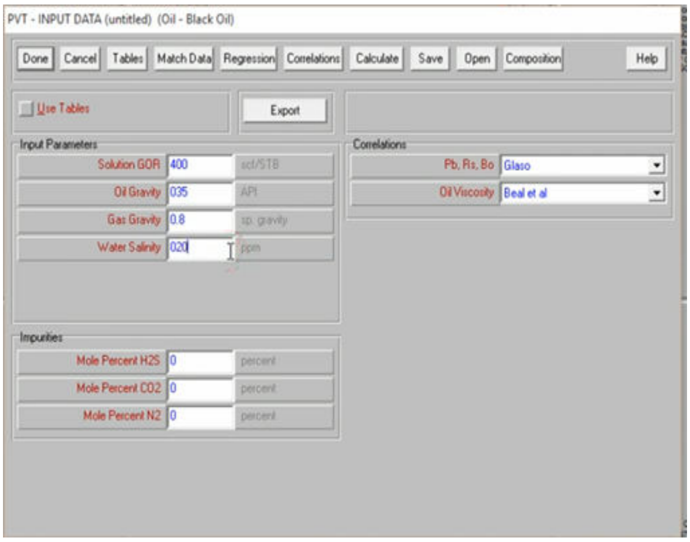

Diagram-1: IPR PROSPER INPUT DATA SCREEN

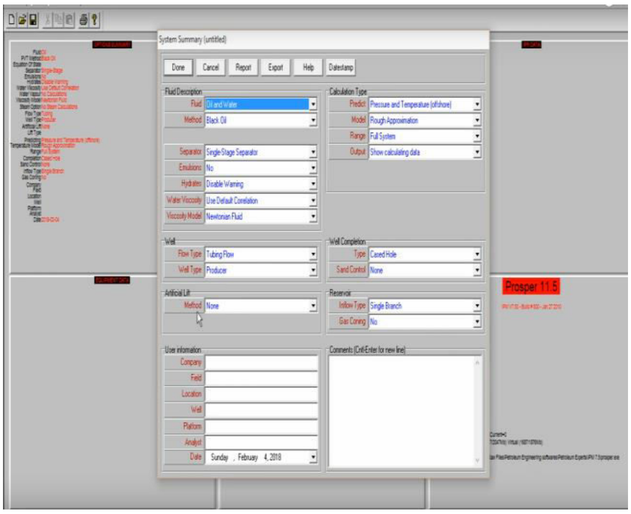

Diagram -2: System summary input data screen

Table-2: IPR Data

Reservoir Pressure (psig)	3000
Reservoir temperature (oF)	250
Water cut (%)	60
Total GOR (Scf/STB)	400

The following is shown in the diagram-1

4. RESULT AND DISCUSSION

4.1 IPR Curves

It is found from the results that GOR is approximately the same for IPR curve and PVT, so the value of GOR is kept constant . fig of generated IPR curve in this software shows that an absolute flow potential of 15462 STB/D was observed.

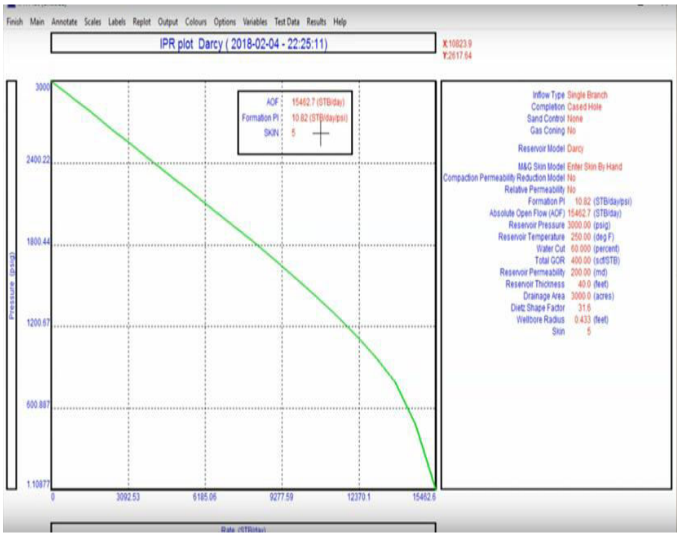

Diagram-3: IPR curve

Deviation survey downhole equipment data are shown in the well completion diagram. Downhole equipment are casing, tubing and gas valves

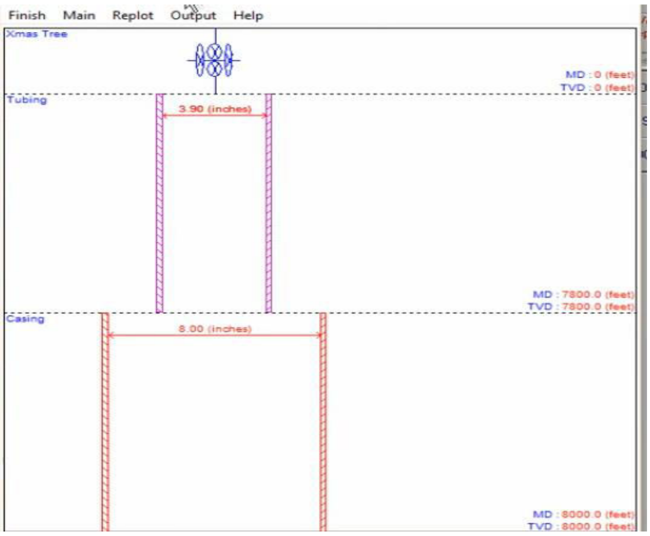

Diagram-4: Well completion diagram

4.2. IPR &VLP curves

The Inflow & outflow performance of well A1 are simulated before the gas is injected. Well is not producing fluid at top node pressure of 250 psig, GOR 400SCF/STB and at water at 60%.

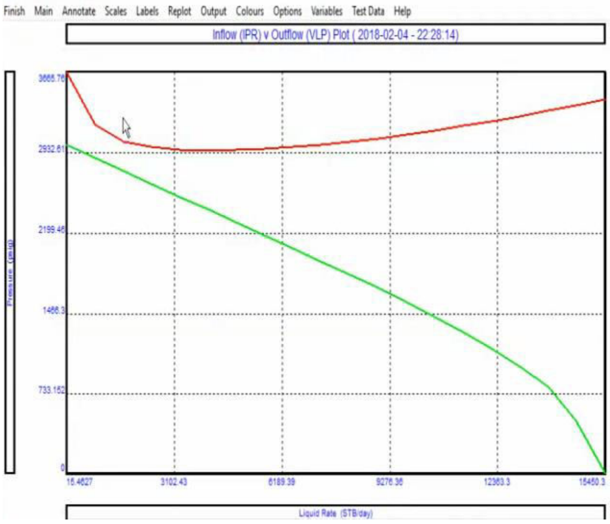

Diagram-5 : IPR VS VLP curve prior to gas injection)

4.3 Optimization by using gas lift

It is observed that gas injection is independent of the GOR, hence the IPR &VLP plot obtained by gas lift method & it is observed that an injection rate of 0.59323 MMSCF/D causes increase in oil production 1258 STB/D at 60%water cut and GOR 400 SCF/STB.

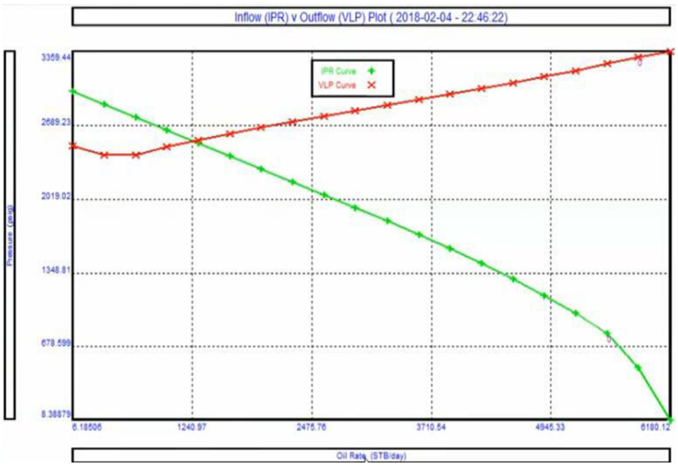

DIAGRAM-6: IPR vs VLP curve after gas injection

For optimization, different injection rates can even be simulated using sensitive analysis. .Injection of gas increases the production of oil rate. Sensitivity analysis is done to interpret production at different water cut. Before gas injection well was flowing at water cut 10-40% but at less rate as compared to the production of a well after gas injection with no skin effect.

Table-3: Oil production rate at different water cut percent

WATER CUT(%)	Oil rate before gas injection(STB/D)	OIL RATE AFTER GAS INJECTION (STB/DAY)
0	5688.2	5865.8
10	4628.3	5098.3
20	3576.5	4187.5
30	2522.2	3333.5
40	1392.4	2545.4
50	-	1858.2
60	-	1258.7

Table-4: Gas Injection and Oil Rate is shown in the table

Gas injection rate(MMSCF/D)	Oil rate(STB/D)
0.1	251.5
0.2	771.9
0.3	957.5
0.4	1002.5
0.59323	1258.7

5. CONCLUSION

1. Reservoir & production modeling technique are important for reservoir management and field development, history matching ,designing an EOR project for boosting production recovery.
2. Prediction of Well performance ,well design and well optimization program obtaining most of the well configurations performed with IPM prosper. Affect of various water cut and gas injection rates on well performance is investigated which has a great influence on oil production rate.
3. At a particular percent of water cut, an increase in oil production rate was observed as compared with the producing rate before injection of a gas.
4. Performing sensitive analysis at 60% water cut and injection rate of and injection of gas at a rate of 0.1, 0.2, 0.3, 0.4 and 0.59323MMSCF/D, oil rate was observed 251.5, 771.9, 957.5, 1002.5 and 1258.7STB/D respectively. Sensitivity analysis at 50 % water cut and gas injection rate 0.59323STB/D was analyzed to be 1858.2STB/D respectively. Sensitivity analysis at 40% water cut and gas injection rate of 0.59323MMSCF/D was observed as 2545.4 STB/D respectively. For 30% water cut and gas injection at a rate of 0.59323MMSCF/D was analyzed to be 3333.5STB/D respectively. For 20% water cut and gas injection rate 0.59323 STB/D was analyzed to be 4187.5 STB/D. For 10% water cut and gas injection rate 0.59323 STB/D sensitive analysis was observed to be 5098.3STB/D. For 0% water cut and gas injection of 0.59323 MMSCF/D sensitivity analysis was observed to be 5865.8STB/D respectively.
5. There was no well flow on taking skin factor into consideration. While considering the gas injection rate constant, the oil production rate is not observed to be constant.
6. By comparing the gas injection rate with the previous rate, the obtained oil rate is less than the previous rate of oil production. Minimum gas rate is suitable for well "A1" and higher gas injection rate is not recommendable for gas lift and to obtain optimum production.

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