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DESIGN OF A GAS LIFT SYSTEM TO INCREASE OIL PRODUCTION FOR OFFSHORE WELLS WITH HIGH WATER CUT

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Abstract

One of the most important production issues in oil fields is high water production which may lead to wells killing and reduction in an economical production period. With the increment of water production or decrease of reservoir pressure, reservoir drawdown pressure reduces which causes reduction in oil production rate. To preserve the reservoir production, we should apply one of the proposed methods; namely, increasing the reservoir pressure, preventing water source invasion or using artificial lift technique. To compensate this reduction, continuous gas injection into the wells can be used. The injected gas combines with fluid in tubing and the density of the fluid decreases, thereby reducing the hydrostatic pressure loss along the flow path. By utilizing this method fluid can be produced in low flowing pressure through tubing.

In this review paper, a study on the condition of some of high water producing oilfield was compared with the offshore R-1 well which was revived using artificial lift methodology to achieve incremental reserve recovery after the well had stopped producing due to water production.

By an accurate gas lift design, we can have a rational production from the well with high water cut even more than 90%. Implementation of this method, allows oil production as reserves are depleted and the oil water contact moves up. Based on the results in this paper and we can easily use it in some of the offshore well in India having same well conditions to increase the productivity.

1. INTRODUCTION

In production of oil, when there is insufficient pressure in the reservoir to lift the produced fluid to the surface then an artificial lift is needed in the wells. In the beginning of production the majority of oil wells flow naturally and called as flowing wells but as passes of time the reservoir is depleted. An increase in water cut is taken place in the late phase of production life which ceases the natural flow of fluid up to the surface after which we require some artificial means to increase the flow of fluid. There are two basic forms of artificial lift from which we can get increase in flow of liquid.

(1) By the use of mechanical device inside the well(known as pump or velocity string)
(2) By decreasing the weight of hydrostatic column by injecting gas in to liquid some distance down the well

Gas lift technology increases oil production rate by injection of compressed gas in to the lower section of tubing through the casing- tubing annulus. Upon entering the tubing, the compressed gas liquid flow in two ways: (a) the energy of expansion pushes the oil to the surface and (b) the gas aerates the oil so that the effective density of the fluid is less and, thus, easier to get to the surface.gas lift technology has been widely used in the oil fields that produce sandy and gassy oils. Well depth is not a limitation. It is also applicable to offshore operations. Lifting costs for a large number of wells are generally very low. Gas-lift is used only in well that produce economically with relative high bottomhole pressures, typically high productivity reservoirs. It is also preferable when the well has a multi-inclination trajectory, in which installation and operation of bottomhole pump are mechanically difficult. There are two types of gas lift: Intermittent gas lift and continuous gas lift. In this dissertation “gas lift” means continuous gas lift.

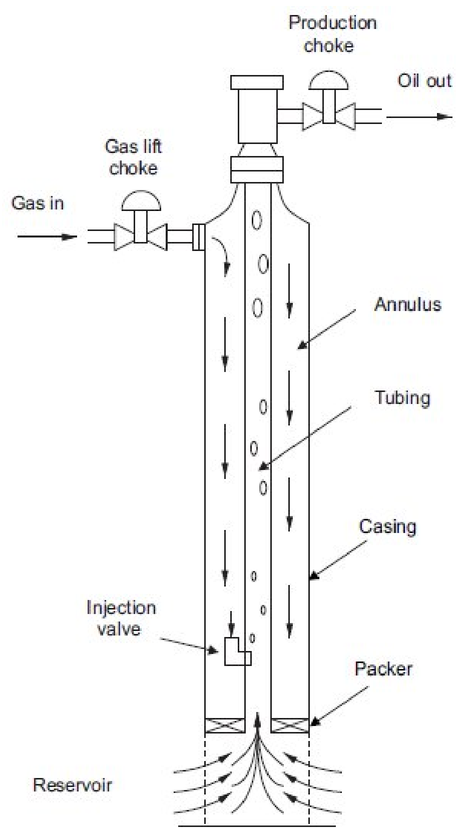

Fig. 1 Single gas-lift well

In continuous gas lift, a small volume of high-pressure gas is introduced into the tubing to aerate or lighten the fluid column. This allows the flowing bottomhole pressure with the aid of the expanding injection gas to deliver liquid to the surface. to accomplish this efficiently, it is desirable to design a system that will permit injection through a single valve at the greatest depth possible with the available injection pressure. This method is favourable for offshore fields due to flexibility in its production rates, ability to handle corrosive fluids, suitable for higher temperatures (M.A.Naguib et.al. 2000).

The gas-lift system is extensively used around the world and most common system of artificial system used in offshore fields in India .it is suitable for offshore fields due to flexibility in production, suitable for high GOR and WOR wells, high temperature wells and compatibility with sand production. From the above explanation, the gas lift is economical and preferable technique for artificial lift in offshore fields.

2. CHOICE OF MOST ECONOMICAL GAS INJECTION PRESSURE

There are two major factors which affect economy of injected gas pressure.

I. Bubblepoint and Solution Gas-Oil Ratio of the Produced Oil
II. Water cut

Both bubblepoint pressure and solution gas-oil ratio are responsible for establishing pressure gradient for the flow of oil at any pressure and temperature condition (P.M. Kilonzo and A. Margaritis, 2004). All gas that is injected into the saturated crude oil system can be expected to remain in the free State. In an undersaturated situation accompanied by low-bubblepoint crude oil systems, the injection of free gas into the fluid column results in increasing the bubblepoint pressure of the mixture, thereby lowering the depth where the free gas is present.

And again in a situation where the watercut of a well increase, larger amounts of gas should be required to supplement the relatively lower amount of gas the well produces with the formation oil. The deeper injection of this gas into the well flow will result in greater reservoir pressure drawdown.

Injection Gas Characteristics:

The static head of the heavier gas provides a higher downhole injection pressure than does the lighter gas for an equivalent surface injection pressure (J.R. Blann, J.D. Williams, 1984). A comparison of pressures at 6,900 ft [2103 m] vertical for 0.65 and 0.90 specific gravity gases is shown in Table 1 (J.R. Blann, J.D. Williams, 1984). It is obvious from Table 1, in comparison to the lighter gas, the heavier gas requires a lower surface pressure, but a higher injection volume per barrel of fluid lifted. As can be concluded, in order to produce a barrel of fluid lower volumes of the lighter gas and higher surface pressure actually may require less compression horsepower compared with the heavier gas.

Table 1: Effect of Injection gas specific gravity on gas injection pressure and rate

Injection gas specific gravity	Injection pressure (PSI)	Gas injection rate (MMscf/day)	Compressor BHP
0.65	1300	1.5	195
	2000	0.5	78
0.9	1100	1.7	200

	1725	0.59	80

3. GAS LIFT DESIGN

Taking case study done in one of the oil well in Iran (R-1 offshore well) in condition of reservoir pressure 3100 Psi and water productivity 50 percent, well R-1 cannot produce So, an artificial lifting technique is implemented on this well.

After calculation of gas lift design, plot of Fig. 3 will be extracted. As can be concluded from Fig. 3, by increasing the amount of injection gas (Sp. Gr. = 0.88), oil production increases and then decreases. By amount of 2.5 MMcf/day Gas injection, oil production from well R-1 will be increased up to 1500 bbl/day. In case of 80 percent water productivity, by increasing amount of gas injection, it has small effect on oil production that it's the characteristic point called Economical Optimum Point. This optimum rate is renowned as over injection. After this point well fluid density reduction due to higher amount of injection gas is equal to friction force increase due to higher amount of passing fluid volume through tubing. As the rate of injection gas increases, friction force has more predominant effect than hydrostatic pressure reduction. At this point, the maximum amount of well production rate can be achieved. By increasing gas pressure, effect of gas injection on production decreases until in a special injection rate, that is if the gas injection rate increases, the effect on production will be inversed.

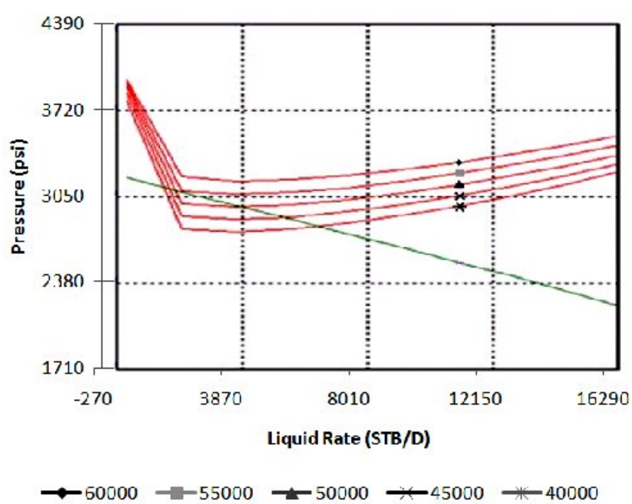

Fig. 2 Plot of IRR/VLP curve of well R-1 at reservoir pressure 3200 Psi in diverse water productivity (natural flow).

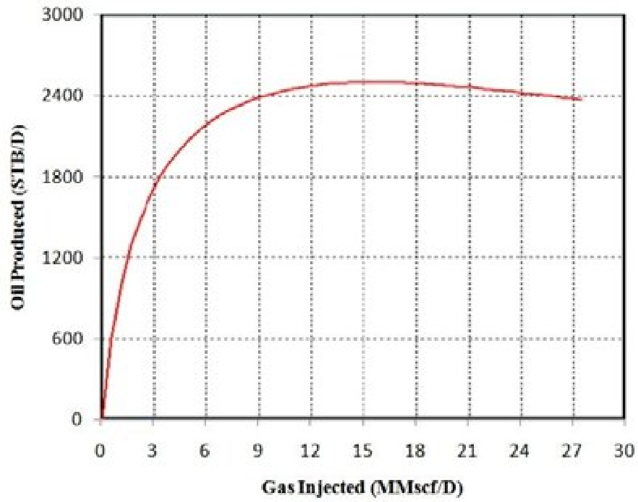

Fig. 3: Performance curve of Well. X.

4. RESULTS

Now it wanted to look into effect of changing water productivity percentage on net well production. According to table 2 based on diverse water productivity percentage (50, 60, 70, 80 and 90), the amount of oil production is indicated in Fig. 4. Effect of reservoir pressure changing on production of well R-1 in case of water productivity 80 percent has been shown in Fig. 5.

Table 2: Net oil rate of well X in diverse water productivity

WC %	Oil Rate bbl/d
50	4750
60	3546
70	2449
80	1480
90	676

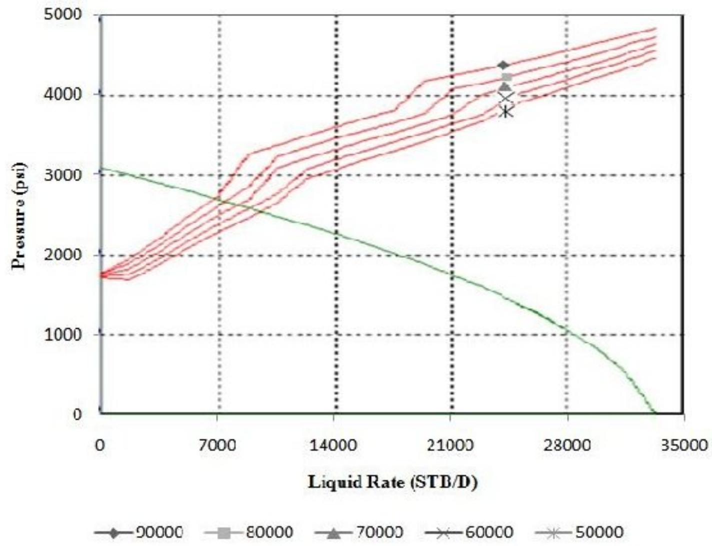

Fig. 4: Plot of IPR/VLP curve of well X in diverse water productivity.

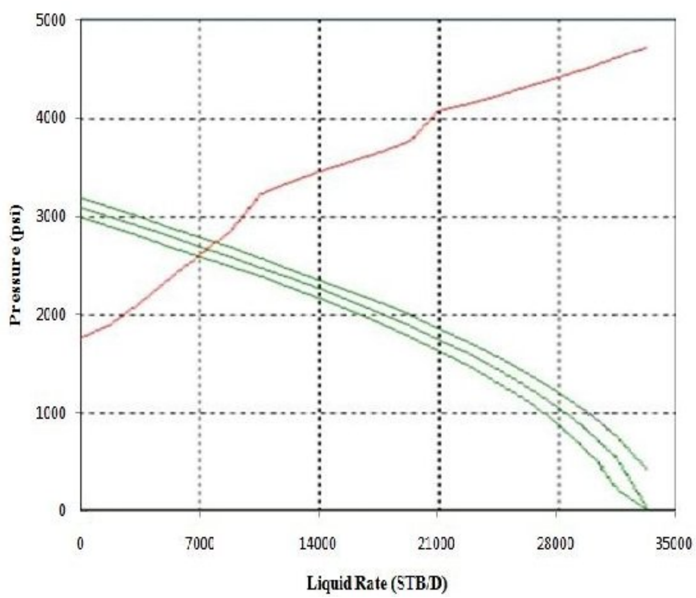

Fig. 5: Plot of VLP/IPR curve of well X in three diverse pressures with injective rate 2.5 MMcf/d.

5. CONCLUSIONS

- In constant well head pressure injection, heavier injective gas causes more pressure gradient. But in order to lift a barrel of liquid in compare to lighter gas, higher amount of gas is required.
- Wells with higher water productivity require higher amount of injective gas due to the shortage of solution gas.
- One can produce oil economically from the wells of field even though with water productivity 90 percent, by a suitable design of gas lifting.

- By increasing the amount of injection gas, oil production will be increased then it will be reduced due the friction force increase in tubing.
- More case studies can be done on Indian offshore oil fields, and by simulating it on software one can see the effect in production too.

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