Production Improving in Gas Lift Wells using Nodal Analysis

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Abstract : - In this work, a gas lift-based oil production wells improvement technique is presented. This technique is based on Nodal Analysis, which is applied to well head level, where the production data are available. Thus, a production model is obtained, representing the production curve. This model allows calculating the production flow and pressure drop relation that can be found in all the components of the completion system. So, it will be possible to determine the oil or gas flow that can be produced by the well, considering the perforation and completion geometry. With this information, we can build a production optimization system in order to increase the production flow rate.

Keywords : - Nodal Analysis, Production Systems, Artificial Gas Lift Well, Production Control.

1 INTRODUCTION

One of the most used techniques for optimizing the crude and gas production systems, considering its verified effectiveness and world-wide level trustworthiness, is the Nodal Analysis (Beggs., 1991). In order to optimize the Production system using this technique, it is necessary describing the production system, making emphasis in the required energy balance between the reservoir and the installed infrastructure, for establish the production capacity of the well. For this, it is necessary to construct a well model with reservoir and production variables.

2 ARTIFICIAL GAS LIFT

Artificial Gas Lift (AGL) is a method that consists of injecting gas at different depths with a determined pressure in the inferior part of the flow column in the well pipe, with the purpose of diminishing the weight of it, helping the reservoir fluids rise from the well bottom to the surface. The AGL well behavior's model (figure 1), indicates that: when the gas injection rate increases, the production also increases until reaching its maximum value; but additional increases in the injection will cause a production diminution (Eikrem et al., 2002), (Jansen et al., 1999). The curve shows under which conditions the well exhibits stable or highly oscillatory flow. It is important to note that the average production rate may be significantly lower with unstable, see the line "open loop production", compared to stable well flow, see the line "theoretical production". The region of optimum lift gas utilization may lie in the unstable region.

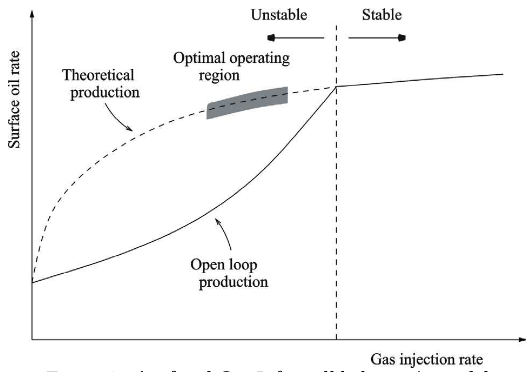

Figure 1. Artificial Gas Lift well behavior's model

3 PRODUCTION PROCESS OF WELL

The process of production in a well of oil or gas begins from the external radius of drainage in the reservoir to the tanks where the oil is stored. The Figure 2 the complete system appears with four clearly identified components: Reservoir, Completión, Well and Flow Surface Line. There exists a pressure of reservoir of the fluids in the above mentioned process, which is the static pressure of the reservoir, Pws, and a final pressure or delivery, which is the pressure of the divider on the station of flow, Psep.

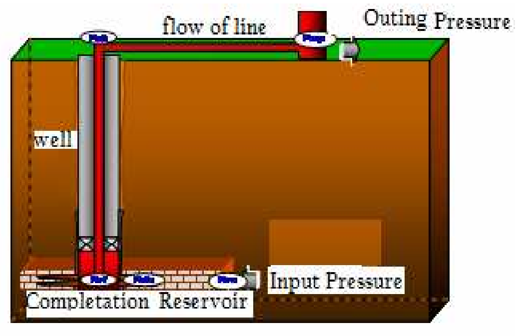

Figure 2. Produce Process of Well

The movement of the fluids begins in the reservoir to a distance "re" of the well where the pressure is Pws, travels across the porous way up to coming to the face of the sand or radius of the hole, "rw," where the pressure is Pwfs. In this module the fluid loses energy in the measure that the way is of low capacity of flow (Ko), presents restrictions in the surroundings of the hole (damage, S) and the fluid offers resistance to the flow (μo). While more big it is the hole major it will be the area of communication between the reservoir and the well, increasing the index of productivity of the well. On having crossed the completatiÓn the fluids enter to the bottom of the well with a pressure Pwf.

Inside the well, the fluids ascend across the pipeline of production conquering the force of gravity and the friction in the internal walls of the pipeline. In the well head, the resultant pressure is identified as Pwh.

The loss of energy in the shape of pressure across every component (see figure 3), depends on the characteristics of the produced fluids, and specially, the transported flow, in such a way that the capacity of production of the system answers to a balance between the capacity of energy input of the reservoir and the demand of energy of the installation to transport the fluids up to the surface.

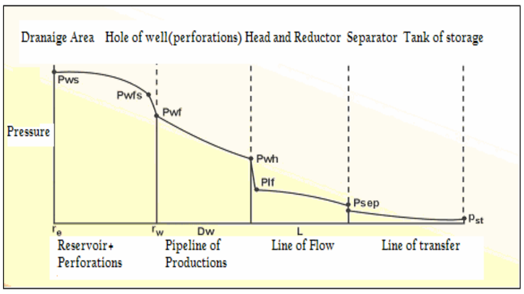

Figure 3. The loss of energy Systems of Production

4 NODAL ANALYSIS-BASED WELL MODEL

The Nodal Analysis technique allows evaluating the production system performance, calculating the production flow and pressure drop relation that will happen in all the completion system components. In traditional Nodal Analysis, the energy balance is made at the well bottom, but in this work the energy balance was made at the well head (Figure 4), because it is available the appropriate instrumentation for that (Camargo et al., 2007). It was made in the following form:

Node Input Pressure:
Pwh (Inflow) = Pws – Δpy – Δpc - ΔPp

Node Output Pressure:
Pwh (Outflow) = Psep + ΔPl

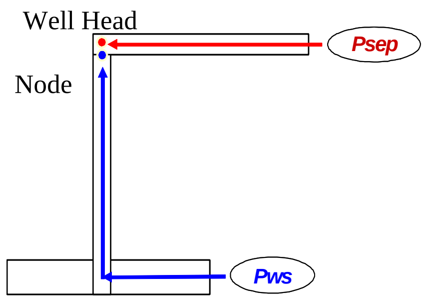

Figure 4. Well Head Node

Where Pwh is wellhead pressure, Pws is bottom hole pressure, Δpy is pressure drop in the reservoir, Δpc is pressure drop in the completion, ΔPp is pressure drop in the well, Psep is pressure in the separator, and ΔPl is pressure drop in the flow line.

To realize the balance of energy in the node several rates of flow are assumed suitably, and for each of them there decides the pressure with which the reservoir delivers the flow to node, and the pressure needed in the exit of the node to transport flow to Pressure Psep.

In order to graphically obtain the solution, both curves are drawn, and the production volume is obtained where the curves are intercepted, concerning different gas flow rates. Qliq is flow rate of the production. (see figure 5).

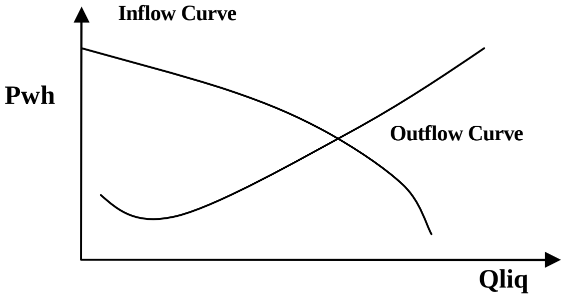

Figure 5. Inflow Curve vs Outflow Curve Intersection

4 RESULTS: INFLOW AND OUTFLOW CURVES FOR PRODUCTION WELLS.

The well characteristics where the Nodal Analysis technique was implemented are the following: It flows without reducer towards the Flow Station located at 5360,89 ft and receives gas lift from the gas Manifold located at 508,53 ft far from it. It presents 25 API crude Gravity, 6% water Cut, 1321 psi Pressure and 141 F Temperature at the bottom (see table 1).

Table 1. Propiedades Física del Fluido

PVT	
Oil Gravity (API)	25°
Water Cutr (%)	6,02
Bottomhole Pressure (psi)	1321
Bottomhole Temperature (F)	141
Depth Perforation (ft)	3489

The gas lift injection behavior versus the production values in those wells was the following: initially the well was operating at a gas injection rate from 1,1 to 2,2 MMSCFD (figure 6), where the associated well production was between 30,5 BPND and 180,1 BPND, which indicates high well production

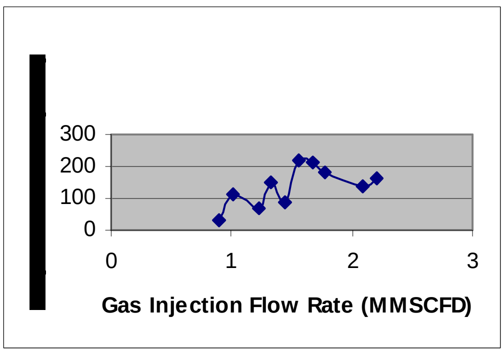

Figure 6. Initial Production curve

Using the Nodal Analysis technique, at the well head, the energy balances were made with several gas injection flow rates, and for each of the reservoir pressures. That give the volume of production of the well (see figure 7) and the pressure required in the well output for transporting it to the separator.

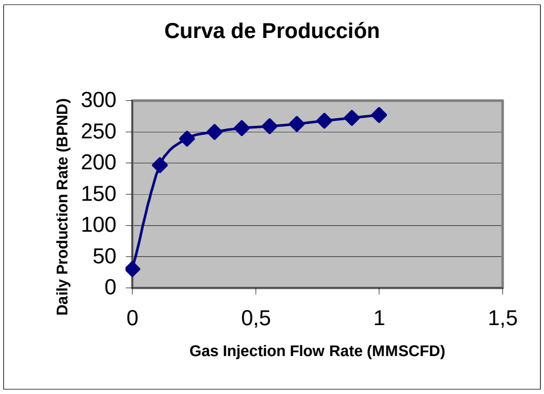

Figure 7. Obtained Production Curve

According to Figure 7, crude and gas production rates must be between 246 and 250 BPND, and 0,5 to 0,7 MMSCFD, respectively. This gas injection was implanted in field founding an stable behaviour, allowing to generate greater production levels (in the order of (248±5) BPND) with a gas injection of 0,6±0,1 MMSCFD. These values were obtained at the flow station of the corresponding analyzed well.

5 CONCLUSIONS

A model for improving the artificial gas lift well production using Nodal Analysis was presented; this model allows determining the well production rate, allowing the control of the gas injection. It was evaluated in high instability well that was generating low crude production levels. Using the supply and demand curves intersection, it was estimated the production curve, indicating that the gas injection rate is near 0,6 MMSCFD with a production of 250 BPND. This value of gas injection was implemented in field, presenting production values of (248±5) BPND with a gas injection of 0,6±0,1 MMSCFD, which indicates the model effectiveness obtained through the nodal analysis technique.

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