CHAPTER 6

GAS LIFT DESIGN

The operation of continuous gas lift valve is very similar to that of a naturally flowing well. Gas is continuously injected into the tubing through a gas lift valve at a fixed depth and the increased gas liquid ratio from the valve to the surface decreases the hydrostatic pressure gradient in the tubing, thus decreasing P_{wf}. The only difference between this type of operation and a flowing valve is that the gas liquid ratio changes at some point in the tubing for the gas lift valve. The depth at which the operating gas lift valve can be located depends on the gas injection pressure available. The more pressure available, the deeper the injection point can be. Also, as the depth of the injection is increased, less injection gas is required to achieve the same bottom-hole pressure. A simplified schematic and pressure traverse for a gas lift valve shown in Figure 6.1 indicates that if the gas is injected deeper in the well, it has the ability to decrease the gradient more effectively.

The design of a continuous flow gas lift system consists of two essential parts 1) determination of the performance of the well once it is unloaded and stabilized operation, and 2) spacing and pressure setting of the upper gas lift valves used in unloading the well.

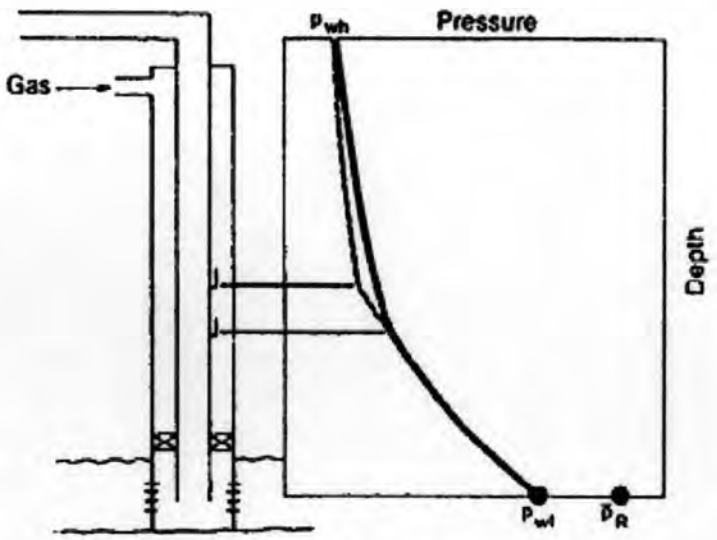

Figure 6.1 Gas Lift Well Schematic [5]

In Figure 6.1, there are essential two variables that can be controlled by the designer for a given tubing size and well head pressure. These are the depth at which

the gas is injected and the volume of gas that is injected. There can be constraints on these values that must be taken into account.

For example, the amount of surface gas injection pressure controls the depth of injection. As illustrated in Figure 6.1, the deeper the injection depth, the higher the pressure in the tubing at the point of injection. The pressure in the annulus at the injection point must be between 50 and 150 psi greater than the pressure in the tubing to be able to inject the gas. Therefore, to inject at a deeper point in the well, more injection gas pressure is required.

As will be seen subsequently, there is an optimum injection gas volume for a well that will result in a maximum liquid production rate. If this volume of gas is not available, the well will produce at a lower rate. If several gas lift wells in a field are utilizing a limited volume of injection gas, nodal analysis can be used to determine the optimum volume of gas to allocate to the various wells.

Another important factor is the gas liquid ratio (GLR) which affects the outflow curve. A different outflow curve would be obtained for each injected GLR. The formation GLR must be used to calculate Δp (tubing below valve) and the total GLR must be used above the valve. As the injected GLR becomes too large, the increasing in piping system pressure drop due to friction will exceed the decrease in the hydrostatic pressure in the tubing above the valve. This is illustrated in Figure 6.2.

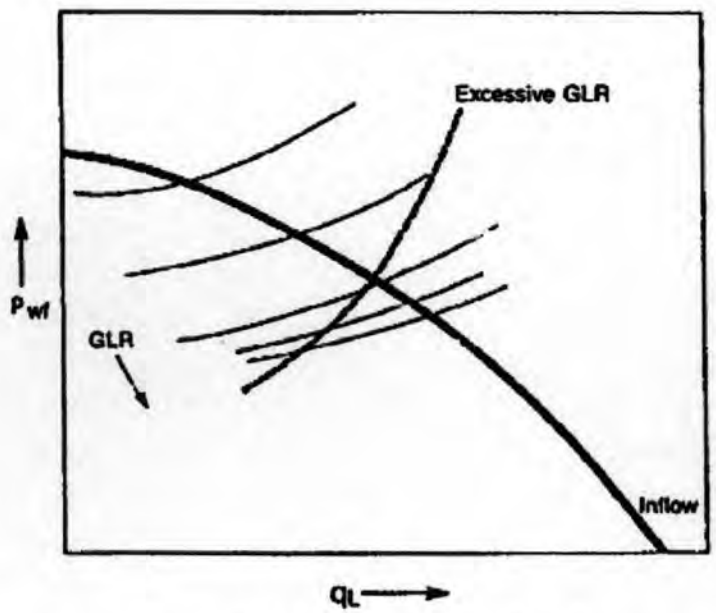

Figure 6.2 Gas Lift Well Analysis [5]

The intersections of the inflow and outflow curves give the liquid production rate corresponding to each injected GLR. The required volume of gas to be injected can then be calculated. And a plot of liquid production rate versus gas injection rate can be constructed. This is illustrated in Figure 6.3.

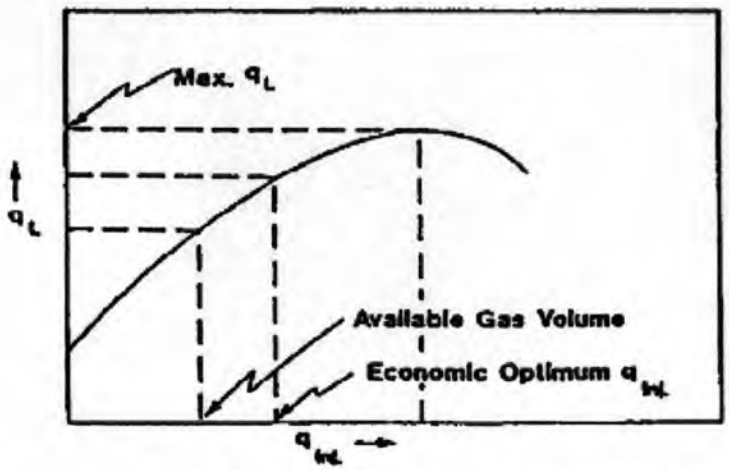

Figure 6.3 Effect of Gas Injection Rate [6]

The maximum liquid rate obtainable for this well and the corresponding gas injection rate can be read from this plot. Injection at a rate higher than this would actually result in a decrease liquid rate for an increased expenditure of money. This is not an uncommon occurrence in gas lift operations. The effect of injection depth can also be observed in Figure 6.4.

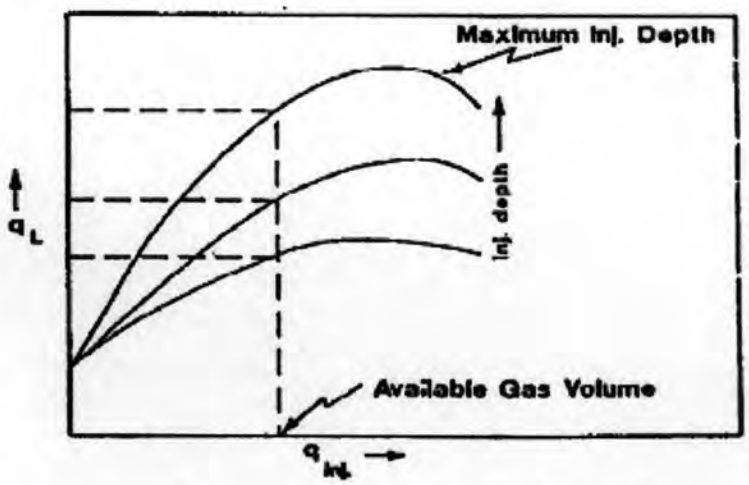

Figure 6.4 Effect of Injection Depth [6]

However, for the base model in this study, there are no unloading valves designed and hence it is assumed by the software that the compressor has the pressure enough to inject at different depths without the unloading valves which is not case for

real wells. This is done because the idea was not to design the compressor size or the unloading valves but to compare performance once the gas lift is operational. However the effects of excess GLR and injection depth is true according to the diagrams shown earlier.