# Continuous Gas Lift

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In straight or continuous gas lift, the flow is continuous, that is, not interrupted by intermitting nor aided by any artificia pumping method for obtaining submergence. This type of gas lift resembles a flowing well more than does any other type of artificial method in producing a well. Gas is injected at the top of the well through the tubing or casing, as the case may be, and the flow of the oil and the gas takes place through the other pipe rather than the pipe through which the gas is admitted.

By reason of its very nature, constant-flow gas lift is the logical method to follow natural flow unless, in the meantime, conditions for its use have become unfavorable. Natural flow is merely gas lift in which all of the gas used in lifting the oil is obtained from the formation, whereas in constant-flow gas lift, the deficiency of the formation gas is made up from another source such as a gas well or a compressor hookup.

Immediately after natural flow ceases, there is almost sufficient gas accompanying the oil from the formation to cause the well to flow naturally. Constant-flow gas lift makes use of this formation gas, and only the quantity necessary to make up the deficiency from the formation of the well is added. No other method can make use of the formation gas to any important extent in lifting the oil; therefore, this energy in the formation gas is largely lost where other lifting methods are applied.

Where considerable sand accompanies the oil, there is very little difficulty in lifting it with constant flow valves -- in fact, this method is used for cleaning out salt water disposal wells that have become choked with sand.

For an understanding of gas lift a number of descriptive terms describing the conditions that exist in the different stages of gas lift operations and well conditions have been set up. The following terms are encountered frequently in gas lift practice:

EFFECTIVE LIFT. Lift in feet performed by input gas as determined by pressure survey in tubing.

CONTINUOUS FLOW. An uninterrupted flow of the well fluid resulting from aeration and expansive action of input gas.

INTERMITTENT FLOW. Head or slug type of flow which is accomplished primarily by displacement of fluid by intermittent injections of lift gas, resulting in an intermittent production of well fluid.

STATIC FLUID LEVEL. The point at which the fluid will stand in a well under equilibrium conditions.

STATIC HEAD. The distance in feet between the static fluid level and the producing formation, or pressure in pounds per square inch corresponding to the fluid column of the above height.

WORKING FLUID LEVEL. The point in the well at which the fluid stands during settled gas lift operations.

WORKING HEAD. The distance in feet between the working fluid level and the producing formation, or pressure in pounds per square inch corresponding to the fluid column of the above height.

STATIC SUBMERGENCE. The vertical distance in feet between the static fluid level and the bottom of the tubing.

WORKING SUBMERGENCE. The vertical distance in feet between the working fluid level and the bottom of the tubing.

PERCENTAGE OF SUBMERGENCE. The submergence divided by the sum of the lift and the submergence.

OPEN INSTALLATION. Flow valve installation without packer or standing valve. Depends on fluid seal to prevent blowing around bottom.

SEMICLOSED INSTALLATION. A flow valve installation which includes a tubing packer.

CLOSED INSTALLATION. Flow valve installation which includes a packer and a standing valve.

ROTATIVE GAS LIFT SYSTEM. Gas lift system in which the produced solution gas and the input gas are collected and the separated gas is recompressed by the system compressor or compressors and is returned to the well for further gas lift operations.

A flow valve is essentially a device which controls injection of high-pressure gas into fluid contained within the tubing. The points of injection are predetermined in the initial design of the gas lift installation.

The forerunner of the flow valve was the so-called "kick-off" valve. This valve was used in the straight gas lift for reducing unnecessarily high starting pressures. The valve remained closed during the actual operation of the well. The flow valve, a later development, is capable of repeated openings and closings and has as its purpose both starting and maintaining the flow of the well.

A large number of different flow valves have been invented, built, and tested. A few of them, which proved to be practical, are now in common use. Their design and manner of operation are amply covered in the literature of their respective manufacturers.

All of the flow valves now used for constant flow are divided into the following three groups; a brief description of their basic principles is given:

1. Differential pressure valves of this group are spring-loaded, kept normally open by predetermined tension of the spring. When installed, the valves remain closed as long as the casing pressure multiplied by the area of the valve is larger than the tubing pressure multiplied by the area of the valve plus the tension of the spring. The valve will open when the pressure in the tubing becomes sufficiently large to overcome the casing pressure with the help of the spring tension. As the valve opens, the casing pressure is larger than the tubing pressure by the differential of the spring tension. Thus the flow of gas into the tubing is made possible. The valve will close again when, as a result of flow conditions, the pressure in the tubing drops to the point where the tubing pressure and the spring are no longer capable of holding the valve open against the casing pressure.
2. Specific gravity operating valves open or close as a result of differences in specific gravity of the tubing fluid and of a special light fluid contained in a 16-foot tube of the valve. Each of the two fluids acts on the opposite side of a diaphragm which, in turn, controls the opening of the valve.

   During the flow conditions, when very light aerated fluid is in the tubing opposite the valve, the fluid of the valve presses the diaphragm in the opposite direction, closing the valve. If the heavy well fluid is opposite the valve, the diaphragm is pressed in the opposite direction, opening the valve.

   When the valve is used in a well that, with a little help, will flow, the valve will close during the flow period, thereby conserving gas automatically without manual or automatic surface controls.
3. Pressure-operated gas lift valves are controlled from the surface by changes in annulus pressure. These valves are operated by pre-pressured metallic bellows. The changing of the annulus pressure above or below the internal bellows pressure

causes contraction or expansion of the bellows. This, in turn, causes opening or closing of the valves. When used for continuous gas lift, the valve has a choke on either the upstream or the downstream side of the seat of the valve, that will cause the valve to stay open when there is a constant flow of gas pressure from the casing annulus through the valve into the tubing. This will move the fluid from the well at a constant rate. This valve must have some type of surface control.

When an installation for a well that is to be produced with constant-flow valves is designed, care must be taken in the spacing of the valves. There are two types of valves, and in each of the valves the formula is different. The fluid gradient valve may be installed without surface controls, as controlling the casing pressure is not necessary.

## FORMULA FOR DETERMINING THE LOCATION OF THE TOP VALVE AND THE SPACING OF ALL LOWER VALVES WHERE:

The input casing pressure is greater than the pressure exerted by an assumed column of fluid (similar to that in the well) equal in height to the distance from the surface of the ground to the fluid level in the well.

A = depth in feet to the first valve below the surface.
B = depth in feet to the valve below "A".
C = depth in feet to the valve below "B".
D = depth in feet to the valve below "C".
E = depth in feet to the valve below "D".
CP = Input casing pressure.
SP = Separator pressure.
PG = Pressure gradient of the well fluid.
K = Flowing pressure gradient of the well fluid.

$$A = \frac{(CP) - (SP)}{PG}$$

$$B = \frac{(CP) - (SP) - KA}{PG}$$

$$C = \frac{(CP) - (SP) - K(A + B)}{PG}$$

$$D = \frac{(CP) - (SP) - K(A + B + C)}{PG}$$

$$E = \frac{(CP) - (SP) - K(A + B + C + D)}{PG}$$

Note: When the spacing of the valves reaches the point where the distance between valves is less than the input casing pressure, this spacing may be continued.

However, this spacing is dependent upon well conditions and, therefore, may vary from well to well.

The pressure or bellows type of valve must be controlled by a surface regulator, which will control the casing pressure as the bellows in each valve are set at a different pressure. The top valve has the higher pressure, and the bottom valve has the lower pressure. It is standard practice to step the bellows pressure down 25 lb. per valve.

## SPACING FOR BELLOWS OR PRESSURE-OPERATING CONSTANT-FLOW VALVES:

To space No. 1 valve from the surface:

$$\frac{\text{Available Pressure}}{.50} = \text{Distance in feet surface to No. 1 valve.}$$

All other valves are spaced as follows: Pressure of valve in operation - separator pressure - (depth x factor):

EXAMPLE:

Available pressure 650 psi
4-valve installation
2 1/2-in. tubing
200-barrel well

Factor 0.04
Separator pressure 25 psi
Valve bellows set at 600 psi, 575 psi
575 psi, 550 psi, 500 psi

To space No. 1 valve:

$$\frac{650}{.50} = 1300 \text{ feet from surface to No. 1 valve.}$$

Distance in feet to No. 2 valve:

$$\frac{600 - 25\ (1300 \times .04)}{.50} = 1046 \text{ to No. 2 valve} = 2340 \text{ feet from surface to No. 2 valve.}$$

Distance in feet to No. 3 valve:

$$\frac{575 - 25\ (2346 \text{ X } .04)}{.50} = 912 \text{ feet to No. 3 valve} = 3258 \text{ feet from surface to No. 3 valve.}$$

Distance in feet to No. 4 valve:

$$\frac{550 - 25(3258 \text{ X } .04)}{.50} = 790 \text{ feet to No. 4 valve} = 4048 \text{ feet from surface to No. 4 valve.}$$

Note: Static gradient of 0.50 is used in the above formula simply to assume that the installation will handle salt water with ease.

When the use of constant-flow gas lift valves is under consideration, it is good production practice to <u>know</u> the condition of the well that is going to be worked. To <u>guess</u> the condition of a well is very bad production practice and in time proves to be very costly. Service companies are in business to run surveys on trouble wells and to give the <u>facts</u> of the conditions existing in a well today. Simply because an installation will work well in one well or field does not mean that the same installation will work efficiently in an offset well. The well conditions will change from well to well.

To produce a well with constant-flow valves, the operator must first determine whether the well will produce 150 or more barrels of fluid per day, how much pressure he has to work with, the size of the tubing, the condition of the flow lines, the separator pressure, and the gradient of the fluid. One of the problems that exist today is trying to produce the maximum amount of fluid from a well that has a poorly designed tree. The number of 90-deg bends should be held to a minimum as a 90-deg bend in the pipe causes back pressure on the tubing string. When more back pressure is placed in the tubing, more pressure will have to be introduced to the casing to offset this back pressure.

When a well is being produced with constant-flow gas lift valves, it can be assumed that a large quantity of salt water will be produced; therefore the spacing should be figured by using a 0.50-static-fluid gradient and a 0.15-flowing gradient to allow a reasonable safety factor in the valve spacing. It is not uncommon for a well to be producing 40% salt water when the valves are installed, and within a year or more to produce up to 70% salt water. By designing the spacing, using a heavy salt-water gradient, any change in the amount of salt water produced will be corrected without an expensive pulling job.

No more valves than those needed should be put in a well that has a high bottom-hole pressure and a high productivity index, as in most cases the water has encroached on the well, causing the well to head up and die. Only enough valves to keep the well flowing should be run, and one or two more to take care of the well as the bottom-hole pressure drops, causing the working fluid level to drop. A well of this type, if it has a good water drive, will produce many years without a big change in the bottom-hole pressure.

Constant-flow valves should not be installed deeper than 5000 feet, as at that depth the movement of fluid constantly has reached its peak of efficiency because of the slippage of fluid in the tubing and of the increased amount of gas required to lift the fluid. When this condition exists, the operator can use constant-flow valves down to 5000 feet and can install pressure-type intermitting valves on the bottom of the string of gas lift valves. When the bottom-hole pressure drops off so that the working fluid level is below 5000 feet, then he can install a clock-type regulator on the surface and can produce the well with intermittent slugs.

In summary, I would like to caution you always to call your local gas lift representative (if you do not have trained personnel in your organization) when you have a well problem requiring gas lift. The gas lift companies are only too glad to help you at any time in working with wells that have, or do not have, gas lift valves installed. It is to their advantage to assist you in any way that they can.