New Solutions to Old Problems in Pumping Gaseous Wells

By L. E. "SAM" JOHNSON And LEONARD BOTTS

Harbison-Fischer Mfg. Co.

Gaseous wells that are difficult to pump are large in number and are often the result of the initial completion not being designed for artificial lift. More emphasis should be placed on the basic requirements that are so vitally necessary in pumping gaseous wells. The casing and liners should be of sufficient diameter to allow adequate reservoir for the subsurface pump to maintain good submergence at a given pumping rate. Tubing perforations should be 30-100 ft below the casing perforations and if this is not possible they should be 200-600 ft above the casing perforations. Tubing perforation height setting will depend on the turbulence in the wellbore. More than one attempt may be necessary to obtain the correct setting.

Design the bottom-hole separator after obtaining a good knowledge of well's inflow performance relationship.

PUMP SETTING

When the pump is set too high the gas separation could be good but the well may pump off and gas lock. When the pump is set too low, the pump intake pressure will be too high and the gas will not break out of solution until it passes the standing valve; and this type gas breakout results in poor pump efficiency.

Tubing anchors are highly recommended for deeper pumping wells and should be set at least 150 ft above the seating nipple to eliminate turbulence that causes gas to break out of solution. Mud anchors should be long enough to allow time for gas separation. Large diameter mud anchors with collars create down-passage area restrictions and create turbulence that can fill the mud anchor with gas. Unfortunately not all problems of gas interference can be solved by gas anchors and separators alone, but they can help to increase pump efficiency in most cases.

Vent casing pressure wherever possible and maintain low casing back pressure.

Gas anchors are needed in most low bottom-hole pressure conditions where the intake pressure is less than 250 to 300 psia.

Maintain good pump efficiency by keeping proper plunger to barrel tube fit close enough to maintain a good, effective seal but not too tight so as to create damage to the pump due to lack of lubrication. Top holddown pumps do not need gas anchors due to the barrel tube being long enough to get the suction below the tubing perforations but they do need a strainer nipple to keep trash out of the pump. Top holddown pumps are usually the most efficient of all insert-type pumps due to the standing valves being better submerged in the mud anchor. Top holddown pumps are limited in depth settings due to pressure differential and are not generally recommended for depths beyond 5000 ft. Stationary barrel bottom holddown pumps are the next best type insert pumps for pumping gaseous wells as the standing or entrance valve is larger than the traveling valve which is necessary to prevent gas breakout inside the pump. Traveling barrel pumps have smaller standing or entrance valves than stationary barrel pumps, causing gas to break out inside the barrel tube between the standing valve and the traveling valve.

SUBSURFACE PUMP DESIGN

Choose a subsurface pump carefully considering such items as high alloy steels and corrosion-resistant metals to withstand abrasion and corrosion. Choose a good long-lasting ball and seat that will resist corrosion, electrolysis and abrasion. Make sure that this subsurface pump is the type best suited to the particular well condition. Gather all available well data and make sure the bottom-hole temperature is known, as this is most important in determining the fit between the barrel tube and the plunger. Correct plunger fit will guarantee longer pump life, better pump efficiency, and fewer rod breaks due to rods going into compression where the fit is too tight. Close spacing of the traveling valve to the standing valve is very important when the pump is assembled, if maximum efficency is to be achieved. After pump is set in the seating nipple, make sure the plunger is spaced as close to bottom as possible to give maximum compression.

BACK PRESSURE VALVE

When a well is placed on pump and the correct subsurface pump, mud anchor, gas anchor, tubing anchor, and all other related equipment are in proper place and erratic production still exists, it is recommended that a back pressure valve be installed on the tubing to hold sufficient back pressure to prevent the well from flowing off and emptying the tubing of fluid. This back pressure valve, properly set, can keep the tubing full of fluid; this helps maintain correct pump spacing, prevents paraffin buildup, offers lubrication for rods in tubing and subsurface pump, prevents stuffing box packing from burning out due to lack of lubrication and maintains constant load on pumping unit. These advantages outweigh the cost of installing this valve and the time needed to get it set correctly.

Unfortunately, not all wells meet requirements necessary for artificial lift and other equipment must be installed on existing subsurface pumps to get maximum efficiency under adverse well conditions. Wells that must be pumped from below a packer (where all fluid and gas must pass through the pump) need properly installed equipment and all of the previously mentioned attention. Also, wells that pump several thousand feet above casing perforations usually have gaseous fluid to handle and it is well to remember that agitation of fluid into the wellbore, perforated nipples, and pressure changes cause gas to break out of solution and very little gas ever goes back into the solution. The authors recommend regulating the pump size and pumping cycle to cause as little turbulence as possible. Use long, slow strokes to give a higher compression ratio. Entry of fluid into the wellbore may be erratic from day to day and if profits are to be realized a thorough knowledge of the production characteristics of the well is of vital importance. Fluid level sounders used with regular frequency are highly recommended on marginal and secondary recovery operations. Fluid level checks will indicate if the well is being pumped off. This pump-off condition will break gas out of solution, unbalance the pumping unit, damage the rods, unit, pump and other associated equipment. This pump-off condition could be prevented by installing a pump-off control, time clock, or back pressure valve with the proper bore subsurface pump.

DYNAMOMETER SURVEY SHEET

Make out a dynamometer survey sheet using all of the available information on record, and record the same on the calculation portion of the sheet. Next, take dynamometer readings to be compared with the calculated record. Dynamometer readings are recorded to show the actual loads and reactions of the well operation and they will serve as indicators for pointing out items that need attention during the analysis.

SLIDING TOP VALVE (FIG. 1)

Some well characteristics cannot be changed, but they can be anticipated; install some sucker rod pump accessories that can improve the efficiency of the pump and eliminate some damage to other related equipment, thereby helping to reduce lifting costs.

The addition of the sliding top valve to a standard stationary barrel rod pump has proved, in numerous field tests, to be an economical means of improving efficiency in gaseous wells. The principle of operation is similar to that of the gas-chaser pump, in that a two-stage effect is achieved and gas lock is virtually eliminated. The sliding valve closes at the start of a downstroke, creating a low pressure chamber above the plunger. Due to this low pressure, the traveling valve (plunger valve) opens quicker, allowing a more efficient displacement of gas and fluid from below the plunger.

Fluid pound is minimized in low fluid level wells because the sliding valve keeps the hydrostatic load of the fluid column off the traveling valve on the downstroke.

Several companies offer a similar valve. One manufacturer uses a metal valve and Teflon packing, and another uses a circle valve arrangement. They all operate on the same principle.

A few operators who installed the sliding valve system failed to increase their production, and therefore indicated that they had not received any benefit from the accessory. These

FIGURE 1

Sliding Top Valve

Pump

people were anticipating more production and in some cases, their present pump was getting all the production the well was capable of yielding. The benefits derived from the sliding valve are many, even when additional production is not obtained. These benefits are: lower minimum load, less damage to rods, pump and unit from fluid pound, elimination of gas lock in the pump, and a better distribution of work throughout the pumping cycle. Where tubing is not anchored and tubing movement disrupts the close pump-plunger spacing, the valve allows improvement in compressibility efficiency of the fluid.

The size of the valve rod has some effect in maintaining a well-distributed pump load. Larger valve rods have a tendency to speed up load pickup on upstroke.

Space the pump with this sliding top valve assembly exactly as one would a single-stage pump (as close to bottom standing valve as possible). Pumps equipped with this sliding top valve or two-staging assembly also prevents sand or trash from re-entering the pump once it is pumped out into the tubing.

LOC-NO PLUNGER (FIG. 2)

The Loc-No plunger was designed primarily for wells with high gas-oil ratios where gas lock reduces volumetric efficiency and for use in stationary barrel rod pumps. The Loc-No plunger connects directly to the valve rod and replaces the conventional plunger. On the downstroke, the valve at the bottom of the plunger is positively and immediately opened. The fluid load is instantly transferred to the lower (intake) valve and gas lock cannot occur. Where a pump-off condition exists, the use of the sliding top valve is recommended to prevent the previously mentioned damage caused by fluid pound.

This Loc-No plunger is also recommended where thick fluid is to be handled.

In wells where no back pressure is held on tubing and pressure varies from high to low, and the well flows off, the installation of this plunger in the present stationary barrel rod pump can prevent a gas lock by opening the valve at the bottom of the plunger at the beginning of the downstroke, where little or no pressure is present in conditions of this type. The friction between the plunger and the barrel tube is sufficient to hold the plunger up until the top bumper

TOP

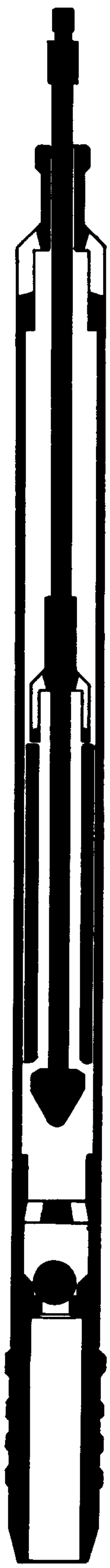

FIGURE 2

Loc-No Plunger

Pump

adapter contacts the plunger to push it downward until it reaches the bottom. Immediately on the start of the upstroke, the valve is mechanically closed and pressure differential is created between the plunger and the standing valve; the gas and fluid are pulled into the pump to be lifted on the next upstroke.

This Loc-No plunger is made by the new Thermo-Spray method of producing an extremely high-wear and corrosive-resistant surface on the metal. The surface material is an alloy of nickel binder thoroughly interspersed with fine mesh boride or boron carbide particles. These particles are so hard that they must be measured by comparison with a diamond; they have a scratch hardness of 9 mod. The nickel binder provides corrosion resistance against salt water, hydrogen sulphide, and all known well fluids. This plunger can be used in barrel tubes of any type metal that is presently known and meets API specifications for metal plungers.

These simple devices, easily installed on existing stationary-barrel rod-insert pumps, measurably increase their efficiency.

GAS-CHASER PUMP (FIG. 3)

Most pump companies feel that maximum resistance to gas interference for longest runs is best provided by their dual-ratio, high-compression pump. When this type is designed and spaced with a minimum of unswept areas, free or entrained gas or foamy, frothy fluid will be pumped without gas-locking.

In this gas-chaser pump, the upper compression chamber is formed by connecting a secondary plunger above the primary plunger and sealing it from the tubing fluid. Its volume is roughly one-half that of the lower chamber.

Downstroke fluid head load is supported by the upper plunger and its valves. As there is no load on the valves of the primary plunger, they open quickly, insuring maximum displacement from lower to upper chambers.

On the following upstroke the valves of the primary plunger close and the charge is compressed in a compounding ratio in the upper chamber, overcoming fluid head pressure, and is discharged into the tubing.

Meantime, the standing valve opens, filling the lower chamber with a fresh charge.

To insure maximum compression for the

TOP

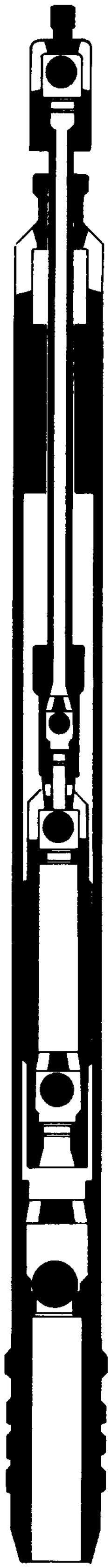

FIGURE 3

Gas-Chaser

Pump

stroke length and bore sizes provided, built-in, unswept areas should be minimized and in operation with the pump spaced as close to the top of the stroke as conditions permit.

The stronger construction of the secondary chamber of this pump normally provides a longer service run than the valve rod top valve type.

The necessarily smaller fluid passage dimensions of the upper chamber and plunger and the open top cage may result in a lower minimum downstroke load when compared with the valve rod type. Therefore, as with the single-stage pump, the authors urge placing enough added weight in the rod string directly above the pump to offset pump downstroke resistance and fluid pounding differentials where present.

The "Z Factor" reference guide table presented by Mr. Joe Chastain in his text book for "Artificial Lift Efficiency School" can be used to determine the weights necessary for different bore sizes.