New Developments In Pumping Equipment

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To anyone who has been associated with the operation, selection, or purchasing of production equipment over the past 20 to 30 years, it is obvious that in the beginning oil producers made money in spite of the operating equipment, and methods, rather than because of them. In the very early days of cable tool rigs, the well was drilled and pumped with the same engine, and surface equipment. Upon completion, the rope, jars, and drilling bits were pulled out, and sucker rods and a common barrel were installed. Very seldom, if ever, was any type of counterbalancing used. It was thought that if the erratic motion of the walking beam was good enough to drill the well, then it was good enough to produce it. Of course, even with such crude and unsuitable equipment, producers were able to sell all of the oil they could produce at prices as high as $5.00 per barrel. Naturally, they made money. With the advent of proration, deeper wells, taxes, engineers, and banks, into the production field, it became necessary that close attention be paid to the equipment used so as to produce the well efficiently. Only in this way could the loan be paid off, the taxes kept up-to-date, and a little profit left for the man who had stuck his neck out. At the present time, production equipment is being tailored to fit the production pattern, which has been decided upon after thorough consideration of the many, many, factors affecting economics of oil production. In order to discuss new developments in pumping equipment, we believe that it is only proper to begin with the bottom hole pump because this is the item of equipment that starts the cash register ringing for the producer.

I. Dual Pumping Developments

During the past year, great steps have been made in the application and flexibility characteristics of equipment suitable for producing two pay zones through the same string of casing. About a dozen installations have been made using two bottom hole pumps, two strings of tubing and two strings of sucker rods, all installed in the same casing string, with a packer to separate the producing zones. In addition to higher original cost of equipment, this set up has, in general, proved to be unsatisfactory, due to the fact that gas troubles cannot be handled properly. This type of application will continue to be used occasionally, but we believe that the high cost of the duplicate pumping set-ups will cause it to be used less and less as time goes on.

Three of the major sub-surface pump companies now have dual installations based on pumping both zones with one string of sucker rods and one pumping unit. The general characteristics of these three set-ups are similar but the flexibility of installation and operation varies. Only one of these offerings seems to lend itself to almost any type of production set-up desired. This one enables the producer to vent gas from either the upper or lower pay, or from both, if so desired. It also allows him to flow or pump either, or both, the upper and lower zones according to necessity. It offers further the advantage of retrieving all operating parts of the dual pump equipment on the sucker rods with no necessity of pulling tubing in order to get at some of the working parts. A new feature of this offering is the pressure-actuated traveling valves for either, or both, upper and lower pumps. With these valves, if either zone has produced its allowable but the other has not, by closing a gate valve at the surface one zone can continue to produce while the other does not, because the traveling valve becomes inoperative against the pressure of the closed-in valve. When it is desired that the closed-in pay be put on production again, all that is necessary is that the gate valve at the surface be opened, and when this is done the traveling valve commences to operate again. This same offering in the dual pumping line can be used with Bottom Hole Chokes and Cross-Overs so that either the upper or lower zones can be acidized, or other type work-over operations conducted without affecting the other pay. In addition to the increased flexibility of the dual pumping equipment, much progress has been made during the past year in its proper application. Detailed dynamometer analyses brought to light operating difficulties such as rod stretch, tubing stretch, and many other problems. Much is yet to be found out on dual installations, but it is apparent that very much has been learned the past year.

II. Two Stage Pumps

We believe that a paper was given here last year covering the details of the two stage, dual compression or ratio compound type of bottom hole pumps, so we will merely say that this type of pump is basically two pumps—the oil and gas is sucked into the larger one on the up-stroke, and on the down-stroke is passed through a traveling standing valve into the samaller pump. On the following up-stroke, the mixture is compressed so as to operate the traveling valve, and thus be discharged into the tubing. This type of pump was designed to prevent gas locking and has proven to be successful in general. It does not, however, take care of a condition not generally recognized among producers, that of gas flow. Many, many, wells will pump satisfactorily for awhile, until the fluid level is lowered to the pump. At this point a gas flow is started from the pay into the well bore, through the pump, up the tubing, and out through the flow line and vent. We know of cases where the flow continued for six to ten hours before enough fluid was built up to break through the gas flow conditions. In general, we differentiate between gas lock and gas flow pumping conditions by saying that in the gas locked condition, the tubing has fluid in it, but the pump has only gas in it which is being compressed and decompressed alternately, but no fluid is being discharged into the tubing. Now when the gas flow condition prevails we find that the pump and the tubing are both empty and contain no fluid, just gas. The two-stage type of pump has proven itself worthwhile for gas lock conditions and is worth consideration when those conditions are present. We suggest that some consideration should be given to the gas flowing condition mentioned.

III. 3-Tube Pumps

This type of bottom hole pump is not new, having been developed several years ago as a special pump for sandy conditions. As most producers know, the 3-tube utilized fluid seal, rather than a metal-to-metal seal. The new developments that have taken place in the basic type pump are those having to do with the retrieving of the standing valve assembly, with the method of discharging fluid from the pump. Ordinarily, 3-tube pumps are run in and seated, then the barrel assembly is unscrewed from the standing valve assembly, the pump is spaced and put in operation with no positive connection between the traveling barrel and the stationary valve assembly. When it was desired to pull the valve assembly, it was necessary to set down and attempt to screw back onto it. Often this was unsuccessful due to sand build-up, damage to threads, corrosive action, etc. New developments enable these pumps to be run and operated exactly like a standard insert pump of any other kind. No screw-on or screw-off is necessary, and this feature alone has made 3-tube pumps more desirable. One other new feature that is now available is parts whereby some of the fluid (approximately 20%) can be discharged immediately above the seating cups, thereby keeping in motion any sand which is at the top of the barrels that might possibly settle out below the main discharge of the pump. This minor feature gives improved runs and this type of pump can now be considered a good type for sandy conditions in almost any producing area.

IV. Injection Pumps

This type of pump is a new-comer to bottom hole installations. It is specifically for use with hollow sucker rods. Using this pump, a diluent or a paraffin solvent can be pumped down the hollow sucker rods then through the plunger, which allows the fluid to be discharged through a liner of the pump, as a port in the plunger passes a port in the liner column. This allows the desired chemicals to be introduced into the well bore at the pump and thus be carried through the pump and up the tubing, giving the corrective benefits of the chemicals to the whole string of tubing as well as to the well bore. This pump, at the moment, is not a standard off-the-shelf item but we believe that during the following year there will be some very interesting and effective applications of it in wells where corrosion, paraffin, or low gravity conditions prevail. It is apparent that such a method of treating a troublesome well with either corrosion inhibitor, paraffin solvent or a diluent is highly preferable to the dump method in use to this time. We are sure that this new-comer will make itself known during the following year.

We feel that the subject of new developments in bottom hole pumps is covered in the main by those mentioned previously and we will pass on now to a development in sucker rods. Several installations have been made during the past year of the new 1 1/8 inch diameter sucker rods. These rods weigh 3.67 pounds per foot and are used on very deep wells for their load carrying ability, but are also used immediately above the pump in a casing pump installation in order to have a "piston rod" effect to push the big traveling valve assembly down. This enables producers to operate casing pumps at a higher stroke per minute rate than was possible before these 1 1/8 inch rods were available. Other than the new size, we do not know of any radical developments on sucker rods that have been brought out during the past year. There are, of course, tests being made of aluminum sucker rods, shot-peined sucker rods, and sucker rods of special analyses of steel. None of these tests are conclusive as yet and we must wait for time to furnish desired data on them.

We would now like to mention an item which is installed on the surface, but which has a great effect on the operation and performance of the subsurface equipment. We are referring to the pressure control vale. This item is not exactly new but it has been improved recently and is becoming more widely used than before. The equipment itself is very simple—consisting mainly of a globe valve type body with a spring loaded ball in place of the plug used on globe valves. By increasing spring tension acting on the ball the valve can be made to hold a certain pressure, opening only to relieve pressure build-ups that occur. This valve already has many known merits and we are sure that more uses for it will show up as their use increases. We know that the installation and proper operation of a back pressure valve will secure the following advantages:—

(1) It will conserve bottom hole energy in the form of gas pressure by preventing any gas flow without a concurrent liquid discharge.

(2) It will give longer life to balls and seats by holding them closed against gas flow thereby avoiding cutting and spinning.

(3) It will even out the production rate, i. e., production will be secured at a smooth rate rather than by spurts.

(4) It will add to the life of the packing in the stuffing box by providing constant liquid around it.

(5) It will lower the measured gas/oil ratio of the well because it prevents any gas discharge without liquids.

(6) It enables surface equipment to be effectively counterbalanced by evening the load on the unit. It does this by preventing flow-off. This is an extreme advantage when electric motors are used as prime movers because it provides a steady demand rate to the electric motor.

(7) It will prevent, or at least retard, paraffin deposition caused by the chilling effect of expanding gases by holding these gases in solution until they pass the valve itself.

The main fault which has been observed with the installation of these valves has not been with the valves themselves, but with the operators who did not want to carry sufficient pressure to accomplish the job for which the valve was installed. In some cases it has been necessary to hold a pressure of 600 pounds per sq. inch in order to prevent the well from flowing by heads.

In general, we believe that the pressure control, or back pressure valve, has definite application on a well in order to force the well to actually pump. We believe that the so called agitation or "flumping" (flow pumping) period of production is actually very inefficient and detrimental to the equipment and to the well itself. Experience has indicated that if a well will not flow its production, then equipment should be installed to make the well actually pump. The advantages of this scheme should be obvious.

We feel that we can now begin discussion on new developments on equipment used around the well heads.

Very recently a flow line gas separator has been developed which is causing quite a bit of interest. It is a small pressure vessel, roughly 12 inches in diameter by 22 inches high, which is installed between the pumping tee and the flow line. The oil and gas mixture coming from the well comes into the separator from the bottom, up through an entry pipe. The gas and oil mixture then hits a baffle and is spilled over in a reverse direction. The speed at this point is reduced 25 to 1, and therefore any free gas that wants to separate has ample opportunity. This free gas collects in an inverted bucket which floats. The solid fluid goes on out the top of the separator while the gas is taken out another connection at the bottom. This principle, of course, has been in use for years, but its application as a separator at the well head is new. Its prime function was to help to provide gas to run the pumping engine when the well normally would not make enough gas through the casing. The installation of this separator will void the necessity of laying a gas line from the lease separator back to each well in order to have gas for the engine. From the economic standpoint alone, it is interesting—but even further possibilities are offered. Using this separator in conjunction with a good fluid meter, it would be possible to have an exact check on the fluid produced from the well each day. This, of course, is advantageous where several wells are pumped into one tank battery. It is even possible with this separator to rig up a set of equipment (especially on an electric motor) whereby the pumping unit could be started by a time clock at a specified time each day. Then by using the separator with a meter and with special attachments, the unit could be allowed to operate until the allowable oil production had been pumped, regarless of the time it took to pump that amount. By setting the desired volume on the meter and having the meter trip a cut-off switch, this feature would assure the operator that his allowable had been pumped from each of his wells each day. This feature, of course, would make the railroad commission very happy. The separator even offers possibilities of doing away with the big, expensive, separator in use now on some leases. It is entirely possible that on a lease with several wells, it would be cheaper to install one of these individual well separators than it would be to install one of the big separators at the tank battery on its necessary concrete foundation. The prime function of this separator has already been proved and tests are already under way which will prove the other factors mentioned.

During the past year several tests were run on bottom hole pumps equipped with ceramic balls which may prove to withstand sand, gas, and fluid cutting to a greater degree than the best of the metal balls. These tests are inconclusive as yet. Ceramics were also introduced as polish rod liners and have shown definite improvement in wear characteristics over the standard bronze liners. These ceramic items, while they are very interesting and may develop much further in the future, are definitely on test at this time.

The past year saw the introduction of a new polish rod clamp featuring greater holding power along with quicker installation. With this new clamp, producers can obtain the flexibility needed for re-spacing the pump or for installing well-weighing instruments without sacrificing holding ability. This clamp gets its greater power through the use of fine threads which are protected from damage or rusting by a long standard size nut. The holding power of this new clamp tightened with a 24 inch cresent wrench is equal to the holding powers of other clamps tightened with a 36 inch or even a 48 inch rigid type wrench. It is offered at a comparable price, which makes it an interesting offering even though it is a small accessory item.

Let us now take up new developments in the surface production equipment. We will begin with the major item which is, of course, unit pumpers.

1. UNIT PUMPERS are now offered with modifications which allow longer polish rod strokes for a certain API size reducer. This type of modification was brought about in order to handle increased volumes of fluid from rather shallow pays being water flooded. The torque requirements are rather low but the increased stroke is necessary in order to secure economical volumes. These modifications are now generally available and have proved entirely satisfactory.

2. ANOTHER MODIFICATION of standard unit pumpers which is now offered is that of lighter structurals than standard with rather heavy-capacity reducers. This modification was brough about because of the volume of relatively deep wells from which rather small fluid volumes were available. In this case, the major portion of the load is sucker rods, while the fluid load is very light. This type of loading requires high torque capacity in the reducers with a lower than normal polish rod load. This modification is generally available and has proved entirely satisfactory in operation.

3. DUE TO economical as well as certain legal requirements, steel sub-bases of increased width are available now on unit pumpers. This type of sub-base does away with the necessity of the expensive concrete foundation and also gives portability and flexibility. We feel that the demands for, and application of, wide bases on unit pumpers is definitely a growing thing. We suggest that the wide base be investigated thoroughly to be sure of the proper strength and rigidity necessary for this type of mounting. Bases fabricated from I-Beams and H-Beams are definitely superior to those made of channel iron, or used drill pipe. The latter two types allow entirely too much weaving for the modern pumping unit and have proved to be unsatisfactory.

4. AT LEAST three of the accepted makes of unit pumpers now offer oil producers the advantage of the hydraulically removable wrist pins. Actually the title is a misnomer because the basic idea is that the pressure built up with a grease gun is only an aid to the sledge hammer. It was never really intended that the wrist pins should be pumped out 100% with the grease gun pressure. These types of wrist pins give oil producers greater flexibility in applying the unit power at the proper stroke length needed over the life of the well. With them the polish rod stroke can be easily and quickly changed. This definitely was not true until this feature was introduced. Anyone who has been eaten up by a 16 pound sledge hammer beating on wrist pins will verify this statement.

5. MOST OF the accepted makes of unit pumpers during the past year followed lines previously indicated by offering controlled type counterbalances. Some companies use screw adjustments while others allow the counterweights to pivot easily around a bearing to the desired position, but the effect secured by both methods is the same. These counterbalances are safer and easier to operate and we find that the average pumper will keep his well in better counterbalance when it does not mean a half days work for him to insert weights which may be either too much or too little when he's done. The new counterbalances are definitely worth the cost to the oil producer since they will save wear and tear on the gears and the bearings in the reducer.

6. ONE MANUFACTURER of unit pumpers has taken a rather radical step forward. That company has lightened the weight of their new line of unit pumpers by using good and accepted engineering design. After the pumpers were built they were checked thoroughly through the use of strain gauges at all load points while operating at the polish rod load rating of the unit pumper. He was able to get a positive check on his engineering design and it proved satisfactory. This light weight is desired from several angles, such as portability, and of setting, as well as the saving in freight. In other words, the whole idea of "if its good, its got to be big" is now out the window.

7. IN LINE with the specific application of unit pumpers as well as the new designs which have followed, dynamometers are now being used in greater measure than ever before to check on the actual loads imposed by the well, the counterbalance effect secured, the HP required from the engine, and the operation of the bottom hole pump. The use and intelligent analysis of dynamometer cards, result in definite savings to the operator not only on his equipment but in his production methods.

We would like to mention here that one supply company is now offering application recommendations covering V-Belt Drives which base the belt requirements on the torque capacity of the gear reducer, and do away with the old HP/Ft. per minute application by which V-Belts were applied to industrial and farm uses. This method of application tailors the drive for the unit pumper on which it is applied and provides the highly desirable resiliency which the old application methods did not give. Greater life of gear teeth, bearings, clutch shafts, etc., can be expected with the use of the torque drive application.

On the general subject of prime movers there have been no startling developments during the past year although several new engines were brought out. They were merely different sizes of regular type engines. The popular acceptance of the single cylinder, horizontal, medium speed engine designed for the oil fields, and used in the oil fields only, have been extremely gratifying. It indicates that equipment used in the oil fields should be made for use in the oil fields and not for use on compressor, a generator, or a hammer mill on the farm. Several manufacturers have increased flywheel weight on their engines in order to cut down on the cyclic variation. This variation proved to be not only undesirable but actually damaging to gear teeth and bearings, and it is well that flywheels have been made heavier.

Electric motors continue to gain in applications on unit pumpers even though they are not necessarily the least expensive. They are clean, and easy to operate, but do not allow any flexibility in the operation of the unit pumper. Sometimes this flexibility is highly desirable. In general, electric motors are installed to counter-act the poor quality of pumpers available to operate production equipment, and in this light they are a good development.

In closing, we would like to say that as equipment becomes more tailor made to well conditions, increased knowledge is necessary concerning the application of this equipment. It imposes an obligation of operational checks and operational maintenance which oil producers cannot and should not avoid. We have endeavored to cover quickly new developments that have taken place in pumping equipment during the past year. We are sure that we have missed some of the new items. We will admit to purposely avoiding any mention of "Sonic Pumping". California is running an experimental installation on this now. Generally, the principle is this—tubing is vibrated at the surface at 200 short cycles per minute; these vibrations are carried down the tubing as waves and nodes; each tubing joint has a special type valve in it to let the oil only go up—by the stage-lifting achieved thusly, oil is brought to the surface. That's all I know about "Sonic Pumping".

Rather than to go on further, and run the risk of encountering a "Nuclear Fission Pumper", which lifts oil by the mushroom shaped cloud method, I shall end this paper now.