Late Developments in Equipment for Multiple Completion Rod Pumping Wells

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In 1959, we were privileged to present, at the West Texas Oil Lifting Short Course, a paper entitled "Selection of Equipment for Multiple Completion Rod Pumping Wells." In this paper, we traced the evaluations of the two-zone pump and reviewed some of the economic reasons for the multiple completion practice. At this time, two basic reasons were given for dual completions:

(1) Shortage of steel (tubular goods)
(2) Increased demand and price of oil

Both of these reasons have now given away to more economic factors, such as:

(1) Oversupply and lowered price of oil.
(2) Increased costs of steel.

As you can see, the reasons used today are completely opposed to those reasons which brought about the early development of multi-completion practices; yet they have in common one factor: a desire to produce the maximum amount of oil at the lowest possible cost per barrel. This desire, after all, is the basic reasoning behind the short course.

DEVELOPMENTS IN ROD PUMPING OF MULTIPLE COMPLETION WELLS

Two-Pumping Unit Method

Since 1959 there have been, in the design of tubing joints, many improvements giving higher joint efficiencies, and thereby permitting cheaper grades of tubing to be run. These improved tubing joints also have reduced joint O D's which frequently permit the use of a larger tubing in a given casing size, and since larger tubing can often be used, larger sucker rods can be applied and can allow the use of larger bore pumps at a deeper setting. Some of the tubing improvements are buttress thread, box and pin or integral joint tubing, and improved thin well seamless tubing. There are still the disadvantages of increased costs of equipment and increased fishing hazards, but two of the disadvantages listed in 1959 -- those of depth and volume limitations -- have been greatly reduced.

One Unit With Two Horseheads or One Unit With Twin Carrier Bars

In this method of dual pumping very little improvement has been made, altho there is one new development, or perhaps it should be called a new application, e.g., the development of the "Siamese" unit. In this operation, a pumping jack similar to those used in central power installations is placed head to head with an oversized geared pumping unit. It is driven by pitmans running from the powered unit. Stroke length can be varied, but the Siamese unit must be operated at the same speed as the master unit. The Siamese can be hooked off, but then the master must be re-balanced since the twin provides a portion of the counterbalance effect required for each zone. This is not an easy job and consequently many pumpers over-produce one of the wells unless care is given to selecting the proper stroke length and pump size. However, the disadvantages of having to buy an extra rod string, one pumping unit large enough to handle two rod strings and two fluid loads, and two large diameter tubing strings still exist, in addition to the increased fishing hazards mentioned in connection with the two pumping unit method.

Simultaneous or Tandem Rod Pumps in Multiple Completion Wells

It is in this type of equipment that are found the most new developments. Here progress has gone from the original idea of pumping only the two zones to that of pumping three, four, and even five zones with one sucker rod string and up to four tubing strings within the same casing. As new materials and ideas permitted the development of the tandem pumps, continued research has allowed tandem pumping applications to be made far beyond the old limitations.

In 1959, one was able to vent the lower zone with an independently run vent string only in 7 in. or larger casing; then a 3/4 in. string was run inside the 2 in. short string. Now there have been developed crossovers which will pass a 1 in. tubing joint O D of 1.552 in. in 5-1/2 in. casing and 2,700 joint O D in 7 in. casing Packer manufacturers have developed landing heads for their vent type packers which accept the parallel string landing and seal assembly used in one manufacturer's crossover. This development makes relatively simple and easy the venting of gas from below a packer.

The development of the by-pass crossover has also allowed triple pumping completions, using two pumping units, to be made at depths of 8,000 ft to 10,000 ft. In this type of application, 7 in. casing is required and will permit the installation of two 2-3/8 in. tubing strings and one string of 2 in. or smaller tubing. First, a long string of 2-3/8 in. tubing equipped with a seal assembly is run to land in a permanent type packer; a seating nipple and a parallel snap set packer are set with the parallel string. Then a second 2-3/8 in. tubing string equipped with a seal assembly for the snap set packer, a seating nipple and a by-pass crossover is run beside the long string. Lastly the small short string is run and landed in the crossover, and a single pump with an individual unit is provided to produce the deepest zone while tandem pumps are then used for the two upper zones. A number of these installations have been made where Devonian, Pennsylvania and Wolfcamp pays are being produced.

In shallower depths, successful applications have been made with triple and quadruple pumps applied on one sucker rod string in 2 in. tubing with two independently run strings of 1 in. in 5-1/2 in. casing and three clamped 1 in. strings in 7 in. casing. In quadruple completions, inside of 5-1/2 in., four packers must be used with one zone being produced in the casing annulus. In this type of multiple completion, the largest pump's

seating receptacle is placed at the top and successively smaller seating receptacles are placed below this. Then one carefully measures the distances between seats and matches the pumps and rod string to this measurement; and simultaneous seating of all pumps and separation devices can be made. Once the pump barrels are in place, the three or four plungers are actuated as one by the pumping unit and sucker rod string. Obviously, since three and four fluid loads must be supported by one sucker rod string, application must be limited to the shallower wells or very light fluid loads.

The latest and one of the most significant developments is the tandem pump for 2-7/8" casing or the so-called tubingless completions (Fig. I).

In this application, it is best that a pump landing device be placed in the casing somewhere between the two zones to be produced. The tandem pump assembly, which is complete, is then, on sucker tubing, run in the well and landed in the seating device. Thus, the lower pump intake is placed at the lower zone and provides for the zone separation. In other words, the pump hold-down becomes a packer. The pump assembly length must be sufficient to reach above the upper zone perforations and another packer or top seal is incorporated in the pump at this point. This hook-up in packers or pack-offs is the same that one would have in a conventional two packer tandem pumping well, for the upper producing zone is straddled by packers. The only difference is that these packers are an integral part of the pump assembly.

In place of the seating device recommended earlier, a conventional insert pump anchor can be used for the lower sealing element. The lower pump is a standard two-stage pump with one exception, the length of the upper plunger. In this case, it is a 1 in. plunger which passes through a patented ring type standing valve (for the upper pump) and then inside the upper pump plunger. At the top of the upper pump plunger, this 1 in. tube is connected to a crossover device which directs this lower fluid to the outside of the upper pump plunger, and on to the casing sucker tube annulus above the upper packer or top seal. The upper zone fluid is introduced through the ring-type standing valve, through the inside of the upper pump plunger but outside of the lower production tube. It is then crossed over in the same device used to divert the lower fluid, through a traveling valve and into sucker tubing to the surface. The separation of the produced fluids is accomplished by (1) the lower seating device, (2) Teflon Chevron packing at the top of the lower pump and immediately below the upper pump standing valve, and (3) the top seal or packer on the upper pump. All elements are retrievable by pulling the one string of sucker tubing; but to prevent pulling a wet sucker tube string, a drain coupling is placed in the sucker tubing immediately above the upper pump. A sinker bar is dropped down the tubing. This shears a drain plug and, thereby, unloads the sucker tubing. The top seal or packer which supports the lower fluid is opened by bypass fluid when the crossover is pulled into a sleeve which then slides upward and aligns the internal and external drain ports. This operation is similar to that of a sliding sleeve assembly with which, the reader is familiar. This unloading action prevents swabbing the annulus, an operation which, in addition to being somewhat messy, adds undue loading to the sucker tube string.

At the present time, this equipment is limited to depths of approximately 5,000 ft with 1-1/2 in. lower pump and a 1-3/4 in. upper pump. Maximum pump bores are 2 in. for both upper and lower pumps, and these pump sizes limit the maximum depth of approximately 4,000 ft.

In this day of low return for the invested dollar in oil, one can expect to see more slim hole completions; and with this new tandem pump development, a better profit picture can be obtained for the operator where he can secure two allowables for one slim hole completion.

In summary, these new developments if applied with care will enable the operator to produce more at a lower cost than was hitherto possible.