Installation Considerations For Dual & Triple Zone Pumping

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METHODS OF PRODUCING A WELL

As the total number of multiple zone wells grow we are also finding a diversity of ways and means to complete the wells. The rapidly changing demands and growth have brought about specialized equipment and practices which by their success, have in turn fostered growth.

In a dual zone installation, the methods of producing a well must be considered first. In general these are (1) single string double packer, (2) double string single packer, (3) triple string single packer, (4) hollow rod pumping and (5) two surface units, double string method.

With triple zone pumping either tandem pumps with one surface unit or independently run tubing strings with two surface units may be used.

In determining the method to employ, the production requirements, along with the producing depths, will influence the selection. For instance, if large volumes are to be produced then large bore pumps must be used. This in turn requires 2-1/2 inch tubing. The casing size will then determine whether a parallel string can be run or if a two packer installation must be made.

Also, if the producing depths are great, one inch rods must be employed to handle the high loads. It is, of course, necessary to cover the one inch rods with 2-1/2 inch tubing. The depth to which a two zone pump can be run is limited by rod stress. The combining of long stroke hydraulic pumping with dual zone equipment has made deep, high volume pumping practically and economically feasible.

The same general advantages of the long stroke hydraulic unit apply to two zone pumping as to single zone pumping. The slower cycle rate per minute coupled with the long, slow stroke make it easier on the rod string, thus permitting higher rod stresses. The schematic drawing for a long stroke installation is shown in Fig. 1.

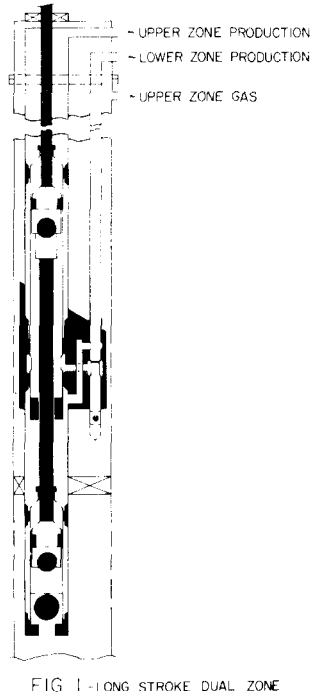


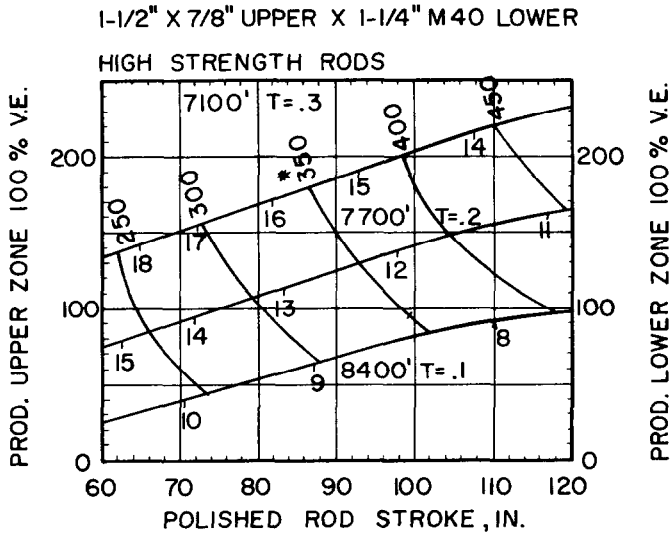
FIG 1 - LONG STROKE DUAL ZONE

The chart shown in Fig. 2 illustrates the production, depth, cycle rate, peak torque and peak load for a 1-1/2 in. x 7/8 in. upper zone pump and a 1-1/4 in. minus 40 lower zone pump.

The net producing area of the upper zone pump is the difference in areas of the 1-1/2 in. plunger and the 7/8 in. connecting plunger. This is closely that of a 1-1/4 in. minus 40 plunger. For the example of the chart, the volume of the lower zone and upper zone are equal. It should be noted that size of either plunger of the upper zone pump can be changed. This versatility aids in balancing the necessary production of the zones.

After the procedure for interpreting the chart has been mastered, it is possible to tell at a glance that with a 74 inch stroke unit operating at 14 strokes per minute the production from each zone will be about 95 barrels a day at 100 per cent pump volumetric efficiency. This production is at the maximum permissible depth, limited by high strength rods, of 7700 feet.

The peak torque is about 270,000 pound-inches and the peak load is 22,900 pounds. The rod string ratio is 31 per cent 7/8 in. rods and 69 per cent 3/4 in. rods. For simplicity in calculations the pumps are assumed to be close-



PROD. LOWER = 1.0 X PROD. UPPER

T	%7/8"	%3/4"	%5/8"	WT./FT.	PL
.1	32	68		1.80	23,500
.2	31	69		1.79	22,900
.3	30	70		1.78	22,300

* PEAK TORQUE IN POUNDS - INCHES X 1,000

FIG. 2

DUAL ZONE PRODUCTION INDEX

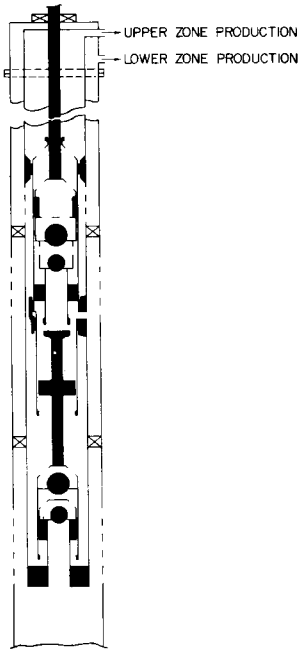


FIG. 3 - SINGLE STRING, DOUBLE PACKER

coupled. The fluid is assumed to have a specific gravity of 1.0 and the fluid levels are at the pumps. The development of charts such as this have greatly reduced the once tedious and cumbersome job of dual zone calculations.

Single String, Double Packer Method

This is the most economical method of dual zone production as only one string of tubing is necessary. Fig. 3 illustrates this hookup wherein the lower zone fluid goes up the tubing casing annulus and the upper zone fluid goes up the tubing. As it is not possible to vent gas from either zone, if the gas oil ratio is over about 500 to 1, gas lock problems and low efficiencies may be a problem.

The control of paraffin and corrosion is difficult as it is not possible to treat either zone. The exposure of the casing to corrosive attack is an hazardous practice. However, this type of installation does permit the largest size tubing in the hole, consequently the largest bore pumps, and the greatest production can be realized. The type of well suited for this completion method is a clean, gas free, non-corrosive well.

Two String, Single Packer

With this installation the lower zone production goes up the secondary tubing string and the upper zone production goes up the primary tubing string. The use of the secondary string eliminates the need for the packer on top of the upper zone. This, in turn, exposes the upper zone formation fluid to the casing tubing annulus as in a conventional well. Upper zone gas is vented up the tubing casing annulus. The problems of corrosion, paraffin and gyp, in the upper zone, can be controlled as in a conventional well.

In the lower zone, the problem of paraffin can be met by plastic coated tubing or by hot oil treatment down the casing tubing annulus. As all the lower zone gas must be handled through the pump, anti-gas lock pumps such as two-stage pumps are often used in the lower zone. From practical experience it has been found that the lower zone will produce much more satisfactorily through the smaller secondary string than through the larger casing tubing annulus as in a two packer installation. If there is any gas help or if there is any tendency to flow, this will be done much more readily through the smaller tubing.

The secondary string can be either clamped to the primary string or run independently. The independent or free-running secondary string is the more popular type due to ease of installation. There is less running time, consequently less rig time is involved. The free-running secondary string can also be pulled without disturbing the primary string and the pumps and rods.

Three String, Single Packer

The use of a third string allows the lower zone to be vented or to be treated for corrosion, paraffin and scale. The casing size will determine if this type of installation is physically possible. The third string can be free-running, clamped or can be run inside a larger secondary string as shown in Fig. 4. The lower zone fluid is produced in the annular area of the two free-running strings. The lower zone gas is vented up the third string. Again, rig time is saved by a free-running type of installation over a clamped string.

This method of completion, wherein both zones are vented, allows possible control for both zones for gas problems, corrosion, paraffin and scale.

Single String, Single Packer, Hollow Rod Type

Another method which is gaining in popularity, due to economy and simplicity, is to utilize tubing as both a sucker rod and a production line. This is known as hollow rod pumping and is illustrated in Fig. 5. The fluid passage for the upper zone is up the hollow rod. The lower zone fluid goes around the upper zone pump and up the annulus between the hollow rods and the tubing. The upper zone gas is then vented between the tubing casing annulus.

Cost savings are realized by not having to invest in a string of sucker rods. Further equipment savings are made by not utilizing a crossover receptacle or a special casing head. Rig time is also saved by running but two strings in the hole.

This type of completion is not suited for moving large quantities of fluid because of the smaller fluid passage area. However, it will fit a large group of potential dual

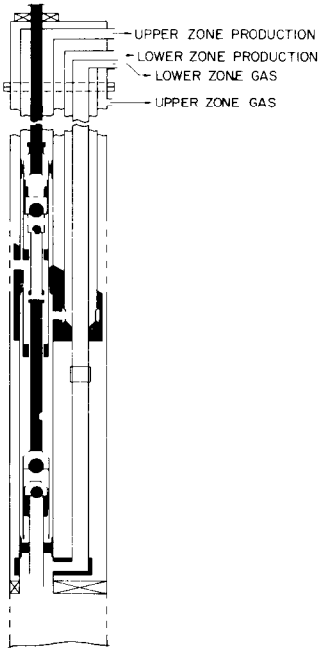


FIG. 4 - THREE STRING SINGLE PACKER

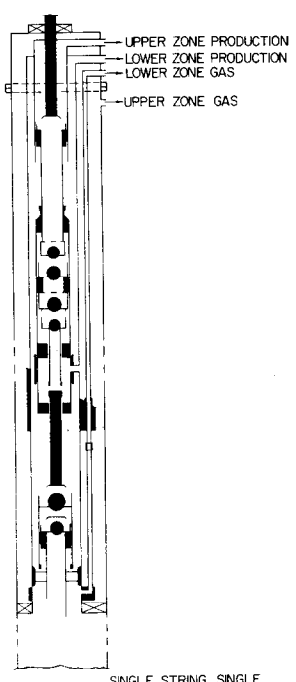


FIG. 5 SINGLE STRING, SINGLE PACKER, HOLLOW ROD TYPE

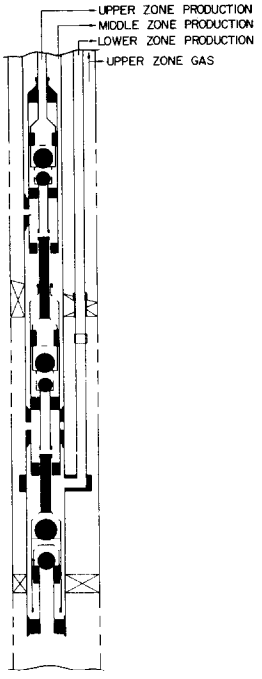


FIG. 6 - TRIPLE ZONE TANDEM PUMPING

zone wells. A more restrictive disadvantage is the depths to which the hollow rods can be run. Special joints are currently being evaluated which, if successful, will measurably improve this situation.

The loading characteristics of the hollow rods are good, as the tubing is subjected to the hydrostatic load of the lower zone fluid. This overcomes the buckling tendencies on the downstroke which materially contribute to high localized stresses at the last engaged thread in a non-preloaded tubing joint.

It is possible to vent the lower zone by running a secondary string. The secondary string can be either free-running or clamped. This, of course, also makes possible treatment of the lower zone for paraffin, corrosion and scale. The packer would be the same type as that used in triple string installations.

Two Surface Units, Double String Method

This method uses two surface units, two strings of sucker rods and tubing and one packer. The upper zone gas can be vented up the casing. The lower zone gas can be vented by adding a third string or by using hollow rod type pumping. This method of completion is costly, due to the amount of equipment involved, but does give the flexibility of individual production control for each zone.

With tandem rod pumping, production control is maintained by sizing the pumps to fit production requirements or by circulating production.

Triple Zone Completions

There are two basic ways by which a triple zone completion may be made: (1) by tandem pumping or (2) by utilizing two pumping units at the surface. The tandem pumping method is illustrated in Fig. 6. This method utilizes one pumping unit at the surface and two packers for separation of the three zones. For simplicity in installation the two upper pumps are usually close-coupled. The lower zone pump is then set at the desired depth. This reduces the spacing requirement to essentially that of between two zones.

With the two pumping unit method two strings of free-running tubing are used. The tubing with the two tandem pumps is identical to that of a conventional single string two-packer installation. The porting of the zones can vary but either the upper or the middle zone can be produced up the primary tubing string. The production and depth will determine the selection of which zone is to be produced by the secondary string. Again, this type of completion may be modified by using hollow rods to contain one of the zones.

INSTALLATION AND EQUIPMENT CONSIDERATIONS

The one single item which will help, more than any other, toward a successful multiple zone completion is a sound program of completion practices. Some procedures which will eliminate costly trouble at the time of installation are as follows.

The well should be properly cleaned up. This will eliminate pulling jobs due to excessive sand or trash in the valves. Also, the primary tubing string should be drifted as it is being installed to insure the pumps being free-running to the bottom of the hole. A rabbit should be run through the secondary string to eliminate the possibility of plugged joints due to scale, paraffin deposits or sand buildup.

In running the pumps and rods the critical item is the spacing between the pumps. This is not a complicated affair but it should be fairly accurate and it is a matter of simple arithmetic. As a general practice it is good procedure to run an on-or-off tool above the upper zone pump. The ability to retrieve all the rods to the upper zone pump pays off in two ways. If either pump is stuck, the rods may be pulled before the tubing. Second, if the tubing is stuck then it is possible to cut off the tubing at a low point. Precautions of a stuck pump are usually taken by running upper seal sections in both the upper and lower zone pumps.

As in conventional wells, the fluid to be produced determines the design and type of pump. For instance, a stroke-through pump should be used with scale conditions. Sand conditions dictate the use of top seals or a traveling type pump in the lower zone. Hard, abrasion-resistant materials should be used to resist abnormal wear. Corrosion makes it mandatory to use premium materials.

In those wells where either one or both zones may be flowing, it is practical to run the necessary tubular goods and wire line blanking or porting tools. Either zone can be made to flow up the secondary string and either zone can be pumped. At the time of installation, the necessary tubing measurements are recorded. When it is necessary to pump both zones, the wireline crossover tools are retrieved and the pumps are run into the hole. Tubing need not be disturbed.