Production of Deep Dually Completed Wells with Tandem Rod Pumps

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INTRODUCTION

Production of dually completed oil wells by various methods of artificial lift has presented ever increasing problems for the past several years. Realizing the conditions to be met and approaching them through correct design of equipment is of primary importance. The most prominent of the problems are well depths, application of surface and subsurface equipment, casing sizes, and clearances in the case of parallel tubing strings.

This paper deals with these and other eventualities as approached from a standpoint of tandem rod pumping.

One operator was faced recently with the necessity of artificially lifting dual wells, completed with 5-1/2 inch casing, to a depth of 12,300 feet. To February 1, 1958, eight dual wells have been converted to artificial lift using tandem rod pumps on a common sucker rod string and utilizing two independently run tubing strings as the conductors for the two zones' fluids. Experience gained in these installations is being offered as an approach to the eventual solution of efficient and economical dual artificial lift.

INSTALLING PARALLEL STRINGS

In a parallel tubing string installation, clearances are the primary consideration. In addition, the pump depth and the fluid withdrawal rate determine the rod string design, which in turn determines the size of the main tubing string. The pump depths in these installations range from 7900 to 10,100 feet. At this depth, the anticipated peak rod loads are of a magnitude to require a three way tapered sucker rod string consisting of 1 inch, 7/8 inch, and 3/4 inch sucker rods. The main tubing string was tapered with 2-7/8 inch O.D. API EUE integral joint tubing, to accommodate the one inch sucker rods, and 2-3/8 inch OD API EUE tubing. The parallel string was an external upset 1.315 inch O.D. integral joint tubing.

This combination of tubing strings permitted a clearance of 0.121 inch in 5-1/2 inch O.D. 17 lb. casing as shown in Table I. This clearance appears to be rather small for installing the parallel strings; however, no difficulties were encountered in completing the eight installations. In fact, one installation was completed in a well equipped with 2000 feet of 5-1/2 inch O.D. 17# extreme line casing with a running clearance of only 0.007 inch.

TABLE I

Dual Tubing Strings:	Joint O.D.
2-7/8 O.D. A.P.I. EUE Integral Joint	3.094
1.315 O.D. Integral Joint	1.552
Collars Pass	4.646 Inch

Casing O.D.	Weight #/Ft.	Drift I.D.	Clearance Inches
5-1/2	14	4.887	0.241
5-1/2	15.5	4.825	0.179
5-1/2	17	4.767	0.121
5-1/2 Extreme Line	17	4.653	0.007

Major points considered, in the selection of equipment, were flexibility and adaptation to the conditions involved. The surface pumping equipment consisted of a 192 inch stroke, air counter balance pumping unit with a 640,000 inch pound gear box and powered by a 70 h.p. single cylinder gas engine.

Insert Type Pumps

Necessarily, the bottom hole pumps had to be of sufficient length to accomodate a 192 inch surface stroke and the cross over equipment of the type to permit independent installation of the dual tubing strings. All pumps were of the insert type: all mechanisms were retrievable on the rod strings. Various combinations of these pumps involved applications of the positive displacement type and the conventional type, the former being used to provide for better volumetric efficiencies in zones where gas was a factor.

In all cases the positive displacement type pump was used as the upper pump to provide a double standing valve arrangement. All pumps consisted of regular pump parts except the holddown and pack off assembly on the upper pump. The major difference was that a six cup type holddown was substituted for the conventional three cup holddown. With this alteration, the holddown served a three fold purpose; upper pump holddown, upper zone fluid intake port, and a fluid separation device.

The fluid pack off assembly between the pumps consisted of a 7/8 inch precision fitted machined rod in a metal liner section with a tolerance of 0.001 inch. This machined rod was connected to the upper pump plunger and reciprocated through the liner section actuating the lower zone pump. The pack off assembly was anchored in the tubing assembly with a mechanical lock to prevent a pressure differential from unseating the upper pump.

Fig. 1 illustrates the pumps, holddowns and pack off assembly in position in the crossover assembly. The crossover is constructed so that wire line tools may be used to selectively pump or flow either or both zones. The flexibility of this equipment will permit a well to be produced by natural flow and artificial lift without a major equipment change. A variation of this assembly allows the addition of a by pass line for lower zone gas relief.

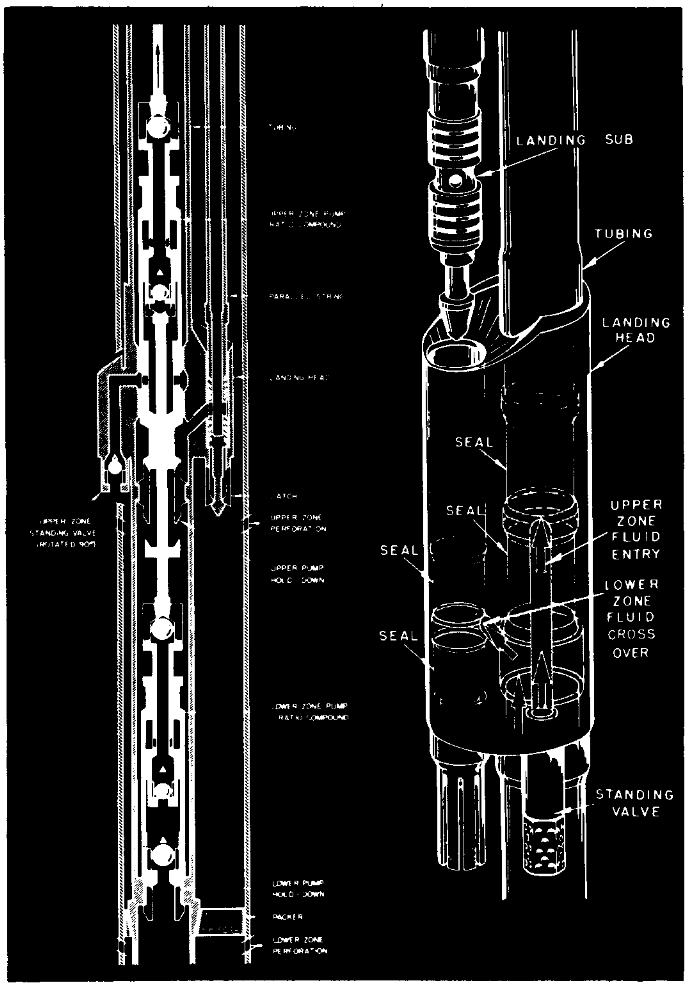

Fig. 1 CROSSOVER ASSEMBLY

Special Equipment

Special equipment used to complete the installation included a parallel string tubing hanger and a control valve for the 1.315 inch O.D. tubing. The tubing hanger flange was threaded to receive the 2-7/8 inch O.D. integral joint tubing and the 1.315 inch O.D. tubing was supported on slips. Three split type packing rubbers and a threaded sleeve produced the seal around the tubing. The body of the control valve was recessed to provide clearance for its installation in a vertical position beside the 2-7/8 inch O.D. pumping nipple. Fig. 2 is an illustration of the completed well head equipment.

This equipment was installed in wells which were produced by natural flow until increased water production forced installation of artificial lift equipment. In all cases the wells were equipped with a permanent type production packer. A latch type locator sub and seal assembly was run on the main tubing string and anchored in the production packer. The main string was landed in 8,000 to 10,000 pounds of tension to prevent any tubing movement during the pumping operation.

The integral landing head and crossover assembly was placed in the main tubing string near the bottom of the upper zone perforations. The lower pump seating shoe was installed about 90 feet below the crossover tool. The placement of the lower shoe is optional but should be placed at a depth where sufficient pump submergence is maintained. The minimum amount of sucker rod spacers between the pumps provides for greater rigidity, thus resulting in more effective lower pump plunger travel.

After the lower seating shoe and the tubing between the shoe and the crossover assembly was run in the well, a trial pump seating was performed to determine the exact amount of sucker rod spacers required. This trial spacing eliminates the possibilities of being unable to seat the pumps when the rod string is installed.

Above the crossover assembly, an oversize seating nipple (1.75 inch + .080 inch) was installed. At a future date, should one zone water out or become depleted, a wire line tool could be installed to blank off the zone and allow the remaining oil zone to be lifted by a pump seated in the oversize nipple.

A sufficient amount of 2-7/8 inch O.D. integral joint tubing was run on the top of the main string to accommodate the one inch sucker rods.

Parallel String Landing Spear

The parallel string landing spear was made up on the 1.315 inch O.D. tubing and the tubing run into the well through the tubing bonnet. A one inch blow out preventer was used to insure well control. The spear was landed in the crossover integral landing head with a small amount of tubing weight applied. The crossover is furnished with an engaging lock for the

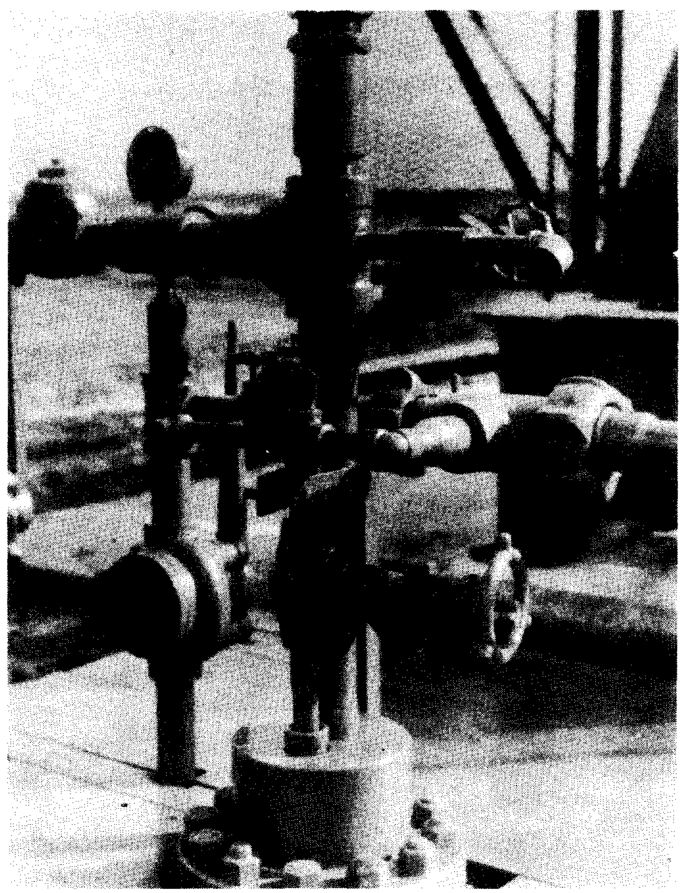

Fig. 2 WELLHEAD EQUIPMENT

spear which will insure an operator that the spear has been seated in the crossover.

To unseat the spear, an upward pull of 2000 pounds above the tubing weight disengages the lock, which is readily checked with a weight indicator. Construction of the spear insures positive pressure balance between the seals, thus eliminating unseating forces on the parallel string.

All of these installations are relatively new but no serious operational problems have been encountered. Paraffin scrapers were installed on several of the rod strings to prevent paraffin build up in the tubing from the upper zone. Should a paraffin problem exist in the lower zone, the small tubing can be cleaned by hot oil treatments down the casing annulus. Paraffin knives are available to cut paraffin in the small tubing.

Production control is a problem in dual zone tandem rod pump installations. Control of the upper zone production can be accomplished by circulating the fluids back down the casing annulus. Construction of the pumps will permit the lower zone pump to be unseated before the upper zone pump unseats. If the lower zone production is obtained at a faster rate, its pump can be unseated and production continued from the upper zone.

Table 2 is a summary of the type of pumps, setting depths, and production tests on these installations.

TABLE 2

	Lower Zone Pump				Upper Zone Pump			
			Production Bbls./Day				Production Bbls./Day	
Well	Size and Type	Depth	Oil	Wtr.	Size and Type	Depth	Oil	Wtr.
A	2 x1-1/4 x26 x30 *P.D.	8697'	45	30	2 x1-1/2 x28 P.D.	8606	144	3
B	2"x1-1/4"x26'x30'**C	8596'	122	Trace	2"x1-1/2"x28' P.D.	8503'	64	6
C	2"x1-1/4"x26'x30' C	10008'	155	72	2"x1-1/2"x28' P.D.	9996'	50	3
D	2"x1-1/4"x26'x30' C	10067'	322	77	2"x1-1/2"x28' P.D.	9973'	47	10
E	2"x1-1/4"x26'x30' P.D.	8044'	105	Trace	2"x1-1/2"x28' P.D.	7952'	***	
F	2"x1-1/4"x26'x30' P.D.	8531'	141	60	2"x1-1/2"x28' P.D.	8436'	***	
G	2"x1-1/4"x26'x30' P.D.	8581	***		2"x1-1/2"x28' P.D.	8490'	***	

* P.D. denotes positive displacement type pump.

** C denotes conventional type pump.

*** Production test not available at this date.

CONCLUSION

This paper has dealt with one method of artificial lifting deep dually completed wells. As dual completions are becoming more popular, more simplified equipment is being made available to meet the requirements. Problems can be approached with a positive attitude because of the availability of informed personnel among the manufacturers and operators.