Two Types of Dual Artificial Lift Systems

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INTRODUCTION

Cities Service Oil Company operates several dual wells in the Goldsmith Area of West Texas. Two Cities Service leases in this area contain a total of seven dual wells that are completed in the Ellenburger formation at 9000 ft and the Fusselman formation at 8000 ft.

Three of these wells are lifted by dual tandem rod pumps and the other four are pumped by free-type tandem dual hydraulic pumps. The rod pumping systems were installed during 1957 and early 1958 and the hydraulic pumping systems have been installed since late 1960. This discussion will consider the artificial lift systems installed on these two leases only and will recount their installation and operation.

DUAL TANDEM ROD SYSTEM

Fig. 1 is an illustration of the down hole equipment installed in the dual wells pumped with tandem rod pumps.

These wells are all equipped with 5-1/2 in. OD 17-lb casing. The main tubing string is a tapered string of 2-7/8 in. OD integral joint tubing and 2-3/8 in. OD API EUE tubing. The parallel string is 1.315 in. OD integral joint tubing.

A permanent type packer separates the Ellenburger and Fusselman zones. This packer is installed just above the Ellenburger at about 9000 ft. Both the Fusselman (upper) and Ellenburger (lower) zone pumps are installed in the main tubing string and are run in, operated and pulled with a single string of rods.

The main tubing string conducts the Fusselman production while the parallel string conducts the Ellenburger production to the surface. No gas is vented from the Ellenburger zone, but gas from the Fusselman zone is vented up the casing. The two strings of tubing were run independently. A crossover shoe with integral landing head was run in on the main tubing string and a landing spear was run in on the bottom of the parallel string. The spear is automatically guided into place by the landing head.

The crossover has an engaging lock which locks the spear in place when it has been fully inserted into the crossover. An upward pull of about 2000 lbs disengages the lock and allows the spear to be unseated. Construction of the spear insures positive pressure balance thus eliminating unseating forces due to fluid pressure.

A tapered string of rods consisting of 1 in., 7/8 in. and 3/4 in. rods was installed in each of the tandem rod pumped wells.

The capacity of the 1-1/4 in. lower zone pump and the 1-1/4 in. displacement upper zone pump is about 150 bbl daily, total of 300 bbl, at rated maximum speed of six strokes per minute.

Surface equipment consists of an air balanced pumping unit with structure rated at 912,000 in.-lbs and gear reducer rated at 640,000 in.-lbs. Maximum stroke is 192 in. and beam rating is 42,000 lbs.

TANDEM FREE-TYPE HYDRAULIC SYSTEM

Fig. 2 is a diagram showing the bottom hole equipment used in tandem free-type hydraulic installations.

These wells are also equipped with 5-1/2 in. OD 17-lb casing. A string of 2-3/8 in. OD API EUE tubing (main string) and two strings of 1.315 in. OD integral joint tubing are utilized.

A permanent packer is used between the two zones and is set just above the Ellenburger at about 9000 ft.

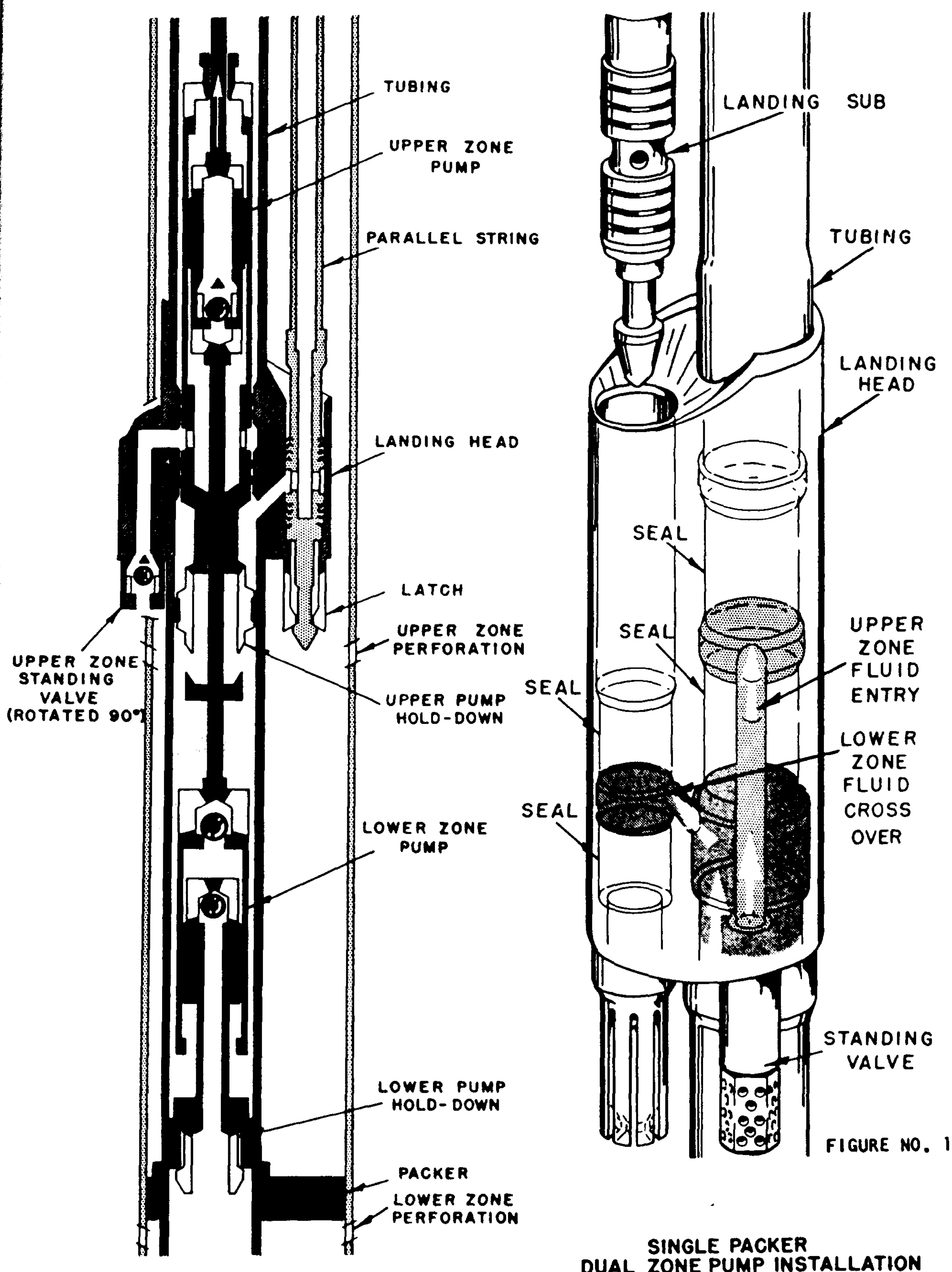

FIGURE NO. 1

SINGLE PACKER
DUAL ZONE PUMP INSTALLATION
PARALLEL STRING SEPARATELY LANDED

A snap set retrievable packer, the bottom hole assembly, the seal assembly for the permanent packer and the one in. tubing between the bottom hole assembly and the upper packer are run into the well on the main tubing string.

The upper packer is set just above the Fussel-

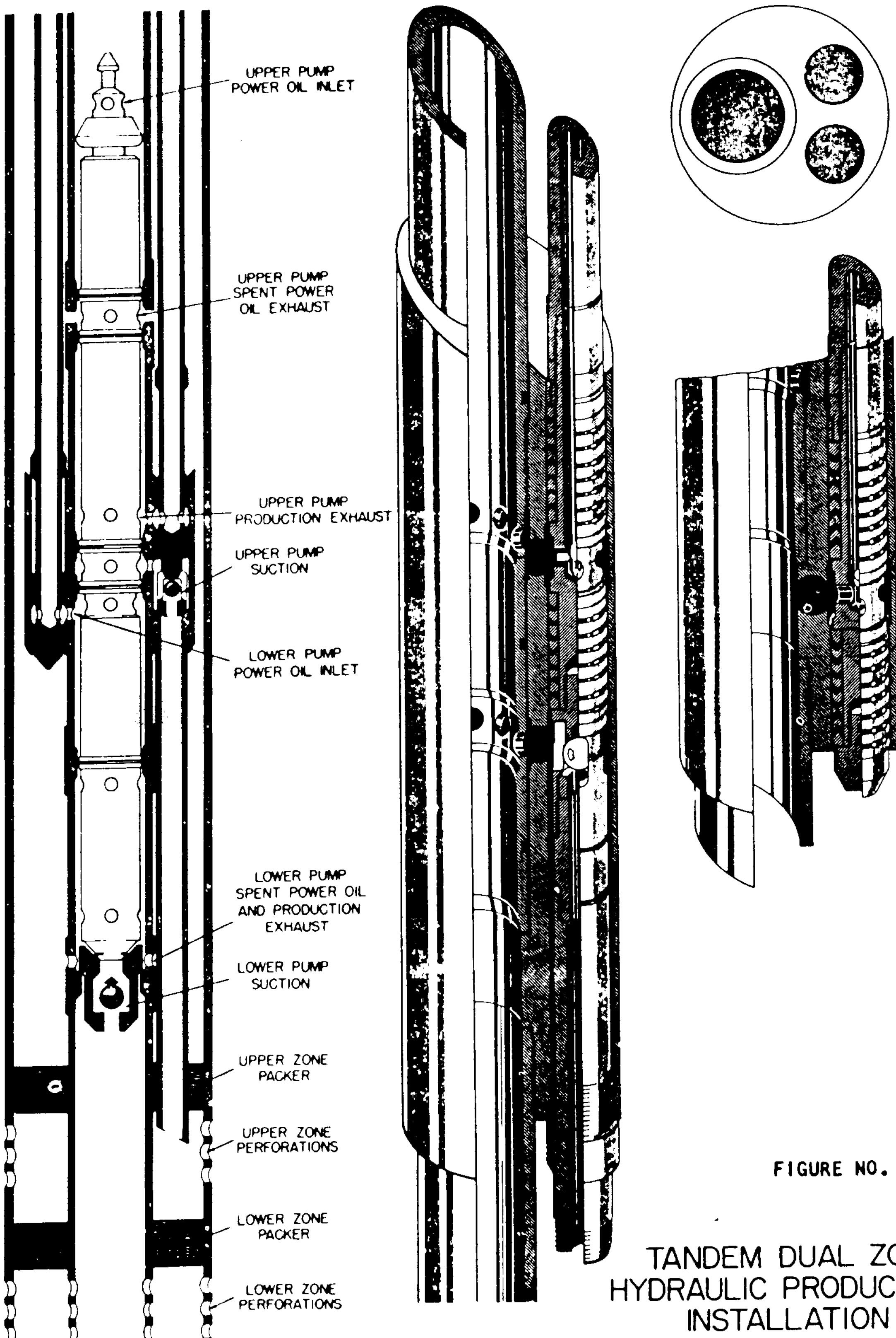

FIGURE NO. 2

TANDEM DUAL ZONE HYDRAULIC PRODUCTION INSTALLATION

$2\frac{3}{8}$" EUR X 1" FJ X 1" FJ IN $5\frac{1}{2}$" CASING man zone at about 8000 ft. The bottom hole assembly for the hydraulic pumps is immediately above this packer.

After the upper packer is set and the main string is landed, either of the one in. parallel tubing strings is run. The pressure balanced spear, which is run on the bottom of each one in. string, is equipped with a friction ring that requires two to three thousand lbs of pull to unseat. This indicates when the tubing has been landed in the landing head. When the second string reaches bottom, it is picked up about one joint length and hung off. The third string is run and seated. Then the second string is again picked up and landed in the landing head.

A standing valve for the lower zone pump is run in on a wireline and set in the standing valve shoe. The pumps are screwed together and lowered into the 2-3/8 in. OD tubing string through a four-way valve and then pumped onto seat by power oil down the main tubing string.

Power oil down the 2-3/8 in. OD tubing actuates the upper zone pump and the spent power oil is discharged through a closed power oil collar into the casing.

The upper pump takes suction through the one in. tubing installed from the upper packer to the pump cavity and discharges its production which is Fusselman oil through one of the one in. parallel tubing strings to the surface.

Power oil to operate the bottom pump reaches the pump through the other one in. tubing string. Spent power oil is discharged into the casing. Ellenburger oil is used to actuate both pumps; so, spent power oil from both pumps is commingled with the Ellenburger production in the casing and from there conducted to the surface.

The Ellenburger production enters the pump through the standing valve in the 2-3/8 in. OD tubing and is discharged by the pump into the casing above the top packer where it is conducted to the surface.

When it becomes necessary to pump the pumps out of the well for repair, this is done by reversing the four-way valve at the surface and pumping power oil down the casing. The pumps are latched by a catcher at the top of the 2-3/8 in. OD tubing.

The capacity of the upper pump is 286 bbl daily at 100 per cent efficiency. The power oil to production ratio is one to one. Capacity of the lower pump is 517 bbl daily at 100 per cent efficiency with a one to one power oil to production ratio.

Surface equipment consists of a 1500 bbl power oil tank, a 125 horsepower pump and a 115 horsepower single cylinder gas engine.

INVESTMENT AND PERFORMANCE

The rod pump systems cost an average of $50,000 per well. The three wells have lifted a total of 1,090,000 bbl of fluid in 236 well months with a maintenance cost of three cents per bbl of total fluid lifted. The average length of pump runs has been 13 months.

The hydraulic systems cost $65,000 for the first well and $30,000 for each additional well. Two wells cost $47,000 each and three wells cost $42,000 each. These four installations have lifted 670,000 bbl of total fluid in 142 well months with the maintenance cost averaging 4-1/2 cents per bbl of total fluid lifted. The average length of pump runs has been two months.

CONCLUSIONS

The free-type tandem dual hydraulic system installed on these two leases costs about $7,000 less per well than the dual tandem rod pumping systems when three wells are equipped. The hydraulic system will lift about 800 bbl daily at 100 per cent efficiency compared to 300 bbl daily for the rod pumps; however, the hydraulic system costs about 50 per cent more to maintain.

When considering which of these systems to install on a given lease it will first be necessary to determine what the maximum rate of fluid withdrawal will be. If it is such that either system can be used to deplete the wells, then it would be necessary to compare the initial costs and the current worth of the expected maintenance costs over the economic life of the wells in order to decide which system to use.