Double - Displacement Pump, Its Care And Maintenance

By John W. Wells
Harbison Fischer Manufacturing Co.
Fort Worth, Texas

There has long been felt the need for a rod insert pump which would fit in the interim from the point in the life of a well where conventional insert type pumps become incapable of handling increasing fluid in the well bore beyond the anticipated requirements of the original equipment. In numerous instances, either for economy or from miscalculation, equipment too small for final depletion of the resevoir is installed. This could be either in the well bore, surface equipment or both.

When the point is reached where either the tubing must be pulled and a working barrel or tubing pump installed to handle increased amounts of fluid, there was nothing available in a rod pump to fill this need until a short time ago. Numerous types of devices were experimented with, but nothing practical was developed until the Double-Displacement Pump was developed and proven. The principals involved in the design of the pump are newly patented.

Present conventional rod pumps consist of top hold-down types, bottom hold-down stationary barrel types and bottom hold-down traveling barrel type. All types include full bore and heavy-duty or liner types. In full bore inserts, strength is sacrificed to gain plunger diameter, making the full bore insert pumps impractical for deep wells. In heavy-duty or liner in-

serts, plunger diameter or volume is sacrificed for strength. In 2" tubing, the maximum bore obtainable in a rod insert type pump is generally 1-1/2". In 2-1/2" tubing, a 2" bore would be maximum and in 3" tubing, 2-1/2".

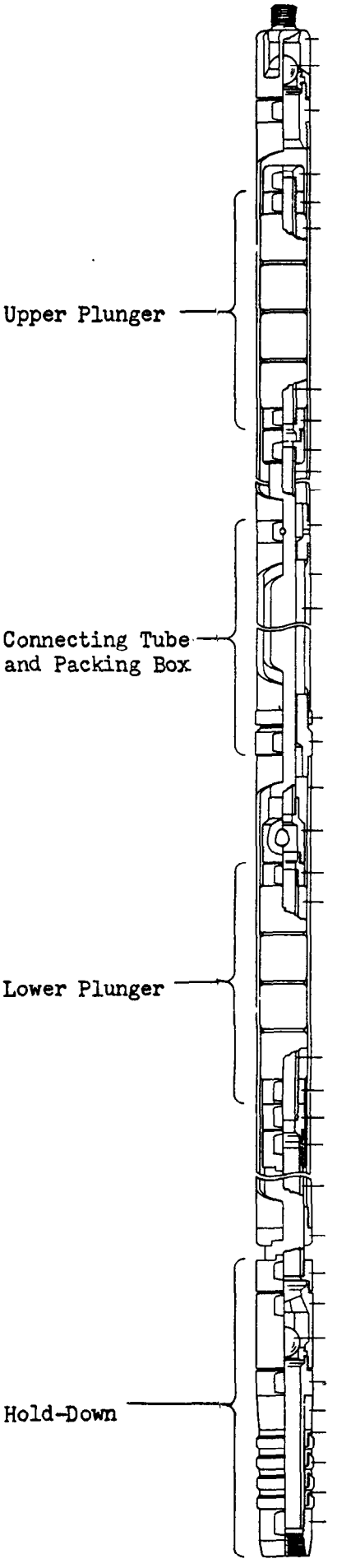
The insert pump is run on the rod string and is serviceable with a rod job. Its limitations being its disadvantages in that insert rod pumps are limited in plunger diameter, and for that reason, unable to produce volumes of fluid.

Tubing pumps available at present, consist of working barrels with conventional plungers and tubing liner or heavy-duty tubing pumps. Tubing pumps are run as an integral part of the tubing string and the plunger is then installed separately on the rod string. In 2" tubing, the largest bore available being 1-3/4" or 1-25/32", in 2-1/2" tubing, a maximum bore of 2-1/4" and on 3" tubing, a maximum bore of 2-3/4". The advantage of the tubing pump over the rod insert pump is because of increased plunger diameter, making it possible to handle increased volumes of fluid in order to obtain daily allowables. The disadvantages is in having to pull the tubing to service the pump when that becomes necessary. Depth of fluid and rod stretch immediately becomes a problem when pump bores are increased in order to handle greater volumes of fluid.

Often, with the increased plunger area of a tubing pump in conventional sizes, an operator finds that he is still unable to handle the necessary volume of fluid and it is possible to resort to an oversize tubing pump. By this, we mean it is possible to run a 2-1/4" bore tubing pump on 2" tubing or 2-3/4" bore on 2-1/2" tubing. The plunger, by necessity, is installed in the pump above ground with accomodations built into the standing valve and plunger to permit the use of an "on and off" device. The oversize tubing pump is then installed in the well on the tubing string with the plunger in the barrel. The rods are then installed separately, and upon reaching "bottom" by means of the "on and off" device attached to the plunger, spaced, and put in operation. Again the advantage being larger plunger diameter, hence handling larger volumes of fluid. The disadvantage being the increased pump cost and expensive tubing jobs to service the pump.

The Double-Displacement rod pump (Fig. 1) is a traveling barrel, bottom hold-down, insert type rod pump. The pump consists of two plungers and barrel tubes which work as a single unit with a single set of valves. The two chambers within the pump are sealed off by a packing box around the connecting plunger tube.

The effective plunger of each size Double-Displacement pump is greater than the largest tubing pump which can be used with any given size tubing. (The increased plunger area is possible because of the combined displacement of two plungers.) There are a number of operating advantages which make the installation of Double-Displacement pumps advantageous over tubing pumps or centrifugal pumps.



DOUBLE-DISPLACEMENT ROD PUMP

TRAVELING BARREL
BOTTOM HOLD-DOWN

1-1/2" Bore for 2" Tubing
(equivalent to 1-7/8" bore)

2" Bore for 2-1/2" Tubing
(equivalent to 2-9/16" bore)

2-1/2" Bore for 3" Tubing
(equivalent to 3-1/8" bore)

FIGURE 1

The Double-Displacement pump is recommended: (1) Where it is desired to lift a greater volume of fluid in order to increase the daily oil production, (2) Where it is desired to lift the same volume of fluid, but at a slower pumping rate. Foremost is the fact that Double - Displacement pumps afford all of the production advantages of tubing pumps and, in addition, afford all the operating advantages of a rod insert pump which can be run and serviced with a conventional rod job.

How to Install the Pump

Let us say for convenience's sake that you have in your well a conventional tubing pump, either a working barrel type with conventional cup or ring plunger, or a tubing liner pump. To install the Double - Displacement pump, pull the rods, if possible removing the pullable type standing valve, or if fluid is known to stand high in the casing and the standing valve is a stationary type, let it remain. Pick up the Double-Displacement pump with a 2' pony rod, supporting the pump in the middle until vertical in the air over the well head, run the pump on the rod string into the well and seat the pump as you would any conventional rod pump in the top of the working barrel or seating nipple, space and put in operation.

How the Pump Operates

On the upstroke, the standing valve opens, and both the upper chamber and the lower chamber fill with fluid. On the downstroke, the standing valve closes and the traveling valve opens, allowing the fluid in the upper chamber to pass into the oil column above the traveling valve. The fluid in the lower chamber is displaced by the downward movement of the packing box section and passes back through ports in the lower plunger connecting tube adapter into the connecting tube, and upward into the production column.

No pressure differential can occur in the space between the packing section and the upper plunger because of opening through which the fluid passes back and forth into the annulus between the pump and the tubing on each stroke. (This is not fluid actually being pumped, but fluid already pumped.) This further serves to minimize overtravel in the plungers and acts as a shock absorber during the downstroke of the pumping cycle.

Double - Displacement pumps operate most efficiently in shallow fields or in wells with high fluid levels. These pumps also reduce operating costs in some cases by making it possible to slow down old or worn-out pumping units. By operating a pump jack at a slower speed, its service life can be increased and maintenance costs can be reduced proportionately. Slower pumping speeds also mean longer rod life.

As in the application of all large plunger-area pumps, the advantages which can be gained by using Double-Displacement pumps necessarily depend upon minimizing stroke-loss due to rod and tubing stretch, and the limiting factors as to depth are determined by the size of the rods and the working fluid level of the well. This limitation is not set up by the designs of the pump, but rather by normal rod and tubing stretch. Usually, stroke-loss is excessive at fluid depths exceeding 4,000' and the benefit of the additional capacity of the Double- Displacement pump is not realized.

Examples of Dynamometer cards and tests data are given in Figures 2 and 3 to show a comparison between conoventional equipment and a Double-Displacement pump.

The Dynamometer cards shown for Well "A" indicate there was no change in the characteristic shape of the card. The increase in the area of the card after installation of the Double-Displacement pump represents more work is required to lift the well. This is an indication that more fluid is being produced.

Well "B" developed a casing leak which necessitated setting a packer. The insert type Double-Displacement pump was later installed to reduce maintenance costs required to service the 2-3/4" "on and off" pump with the packer installation, and the second example is to compare results, Dynamometer card and similar data after the Double-Displacement installation.

The Dynamometer card indicates an increase in load with the installation of the Double-Displacement pump but this was probably due to more weight being set on the packer when it was installed. Theoretically there should have been a decrease in load equal to approximately 10 percent of the total fluid load.

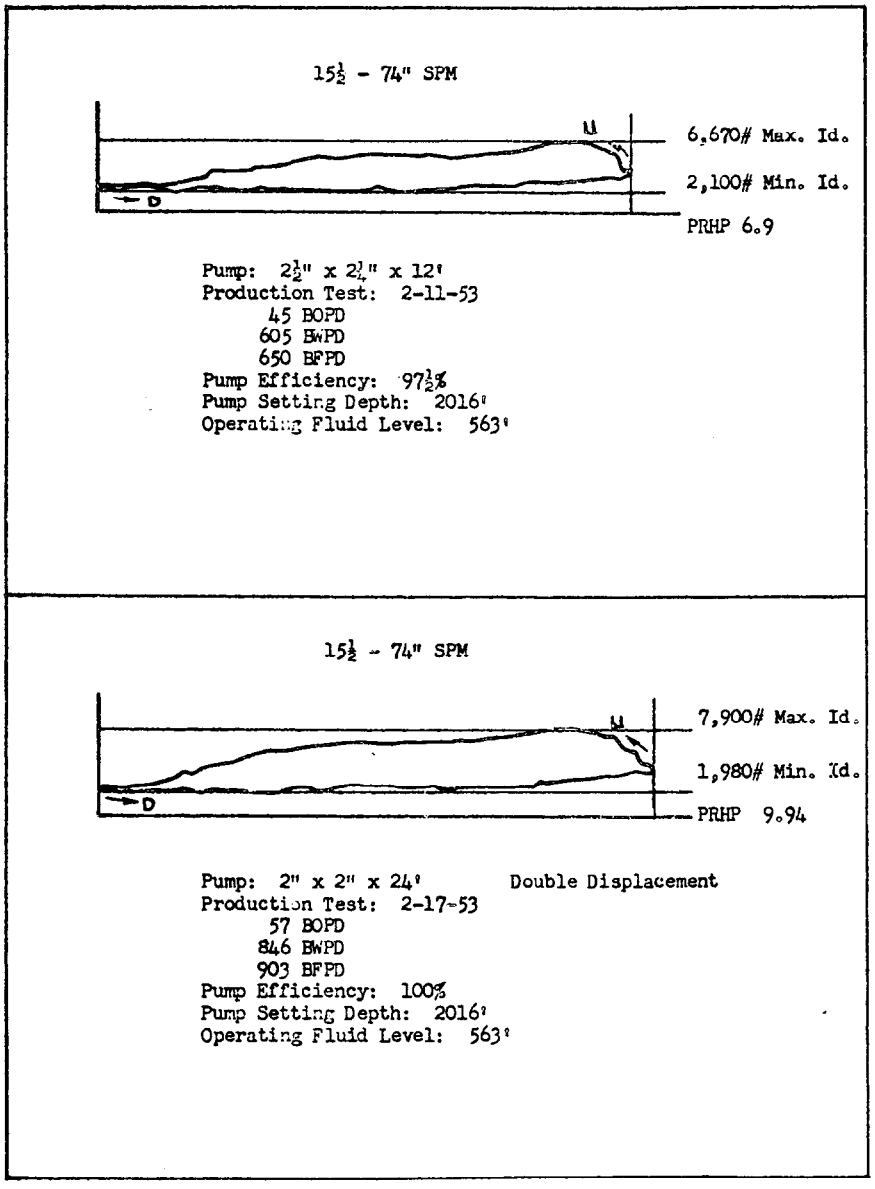


FIGURE 2

Constant for Comparing Theoretical Displacement

Tubing Size	Pump Bore	Connecting Tube Dia.	Type Pump	Constant "C"
2"	1-1/16"	———	Rod	.132
2"	1-1/4"	———	Rod	.182
2"	1-1/2"	———	Rod	.263
2"	1-1/2"	1" Base	D-D	.408
2½"	1-3/4"	———	Rod-Tbg.	.358
2"	1-25/32"	———	Tubing	.370
2½"	2"	———	Rod	.465
2½"	2"	1¼" (-.40)	D-D	.762
2½"	2¼"	———	Tubing	.590
3"	2½"	———	Rod	.732
3"	2½"	1½" (Base)	D-D	1.194
3"	2-3/4"	———	Tubing	.876
4"	3-1/4"	2¼" (-.40)	D-D	1.892
4"	3-3/4"	———	Tubing	1.640
5"	3-3/4"	2¼" (-.40)	D-D	2.71
5"	4-3/4"	———	Tubing	2.63

When considering a Double - Displacement pump, immediate attention

must be given to the rod string and horsepower requirements. If you increase the bore of any pump and lift greater volumes of fluid, there is no question but that greater loads are subjected to rods and prime mover. The same applies when installing a Double - Displacement pump. More fluid is going to be displaced, so horsepower and rod dimensions must be considered to meet the work required of them.

Rod and tubing stretch are greatly influenced by plunger areas and the height of the fluid lift. A pump can be located fairly deep in a well, but if the working fluid level stands high in the casing, the actual fluid lift may not be very great because the lift is measured from the fluid level in the casing to the surface, not from the pump depth.

It should also be remembered that the working fluid level of a well may be drawn down to a lower depth when the rate of fluid withdrawal is increased. Allowance should also be made when calculating pump efficiencies for added rod and tubing stretch if working fluid levels drop after a Double-Displacement pump is installed.

Pounding fluid with the Double-Displacement will lead to early failure, resulting in surface equipment damage, and sucker rod failure, as well as pump damage. The tubing could part or back off. Slowing the unit down to accommodate the rate of well bore flow will correct this trouble.

Gas locking in the Double-Displacement pump is possible, as in all pumps; however, generally when volumes of fluid are being handled, gas trouble is very slight.

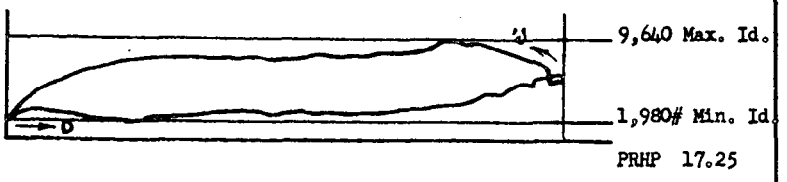
The Double-Displacement pump is very adaptable to water flood areas. The existing insert type pumps may be falling behind the flood rate or tubing sizes are nearing the change-out stage in order to keep up with the injection rate. The Double-Displacement pump can run at a slow rate of speed, then as the flood increases, the unit can be speeded up in strokes per minute to and beyond the rated capacity of a tubing pump.

Choosing The Pump for Your Particular Well Condition!

Plunger and barrel combinations are available for the Double-Displacement pump as in all other types of pumps. Generally, we find that an operator has established from experience the materials best suited for his particular well condition and we equip the pump with material of the same qualities, however, if corrosive resistant materials are necessary, they are also available in stainless steel, monel or bronze.

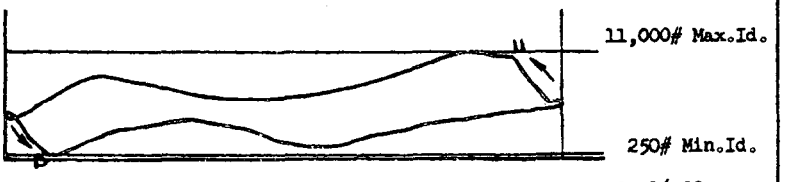
In discussing the care and maintenance of the Double-Displacement rod pump let us stress the fact that extreme caution must be used to support the pump while lifting to the vertical position over the well head. Caution must be taken in laying the pump down when pulling from a well. The pump, by design, is twice the length of the conventional pump. Any bending of the barrels on the packing box will mean definite failure. The maintenance would fall into the category of any insert pump. since the Double-Displacement is built of conventional parts.

20 - 74" SPM



Date: 12-23-52
Pump: 2 3/4" Plunger
Estimated Production:
1100 BFPD
Estimated Pump Efficiency: 86%
Pump Setting Depth: 2040'
Operating fluid level not available as this well is equipped with a packer to shut off a casing leak.

20 - 74" SPM



Pump: 2" x 2" x 24' Double Displacement
Production Test 3-26-53:
9.9 BOPD
1062.4 BWPD
1072.3 BFPD
Pump Efficiency: 91½%
Pump Setting Depth: 2020'
Operating fluid level not available as this well is equipped with a packer to shut off a casing leak.

FIGURE 3