Closed Power Oil Systems For Hydraulic Bottom Hole Pumps

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INTRODUCTION

In many cases it is difficult to appreciate the importance of the role power oil plays in the hydraulic pumping system. The control and operation of the system is such that it is often hard to realize that the turning of a valve can apportion quite large quantities of power to the bottom hole production unit. If the power oil transmitting this energy contains any abrasives, it is inevitable that they will be forced into the working parts of the hydraulic engine, causing wear and expense.

If power oil containing only one-tenth of one per cent of abrasives, such as sand or iron oxide, is used to operate a small hydraulic pump using, say, 100 barrels per day, over a period of only 10 days one barrel of the abrasives will have bassed through the working parts of the pump. Although hydraulic pumps are ruggedly constructed of the finest materials available, they will eventually succumb to this kind of attack.

In the majority of cases, economical treating facilities, treating chemicals and settling tanks can provide in the open power oil system reasonably clean power oil.

In some situations the present economical answer is to completely disregard power oil condition and use produced fluid at the well head for power fluid. This, of course, generally results in shorter pump runs, but with the Free Pump the economics may still be more favorable than investing in a Power Oil cleaning system, particularly for a short term pumping period. In other cases where it is difficult or costly to obtain a continuous and reasonably clean supply of power oil for a long term pumping period, the closed power oil system is a solution. The closed power oil system is a system that insures high quality power oil because it prevents the power oil from coming into contact with the production and therefore it eliminates the source of contamination. The closed system will always provide power oil "equal to" or "better than" the power oil of the open system and therefore contributes to lower maintenance and repair costs both to the bottom hole pumps and to the surface pumps.

Expense Reduced

Even in cases where reasonably clean power oil can be obtained with the open system, the closed power oil system offers advantages that are worth considering. For instance, paraffin removal expense would be considerably reduced in a parallel free pump installation where the power oil and production are co-mingled and conducted to the surface through a string of one inch tubing. If such an installation were converted to a closed system, the one inch tubing would conduct only the production to the surface which would be from one-half to one-fourth of the volume of the open or co-mingled system.

Since the power oil in the open system contains the same amount of paraffin as the production does, the paraffin removal costs in the one inch tubing should be reduced by one-half to one-fourth. The power oil part of the closed system would have an initial paraffin deposition but further paraffin deposits could only come from the power oil added to the system to offset the one to three per cent loss due to lubrication of the pump end of the production unit.

Accuracy

Another advantage of the closed system is in the accuracy of testing wells because only the power oil lubrication loss needs to be accounted for instead of the total amount of power oil circulated. The errors in power oil measurement are thus reduced in the closed system to one to three per cent to their value in the open system.

Fig. 1 illustrates a typical surface installation for a closed power oil system. As shown, the power oil make-up is provided automatically from the treating or storage facilities by a float and valve arrangement. The make-up oil could be provided manually by means of a valve or it could be provided by a tank truck. The latter two methods provide for a daily record to be kept of the power oil loss.

Although the drawing shows a single well installation, any number of wells may be operated by the surface pump, each with a separate power oil line from the central plant but with a common trunk line for the return to the power oil supply tank. The size of the power oil supply tank is governed by two factors: (1) If it is to be manually refilled, it should be of sufficient capacity to permit the refilling operation to be performed at convenient intervals, and (2) If it is to serve free pumps it should have a capacity of two or three times the volume of the well tubing to permit removing and re-installing a pump without having to refill.

Small Surface Pump

For single well installations it is usually better to have the surface pump and tank close to the well instead of close to the tank battery so that the power oil lines will be as short as possible. Power oil make-up for single well installations can also be handled automatically, manually, or by tank truck.

Even on multiple well leases there are certain operating advantages connected with the use of a small surface pump for each well instead of a large one for several

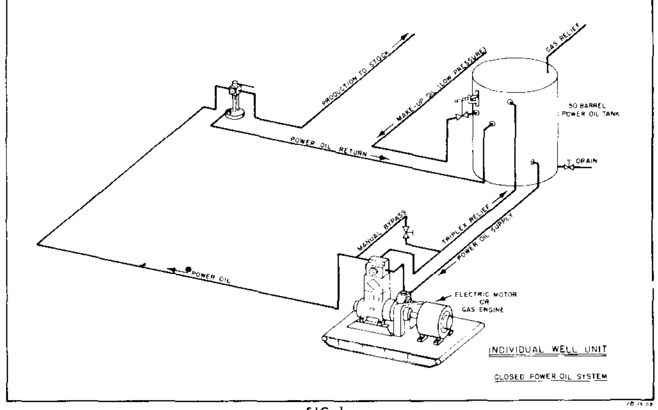
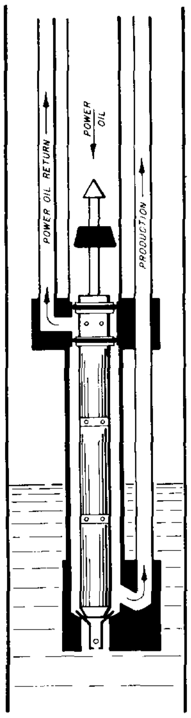
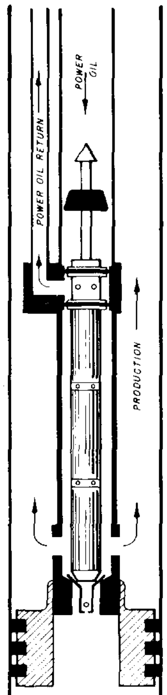


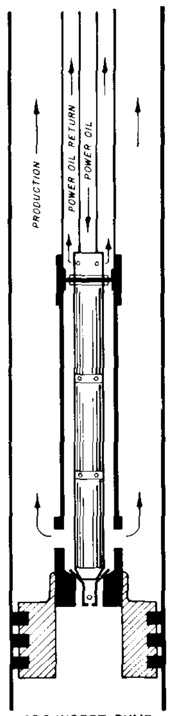
FIG. 1



CPO FREE PUMP
PARALLEL TUBING
FIG. 2



CPO FREE PUMP
CASING TYPE
FIG. 3



CPO INSERT PUMP
CASING TYPE
FIG. 4

wells. For multiple well leases using an individual surface pump at each well, a closed power oil installation such as Fig. 1 may be used; however, an alternate design would place the power oil supply tank at the tank battery.

In this case the individual surface pumps would not need individual charging pumps. The power oil return from the well would be connected directly to the surface pump suction and power oil make-up would be provided by a charging pump at the tank battery, supplying the proper charging pressure and make-up oil through a trunk line or through individual distribution lines connected to each pump's suction.

Fig. 2 shows the arrangement of the tubing in the well for a closed power oil parallel free pump installation. Power oil is shown conducted to the bottom hole pump through the large tubing and returning through one of the strings of smaller tubing. Production is through the second string of small tubing and the gas is vented through the casing. With 2-3/8 inch O. D. tubing inside of 5-1/2 inch casing the small strings can be either 3/4 inch or 1 inch tubing. With 2-7/8 inch O. D. tubing inside of 7 inch casing the small strings can be 3/4 inch, 1 inch or 1-1/4 inch tubing. Equipment is available to run the side strings either clamped together or separate and independent.

Fig. 3 shows the closed power oil casing type free pump. This differs from the parallel type free pump in that the production returns through the casing instead of a side string. This type of installation costs less than the parallel but has the disadvantage of forcing the gas through the pump. In the Permian Basin generally gas-oil ratios are low enough to make this type of installation the most popular. To surface the pump the power oil is directed down the casing in the casing type installation or down the small production string in the parallel type installation and up the large tubing string.

Fig. 4 shows the closed power oil casing type conventional insert pump. This type system would be applicable where a 2-1/2 inch pump is required inside of 5-1/2 inch casing, or where a casing type free pump using the open power oil system is to be converted to the closed power oil system without pulling tubing. Pulling the pump would require pulling the small power oil tubing. Obviously all of the gas would be forced through the pump.

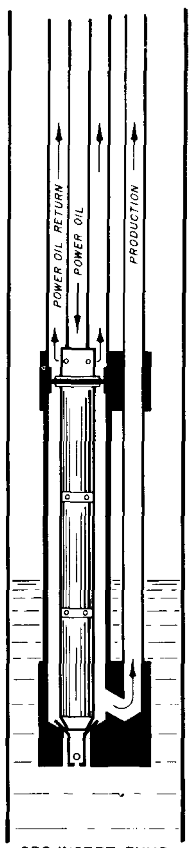
Fig. 5 shows the closed power oil parallel type conventional insert pump. Usually it can be worked out so that the small power oil string can be run parallel instead of concentric providing for a free pump instead of an insert pump, but this type of installation might have an application where a parallel free pump using the open power oil system is to be converted to the closed power oil system without pulling the tubing.

Figs. 6 and 7 show the closed power oil conventional casing type installation with the power oil strings run parallel and concentric respectively. The power oil strings can be pulled separately but both must be pulled to get the pump out. The conventional casing type installation is generally used where 4 inch pumps are required.

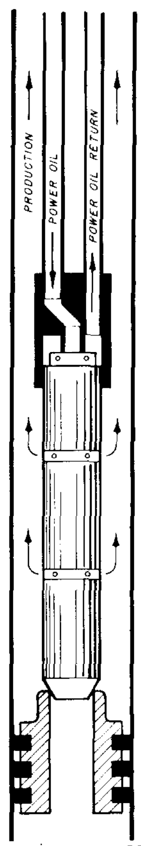
EXAMPLES OF ADVANTAGES

Conditions where the closed power oil system will most likely have an advantage over the open system are:

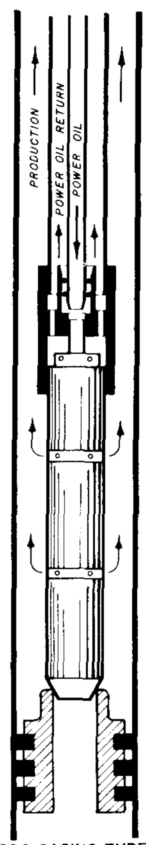
(1) Wells producing sand, especially very fine sand that is difficult to settle out. It should be pointed out here that many people consider hydraulic pumping to be superior to rod pumping for producing sand. This is because some hydraulic pumps lubricate the pump piston and rods with the clean power oil which, as it moves past the close fits, tends to keep sand washed ahead of the piston and out of the sliding clearances.



CPO INSERT PUMP
PARALLEL TUBING
FIG. 5



CPO CASING TYPE
CONVENTIONAL
PARALLEL TUBING
FIG. 6



CPO CASING TYPE
CONVENTIONAL
CONCENTRIC TUBING
FIG. 7

Another factor in favor of hydraulic pumping is that the production can be directed up a string of tubing of relatively small diameter which, because of the higher velocity, will tend to discourage the sand from settling out.

(2) Wells that produce high volumes of water. In the open power oil system the treating and settling facilities might become quite large because of the large amounts of power oil that must be continually re-treated and re-settled when producing large volumes of water. As already mentioned, the accuracy of testing is improved with the closed power oil system.

(3) Wells that produce a corrosive oil that continually produces iron oxide or iron sulfide on the inside of the power oil tubing. These products of corrosion will eventually find their way to the bottom hole pumps where they will cause severe damage to the moving parts.

The power oil can, of course, be inhibited by chemicals to prevent this corrosion, but sometimes the cost of the chemical to inhibit both the power oil and the production continually as against the cost of the chemical to inhibit only the production, or the cost of plastic coating the production tubing, makes the closed system attractive.

(4) Wells that produce oil that is difficult or costly to treat. Oils that fall into this class include those that contain dissolved salt which, if it comes out of solution, can score and even plug the bottom hole pump. Also included in this class can be the oil that contains an amount of gas that is insufficient to fire a heater.

(5) Wells that produce oil with an extremely low or high viscosity. With the extremely low viscosity friction losses would require added horsepower and with the extremely high viscosity, lubricating value of the oil is apt to be poor. With the closed power oil system, power oil may be selected which has good lubricity and viscosity.

(6) In congested areas where surface treating and settling space is non-existant, very costly, or considered unsightly. Town site wells fall into this category.

CONCLUSIONS

When comparing the open power oil system with the closed power oil system, the operating and maintenance costs should be considered as well as the initial investment costs. As a comparison of the initial costs, the closed system is lower than the open system by the difference in costs of the power oil tanks and treating systems (an open system might require a 750 barrel power oil tank whereas the closed system might require only a 50 or 100 barrel tank.), but is higher by the cost of the extra string of tubing. The operating and maintenance savings realized by the closed system are: longer pump runs, lower pump repair costs, lower surface pump maintenance costs, lower treating costs, and lower paraffin control costs — all of which contribute to a savings in operating personnel labor.