The Long Stroke Hydraulic Pumping Unit

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The history of the successful long stroke hydraulic pumping unit is, when compared to the oil industry, a relatively short one. Attempts to build an hydraulic pumping unit were made as early as 1932 but without too much success. In 1939, two of the present day long stroke hydraulic pumping units were first brought out on the market to be offered to the oil industry. Since 1945 two more manufacturers of long stroke hydraulic pumping units have presented their equipment to the oil fields.

You may ask yourself, why is the hydraulic long stroke pumping unit used and what is its application. (refer to figure 1). First of all, let us look at some of the problems found in pumping an oil well using a bottom hole pump which is actuated through sucker rods. Oftentimes the sucker rods part, this is frequently due to stress reversals within the sucker rod. That is, for example, on the upstroke the maximum load is imposed on the rod string and on the downstroke the minimum load is encountered. Repetition of this type loading causes failure of the rod string. To illustrate how the hydraulic unit tends to eliminate this type rod failure let us consider two pumping units, both having the same amount of surface travel. Using 740 inches of surface lifting travel as a basis for our comparison we find that a beam unit with a 74" stroke has to make 10 strokes per minute, while a 30' hydraulic unit has to make only 2.05 strokes per minute to obtain the same amount. (refer to figure 1). In other words, by reducing the number of cycles or stress reversals per minute imposed on the rod string the time necessary to cause fatigue in the sucker rod is greatly increased. A practical example of this can be seen when a piece of wire is bent back and forth until it is broken into. If it is bent back and forth rapidly it breaks in a short period of time, while if it is bent slowly it takes considerably longer to break.

Along the same line of thought the miximum polished rod load is reduced by reducing the number of strokes per minute. For example, assume we are considering the same 74-inch stroke beam as compared to the 360-inch stroke hydraulic unit, both having a 1 3/4" base bottom hole pump set at 8400 feet. At the same time we will consider the travel to be 740-inch for both units. Calculations show that the beam unit will have an acceleration factor of 1.104 while the hydraulic unit has an acceleration factor of 1.021. In both cases, the calculated load is the same: however, when the acceleration factor is applied the beam unit now has a peak polished rod load of 26,437 lbs. or 33,677 PSI stress, while the hydraulic unit has a peak polished rod load of 24,986 lbs., or 31,829 PSI stress. This reduced loading again tends to increase the life of the sucker rod.

Another problem encountered in pumping a well is the mechanical wear between the sucker rods, sucker rod couplings, and the tubing. While maintaining the same travel for each of the two units, it can be seen that although the loading may be the same on both units the mechanical wear on the hydraulic unit is distributed over a greater area than the beam unit. This type wear also occurs in the bottom hole pump. Here again the long stroke hydraulic tends to distribute the wear between bottom hole pump plunger and barrel over a greater area, which in turn tends to increase the life of the bottom hole pump.

Due to the loading and unloading of the sucker rods there is often a twisting movement set up in the rod string which, when the sucker rod couplings are not properly made up, allows the pins and couplings to unscrew. This is particularly true in the

LESS STROKE LOSS DUE TO ROD STRETCH

It's The Effective Stroke That Counts

The table and sucker rod stretch diagram below illustrate how the Hydraulic Long Stroke can more than double production through minimizing the effect of rod stretch.

PRODUCTION CALCULATIONS

SHORT STROKE VS PELTON LONG STROKE

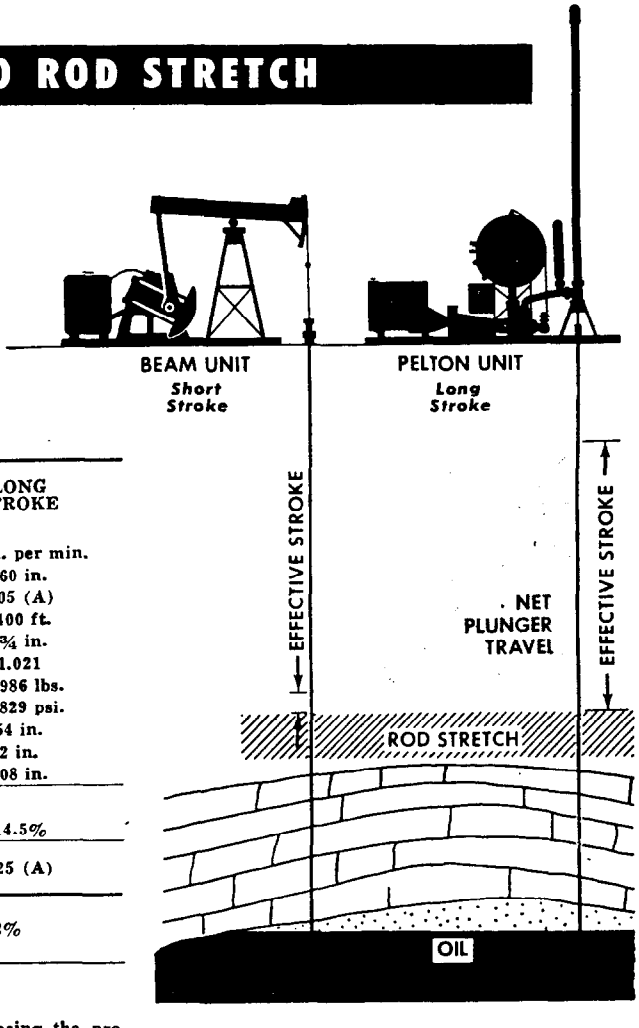
Equal Polished Rod Travel

	SHORT STROKE	LONG STROKE
Upward Polished Rod Travel	740 in. per min.	740 in. per min.
Surface Stroke Length	74 in.	360 in.
Strokes per Minute	10	2.05 (A)
Pump Setting	8400 ft.	8400 ft.
Bottom Hole Pump Plunger Diameter	1¾ in.	1¾ in.
Acceleration Factor (Mills Formula)	1.104	1.021
Peak Polished Rod Load	26,437 lbs.	24,986 lbs.
Maximum Stress in Top Sucker Rod	33,677 psi.	31,829 psi.
Sucker Rod Stretch	54 in.	54 in.
Bottom Hole Pump Plunger Overtravel	10 in.	2 in.
Net Bottom Hole Pump Plunger Travel	30 in.	308 in.
Per Cent Surface Stroke LOST through Sucker Rod Stretch after Correction for Overtravel	59.5%	14.5%
Production in Barrels per Day at 100% Bottom Hole Pump Volumetric Efficiency	107	225 (A)

*Increased production due to the long surface stroke equals $\frac{225}{107} \times 100 = 210.2\%$

Above calculations based on using a tapered 1", ⅞" and ¾" Sucker Rod String, 10° API gravity fluid, fluid level at the Pump.

NOTE (A) The 360" stroke Hydraulic Unit may be operated at 5:9 SPM increasing the production to 680 B/D if required, while maintaining satisfactory sucker rod stresses.



case of the beam unit where the polished rod is not allowed to turn, since it is held in place by the weight imposed on the bridle. In the case of a hydraulic unit, however, the polished rod is free to turn since the piston in the main operating cylinder is actually floating on a column of oil. Therefore, if any twisting action is encountered in the rod string the polished rod is free to turn.

Aside from the mechanical advantages that the hydraulic unit has with respect to the well itself, it can be seen on the diagram that the effective stroke of the hydraulic unit is considerably greater than that of the beam, percentage wise, since 59.5 percent of the surface stroke on the beam unit is lost due to stretch; whereas, on the hydraulic unit, only 14 1/2 percent of its stroke is lost due to stretch.

Reducing this to production, you can see that even though the surface travel in both cases is the same, the total production of the hydraulic unit is more than twice that of the beam unit.

You as operators, though, are equally as interested in the actual surface maintenance problems of the equipment. The maintenance of the hydraulic unit is slightly more than that of the beam unit. However, it can be compared to the maintenance of a standard car shift to that of an automatic shift. In both cases the equipment that offers more advantages has some additional maintenance requirements.

Some tips which will keep your hydraulic pumping unit operating smoothly are:

1. Be certain the balance tank oil level is at the correct operating level.

2. Be certain the operating oil is kept clean. This is done by being certain that foreign material is not allowed to enter through make-up oil—polished rod packing is in good condition and that the filters are changed at regular intervals, as recommended by the manufacturer.

3. Be certain the air pressure in the balance tank is at its required amount.

4. Be certain that the drive—that is, V-belts—are at their correct tension. In many cases V-belts which are too loose jump the grooves and are ruined; while V-belts, which are too tight cause drive bearings and engine clutch bearings to heat excessively.

Care of the hydraulic oil cannot be overstressed. The best way to be certain the oil is kept in good shape is to be certain the filters are changed regularly. Usually, it is recommended that the filters be changed at least three times a year. However, here again if the polished rod packing is not kept in good condition the filter can not be expected to remove all the foreign material which might enter the system.

Along with the problem of keeping foreign material out of the system, poorly maintained polished rod packing can also cause other problems, such as the loss of system oil. This in turn creates a daily problem for the pumper in that he is continually having to add oil to the system. Aside from the fact that it increases the operating cost for make-up oil.

The two maintenance checks which will insure better operation of the hydraulic unit are:

1. Proper oil level.
2. Proper air pressure.

It is believed that due to the fact that the quest for oil is getting deeper daily, the need for hydraulic units will increase. This belief has almost been proven by the fact that additional manufacturers are, even at present, testing new designs and the early manufacturers are continually improving their equipment. Recently, one hydraulic pumping unit manufacturer built an entirely skid mounted unit for a customer so portable that even the cylinder could be layed back over the skid when they moved it. In this case the entire unit can be moved to a new location without dismantling the unit whatsoever. The physical size of the unit is such that no special road permits are required, nor is any special handling equipment necessary to load or unload the unit. At the same time the customer has a 20' surface stroke unit with which to test their wells.

Manufacturers of long stroke hydraulic pumping equipment are continually looking for new ways to improve their equipment. You, the customer and operator, are in the best position to make those suggestions. Between the combination of the two, it is felt, will result hydraulic long stroke pump units which in the future result equipment which requires little or no weekly or monthly maintenance as has been proven by such people as electric motor manufacturers who now supply motors which require only yearly checks.