Hydraulic Bottom Hole Pumps – Lease Operating Procedures

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INTRODUCTION

This discussion is primarily concerned with the operating control of the bottom hole pump of the hydraulic pumping system. Design and engineering calculations are purposely omitted, as well as any discussion concerning operation and maintenance of the surface power pump. In short, the purpose of this discussion is to suggest procedures for operating hydraulic bottom hole pumps and to show that with hydraulic pumping, the operator has an exceptionally fine tool for defining well problems.

OPERATING

To understand the principles of the hydraulic bottom hole pump and how to operate it, it sometimes helps to compare it with the hydraulic long stroke rod type of pumping system. The hydraulic long stroke unit consists of a piston at the surface which raises and lowers the sucker rod string when power oil under pressure is applied to the piston. This piston and its operating pressure have to be large enough to lift the fluid plus the several tons of sucker rods. The hydraulic bottom hole pump is similar. To eliminate the sucker rods, however, the piston is made small enough to be installed in the tubing and is connected directly to the pump. The hydraulic production unit, commonly called the hydraulic bottom hole pump, is composed of an engine piston, which is driven up and down by power oil under pressure, and a pump piston directly connected to this engine piston.

Since the engine piston of a hydraulic bottom hole pump has to lift only the fluid and not several tons of sucker rods, the pressure required is directly proportional to the height of the fluid level in the well bore. In other words, the operating pressure at the surface is an indication of the fluid level in the well. This feature (unique with the hydraulic pumping system) provides for a continuous recording of well condition. The operating pressure also reflects fluid friction and pump friction, which can be determined fairly effectively by closing the valve on the power oil line to the well and watching the pressure decline as the pump slows down. For all practical purposes, the fluid friction and pump friction will be zero when the pump stops stroking. Changes in well conditions or in friction values, therefore, become readily apparent by changes in operating pressure.

Speed Control

The factor that controls production is pump speed; therefore, speed control should be the primary function of the pumper. He should operate the pump fast enough to make the desired amount of fluid, but no faster. Excessive speeds either produce more than the desired amount of fluid or, as in the case of a "pumped off" well, cause shock loadings that lead to short pump life. The proper speed can be determined by consulting tables furnished by the pump manufacturer which give, for each size pump, the barrels of production per day for each stroke per minute. For example, if the B/D per S.P.M. is 2, then 50 S.P.M. should produce 100 B/D at 100% efficiency. The strokes per minute are indicated on the pressure gauge by small rises in pressure each time the pistons of the pump reach their top or bottom positions. Therefore, counting and controlling strokes (pump speed) is an important ability of the pumper operating a hydraulic pumping system. As previously mentioned, the operating pressure is a measure of fluid level and friction, and as such is a poor measure of pump speed.

The pressure fluctuations that occur at the end of each half stroke of the pump are caused by the shifting of the engine valve of the production unit. As the engine valve shifts position the flow of power oil is momentarily blocked, causing a pressure rise that is reflected on the pressure gauge at the surface. If the pressure fluctuations (strokes) are difficult to detect on the pressure gauge, it is probably the result of one of two factors. Either a paraffin accumulation in the lines is "damping out" the strokes or the pump is handling a gassy fluid which causes it to stroke erratically.

If paraffin is the cause, removing it by running soluble plugs in the lines will cause the strokes to show up clearly on the gauge. If a gassy fluid is the cause, an alternate method of speed control becomes necessary. In this case, the solution is to control the barrels per day of power oil input instead of controlling the strokes per minute. To do this, the power oil must go through a meter and the proper meter volume be controlled. Another method of controlling the power oil input is by the use of a constant flow control valve, which will maintain a constant rate of flow of power oil regardless of pressure changes in the system.

Preventive Maintenance

In addition to speed control, two routine preventive maintenance duties should be performed regularly. These are the running of soluble plugs to keep paraffin from building up in the lines, and keeping the bottoms bled off of the power oil tank. These should be preventive rather than curative measures. If soluble plugs are run after excessive paraffin has been allowed to build up, they may cause a complete plugging of the lines. How frequently these duties are performed should be determined by the pumper, since conditions

will vary considerably from field to field.

Remembering that this discussion is not concerned with the surface triplex pump, the operation of the hydraulic bottom hole pump boils down to three functions:

(1) Speed control
(2) Paraffin control
(3) Power oil control

DEFINING WELL PROBLEMS

The more operating information available when well problems are encountered, the easier it is to determine the causes of the problems. With a hydraulic pumping system, there are only four variables or quantities to be measured. They are:

(1) Pump speed
(2) Operating pressure
(3) Barrels per day of power oil
(4) Barrels per day of production

In this discussion of well problems we will assume that the pump has been operating for a sufficient length of time to stabilize operating conditions. Increasing or decreasing values, of pressure for instance, will not necessarily indicate a well problem if the pump has only been running a day or so.

Knowing all of the above four quantities allows one to narrow down the causes of a given well problem to a relative few. For instance, if production drops, it is necessary to know if the pump speed has decreased. If pump speed has not decreased or if it is sufficient, then the operating pressure may tell the story. If the operating pressure decreases, it indicates that the fluid level is rising. If the fluid level is rising while pump speed is remaining constant, it indicates that something is beginning to fail. Either the pump is losing efficiency or the tubing is developing a leak. If the operating pressure increases to or continues at "pump off" pressure, then declining production is due to either plugging of the pump intake or to declining well capacity. This will also be indicated by a "down kicking" stroke instead of an "up kicking" stroke. Since paraffin accumulation increases the operating pressure, soluble plugs should always be run before an analysis of the problem is attempted.

The following guide is offered as an aid to diagnosing problems.

DEFINING WELL PROBLEMS WITH HYDRAULIC PUMPING SYSTEMS

INDICATIONS	CAUSE	REMEDY
1. Increase in operating pressure - Pump stroking.	1. (a) Lowered fluid level	1.
	(b) Paraffin build up	(b) Run soluble plugs
	(c) Pump beginning to fail -- (scoring of parts)	(c) Replace pump
	(d) Pumping heavy material, such as mud	(d) Keep pump stroking, i.e. do not shut down unless absolutely necessary
2. Increase in operating pressure - Pump not stroking.	2. (a) Causes same as in #1 (pump not stroking because maximum pressure setting of the system has been reached)	2. (a) Remedy as in #1 or increase pressure available by increasing speed of triplex or by adjusting by-pass valve
	(b) Pump stuck	(b) Replace pump and check power oil and power oil lines for foreign material
3. Decrease in operating pressure - Pump stroking.	3. (a) Rising fluid level	3.
	(b) Tubing leak causing fluid level to rise	(b) Pull tubing to remove leak
	(c) Pump failure (worn throughout or ball and seat failure)	(c) Replace pump
	(d) Pump speed reduced	(d) Increase pump speed
4. Decrease in operating pressure - Pump not stroking.	4. (a) Leak in power oil string	4. (a) Pull tubing to remove leak
	(b) Pump not on seat (free pump only)	(b) Circulate pump back on seat
	(c) Pump failure (split engine liner)	(c) Replace pump

DEFINING WELL PROBLEMS WITH HYDRAULIC PUMPING CONDITIONS (con't.)

INDICATIONS	CAUSE	REMEDY
5. Pump taking too much power oil for the number of strokes per minute.	5. (a) Worn pump	5. (a) Replace pump
	(b) Tubing leak (power oil string)	(b) Pull tubing to remove leak
6. Production low for the number of strokes per minute.	6. (a) Well pumped off, i.e. pump running too fast	6. (a) Decrease pump speed
	(b) Worn pump	(b) Replace pump
	(c) Tubing leak (production string)	(c) Pull tubing to remove leak
	(d) Pump failure (balls and seats)	(d) Replace pump
	(e) Pump handling free gas	
7. Stroke "down kicking" instead of "up kicking".	7. (a) Well pumped off, i.e. pump running too fast	7. (a) Decrease pump speed
	(b) Pump intake plugged	(b) Surface pump and clean out
	(c) Pump failure (balls and seats)	(c) Replace pump
	(d) Pump handling free gas	