A Power Oil Settling System for Hydraulic Bottom Hole Pumps

By P. M. WILSON
Kobe, Inc.
Midland, Texas

The purpose of this paper is to present specific recommendations for an adequate power oil settling system which will furnish clean power oil for hydraulic bottom hole pumping installations. The design herein given represents the consensus of operating personnel and service personnel and is judged to be a very practical answer when considering adequacy and cost.

As a background it should be pointed out the importance of the role power oil plays in the hydraulic pumping system. The power to operate a hydraulic bottom hole pump is transmitted to that pump at the bottom of the hole by this power oil from the surface which is under pressure. Should the power oil contain abrasives, it is inevitable that they will be put to the work of scoring the hydraulic engine while it is converting fluid power to the work of pumping the well. It is obvious that an engine that will put out 14 horsepower while inside of 2-in. tubing or 100 horsepower while inside of 4-in. tubing must of necessity be a precision piece of equipment. To operate such a piece of equipment on abrasive laden power oil for extended periods is obviously false economy.

In the design of a power oil settling system it is first assumed that the oil entering the system does not contain free water. In other words, it is necessary, if there is water produced with tne oil, to have a heater-treater or washtank upstream of the settling tank to remove all free water. (It should be pointed out here that the treating system should be designed to handle all of the lease production plus the volume of power oil being used.) The power oil settling tank thus becomes an instrument for settling out basic sediment and abrasives, and not a treating tank. To accomplish its purpose a settling system should provide for the automatic continuous operation of the following functions:

(1) It should separate all of the gas that is still with the oil, after the oil has passed through the separrator and treating system, to prevent gas from bubbling through the settling section causing a rolling of the tank or causing local currents or eddies which might carry solid particles upward.

(2) It should be of such size that the flow rate through the settling section will be slow enough to permit the settling out of basic sediment and abrasives.

(3) It should provide for the automatic disposal of the particles (including paraffin) that are settled out so that high bottoms are eliminated and high concentrations of solid particles are not allowed to build up in the settling section.

As to specific recommendations for accomplishing the above ends, a 750 barrel tank designed as follows is adequate where power oil requirements are from 300 barrels per day to 1200 barrels per day - 90 percent of the installations in West Texas fall in this range.

(1) Gas Boot - This is customarily an outside boot instead of an inside boot or flume because severe corrosion often exists at the fluid level inside of the tank and frequently results in holes being "eaten" through the inside boot causing the oil to enter the settling section at the top instead of at the bottom. The boot is normally constructed of standard 20-in. diameter sections up to the height of the tank which is 24 feet, but the section that extends above the tank height and provides for the separation of the gas from the oil should have a 36-in. diameter and should extend for 8 feet above the tank. The oil and gas should enter this 8 foot by 36 inch section at the mid-point, i.e. 4 feet above the tank height.

The boot should be vented into the common vent system but should be plumbed or manifolded in such a way as to prevent contamination of the power oil in the settling section in case of boot pull-over due to treating plant failures, plugged line, etc. This is easiest accomplished by providing the settling tank vent with a riser or loop where it connects into the common vent system.

The oil line connecting the boot to the settling tank should be one foot above the bottom of the tank, should extend to the center of the tank, and should be at least 4 inches in diameter to prevent plugging and to provide relatively frictionless flow of the large volumes of power oil and production that enter through this line remembering that this flow is created by the hydrostatic head of fluid in the boot and has no pressure assist. In addition, if this line is provided with a valve, it should be a full opening valve.

The above design will provide for a continuous gas free supply of oil entering into the settling section.

(2) Settling Tank - For volumes up to 1200 barrels per day the settling tank should be 24 feet high and approximately 15 feet in diameter, i.e. a 750 barrel tank. A tank of this size will permit basic sediment and abrasives to settle out if the upward velocity or flow rate in the settling section is uniform and does not exceed 1200 barrels per day and further, if the whole tank is utilized, i.e. if an adequate spreader is provided.

(3) Spreader - The spreader should be a minimum of 8 feet in diameter to adequately utilize the 15 foot diameter tank and should have a serrated or perforated skirt. This spreader should be 2 feet above the bottom of the tank and should be level. If it is not installed level it will "dump" the oil from the high point causing a channeling through the tank. The 4 inch line from the boot should end with a tee installed vertically bull-headed directly under this spreader.

(4) Stock Draw-Off - The stock draw-off line should be 4 inches in diameter to prevent plugging with paraffin and should be approximately 12 feet from the bottom of the tank. This height is sufficient to eliminate channeling from the spreader and at the same time provide for enough space above for adequate settling of the power oil. Above this stock draw-off point the flow rate is only that used for power oil. The particles settled out of this power oil either fall to the bottom of the tank or are carried, in suspension with the oil, to the stock tanks by the stock draw-off. Therefore, high concentrations of sediment and abrasives are prevented from building up in the tank by this continual purging effect of the stock draw-off. To control the fluid level in the settling tank it is necessary for this 4 inch stock draw-off to rise from the 12 foot point to the height of the desired fluid level in the tank. This point is usually 18 inches from the top of the tank. From this high point the line is

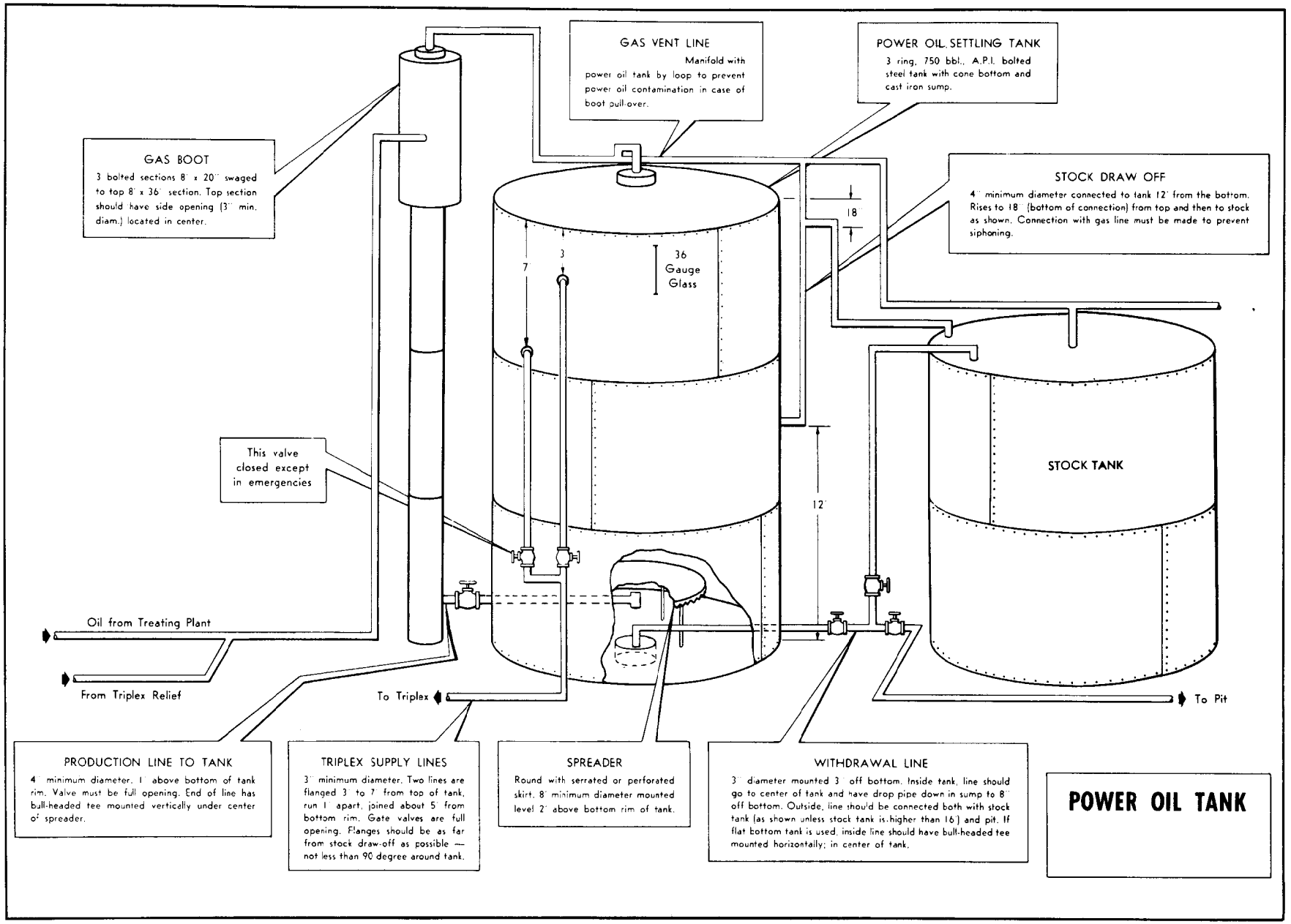
GAS VENT LINE
Manifold with power oil tank by loop to prevent power oil contamination in case of boot pull-over.
POWER OIL SETTLING TANK
3 ring, 750 bbl., A.P.I. bolted steel tank with cone bottom and cast iron sump.
GAS BOOT
3 bolted sections 8" x 20" swaged to top 8" x 36" section. Top section should have side opening (3" min. diam.) located in center.
STOCK DRAW OFF
4" minimum diameter connected to tank 12" from the bottom. Rises to 18" (bottom of connection) from top and then to stock as shown. Connection with gas line must be made to prevent siphoning.
18
7
3
36
Gauge
Glass
This valve closed except in emergencies
12"
STOCK TANK
Oil from Treating Plant
From Triplex Relief
To Triplex
To Pit
PRODUCTION LINE TO TANK
4" minimum diameter, 1" above bottom of tank rim. Valve must be full opening. End of line has bull-headed tee mounted vertically under center of spreader.
TRIPLEX SUPPLY LINES
3" minimum diameter. Two lines are flanged 3" to 7" from top of tank, run 1" apart, joined about 5" from bottom rim. Gate valves are full opening. Flanges should be as far from stock draw-off as possible — not less than 90 degree around tank.
SPREADER
Round with serrated or perforated skirt. 8" minimum diameter mounted level 2" above bottom rim of tank.
WITHDRAWAL LINE
3" diameter mounted 3" off bottom. Inside tank, line should go to center of tank and have drop pipe down in sump to 8" off bottom. Outside, line should be connected both with stock tank (as shown unless stock tank is higher than 16') and pit. If flat bottom tank is used, inside line should have bull-headed tee mounted horizontally; in center of tank.
POWER OIL TANK

Figure 1

connected to the stock manifold. To prevent siphoning this line should also be manifolded with the gas vent line.

It should be pointed out here that the stock draw-off line should not drop from this high point to the ground and thence to the top of the stock tanks, as this procedure provides for a trap in which to collect sediment and water. After a period of time such a trap will collect enough water to cause a water leg in the riser to the stock tanks. To push such a water leg into the stock tanks could very well cause the settling tank to run over.

(5) Drain Line - To remove water and particles not purged by the stock draw-off a drain should be provided 3 inches above the bottom rim of the tank. This line should be 3 inches in diameter and should extend to the center of the tank. For flat bottom tanks the end of this line should be provided with a tee installed horizontally bull-headed. For a cone bottomed tank, which is much preferred, this line should have an ell and a drop-pipe extending down to within 8 inches of the sump bottom. This line can be manifolded to the pit and also to stock to permit the withdrawal of water to the pit or oil to stock. Water should never be allowed to build up above the line from the boot, i.e. one foot.

(6) Power Oil Supply Lines - The power oil supply lines furnish the clean power oil from the top of the settling section. Two outlets should be installed - one 3 feet from the top of the tank (18 inches below the fluid level) and the other 7 feet from the top of the tank. This lower outlet is for emergency use when the level in the tank drops below the upper outlet, such as when filling the tubing strings. At all other times it should be kept closed. These two outlets should be as nearly diametrically opposed on the tank perimeter to the stock draw-off outlet as practicable. They should also be spotted at approximately a one foot interval apart on the tank perimeter to enable them to be manifolded together near the ground level. They should be at least 3 inches in diameter to permit full flow of power oil to the surface triplex pump and should contain full opening valves at an easily accessable height.

(7) Sight Glass - A sight glass should be provided near the top of the tank so that a periodic check may be made of the fluid level. In addition, pet cocks should be provided in the bottom 2 or 3 feet of the tank for checks on B S & W.

The above described settling system is adequate for up to 1200 barrels per day of power oil plus all the resultant production, in almost all applications. Exceptions are very heavy crudes, very gassey crudes, or crudes laden with very fine sand. These exceptions will require modifications, such as larger settling tanks or larger boots. For West Texas generally, or even universally, this design has been tested and proven in hundreds of installations.

On single well leases or small volume leases (power oil requirements of 300 barrels per day or less) a 300 barrel tank has been found sufficient with a 6 foot diameter spreader and a 24 inch x 8 foot top section on the boot. Where the volumes of power oil are in excess of 1200 barrels per day a choice of two 750 barrel tanks or one 1500 barrel tank is possible.

The settling system herein described is not capable of handling problems of salt water, emulsions, or salt dissolved in the oil. These problems are considered as treating problems and should be handled upstream of the settling system.

That the above design is more than adequate in a few cases is recognized, but there are so many "ifs" involved in the deisgn of an adequate settling tank that any modifications invite trouble. The cost of the settling system is charged against the hydraulic pumping system because it is not required unless hydraulic bottom hole pumps are installed. Since the pumping system and settling system represent a sizable investment, modification to the settling tank that could only save a few dollars are hardly worth the risk of the damage that might result to the bottom hole pumps.