Operation, Care and Maintenance Of Beam Pumping Units

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Introduction

The operation and maintenance of equipment on pumping wells has always been considered the function of the field man in the oil business. Primarily this has been true because of the fact that the field man, through his training and experience, has handled the equipment and learned the techniques and procedures suitable for the pumping of individual wells under the varying conditions that are encountered.

The operation, care, and maintenance of the surface equipment, particularly the pumping unit, is what we would like to discuss here.

Installations of Pumping Units

Most pumping units are mounted on skids or main bases and are somewhat self-contained. However, a good concrete block is the best possible foundation. With the advent of the floor clearing models of pumping units, which afford a low setting installation, there is a tendency to cut down on the amount of concrete to be used in the mat or slab. It is true that in most cases the floor clearing unit is installed to get away from a large amount of concrete. However, the supporting slab or mat should be at least 8" thick reinforced concrete with the bearing load on the soil not to exceed 500 lbs. per square foot. This will vary with the condition of the soil. A mix of 1:2:4 (one sack of cement, two cubic feet of sand, and four cubic feet of gravel) is recommended. The foundation should be level and flat and accurately aligned with the well. The unit, to perform properly, must be carefully leveled and aligned to the well. A plumb bob, allowing for half the bridle wire line is commonly used to align the horsehead. The pitmans should be checked with a level to make sure that they are vertical with center line of unit. As additional precaution the gear reducer and Samson post should be checked with a level. Although the tendency is away from grouting, manufacturers still recommend this method of mounting units for maximum performance. Experience has shown that the short cut method in preparing unit foundations is costly. Many field failures on pumping units and high maintenance costs have been traced to poorly and inadaquately prepared foundations.

Installation of Engine and Adjustment of Belts

Most manufactures offer adjustable prime mover mountings to facilitate the alignment and adjustment of the V-belt drive. With the use of a string or straight edge the alignment and parallelism of the two sheaves should be checked to assure proper belt life.

During the initial installation of belts, adequate slack should be provided between the prime mover and reducer as rolling or prying of the belts will cause damage. The belts should be properly adjusted. Belts tighter than necessary will cause premature failure of bearings. Belts that are too loose will cause slippage. Both of these conditions will naturally shorten the belt life.

During the initial adjustment, the belt tension can be checked by striking the belts with the hand. If too much slack exists, the belts will feel "dead." If the belt tension is correct, the belts will have a "live springy vibration." The belts must never be "fiddle string" tight.

Properly adjusted belts when running will be slightly loose on the unloaded side of the drive.

After the proper belt adjustment has been accomplished, the prime mover should be securely bolted to the foundation rails.

Installation and Removal of Wrist Pins

Most manufacturers employ a tapered pin and hole arrangement for wrist pin connection to the unit crank. It is first necessary to assure proper tightness of pins, to clean both pin and pin holes thoroughly before assembling. A number of manufacturers furnish an instruction plate on the crank which gives proper instructions for assembly of the wrist pins.

The wrist pin is considered the "crank" of the pumping unit. This is the point at which rotary motion is converted to reciprocal motion. Because of the function of the wrist pins in this respect, proper installation and maintenance at this point is extremely important.

A few manufacturers, at this time, are offering hydraulically removable wrist pins, which greatly facilitates changing strokes. Some units are furnished with a locking nut arrangement for securing the wrist pin in the crank, while others use cotter pin and castalated nut method. Whichever the method employed, the wrist pin must be made up and kept tight. Inspection for tightness should be done regularly.

There are two types of wrist pin bearings: The wrist pin bearing assemblies are offered with either self-aligning roller bearings or bronze bushing or sleeve type bearings, both types require diligent lubrication and maintenance to assure maximum bearing life.

Reducers and Their Maintenance

There are probably more variations in reducer design than in any other part of the pumping unit assembly. Some of these include solid box, split box, fabricated box, cast box, single reduction, double reduction, helical gears, herringbone gears, spur gears, chain, bronze, bearings, roller bearings, and others.

Regardless of the type, the reducer must be carefully maintained to assure receiving the performance life designed into the unit.

Practically all manufacturers have developed and furnished some sort of self-lubricating system. Many manufacturers attach an instruction plate to the reducer recommending the type of lubricant to be used. Usually this recommendation is for a good grade of straight mineral oil or an extreme pressure lubricant designed for gear use. The weight of the lubricant will be determined by temperature extremities of the particular area in which the unit is operating. Detergent type oils, such as premium grade motor oil, are not recommended for this service.

Reducer oil should be changed as often as necessary to maintain cleanliness of the operating parts. The oil should be changed at least every six months to remove the products of natural wear and oil oxidation. If the unit is operating under any of the following conditions, the oil should be changed at more frequent intervals: in damp areas where temperature changes cause condensation in the reducer; in sour gas fields where gas absorption by lubricant causes corrision; in extremely dusty areas where gritty materials seeping into the reducer causes abrasion.

When changing oil, the interior of the case should be carefully cleaned and flushed with a light oil to assure no contamination of the new oil with the residual foreign matter.

In addition to lubrication, other maintenance of the reducer consists of such things as keeping the reducer breather clean, gasket tight, and the service brake in adjustment.

At the time of oil change, a thorough mechanical inspection should be made of the reducer and all bolts checked for tightness.

There are several types of structural bearings such as roller, bushing, and rubber. The roller and bushing type bearings require lubrication which should be in accordance with the manufacturer's recommendations. Those of reservoir type should be kept filled to the proper level, other types should be lubricated frequently enough to maintain adequate but not excessive lubricant in the bearing at all times.

Counterbalancing

After the well load is applied to the pumping unit., the required counterbalance should be estimated and weights adjusted to this approximate amount. The unit should then be operated until the well has been pumped up and the full load applied. The counterbalance should be checked and readjusted if necessary.

The polish rod load is made up primarily of two loads; one the sucker rod load, the other fluid load. Other loads such as inertia and vibratory force will be omitted in the interest of simplicity.

As the sucker rod load is a fixed load and is more or less constant in the cycle, it can be completely counterbalanced. Most fluid load is imposed on the up stroke only and therefore should be half counterbalanced. This provides a uniform power requirement on the reducer throughout a complete cycle. As an example, if no counterbalance was provided, all of the work would have to be done on the up stroke and no work on the down stroke. It would then be necessary for the reducer and the prime mover to be much heavier in construction in order to withstand these heavy un-balanced loads.

The counterbalance should be checked frequently as often the well loads vary from time to time due to changes in the well conditions.

Various designs of counterbalancing systems are offered, such as, rotary, beam, a combination of rotary and beam, and air balance. In each of the foregoing types, there are numerous variations of design. To enumerate a few of these variations, there is offered the leaf-type rotary balance which is adjusted by the removal or addition of weights. In this design there is also the adjustable type which provides changing the counterbalance effect by shifting the weights in relation to the center of the crank; thereby decreasing or increasing the weight movement about the crank center. In this latter group there are some weights so easily adjusted that one man can change the counterbalance effect in a very short time. Working at ground level is conducive to safe operation.

Beam counterbalance designed units may have their weights adjusted by addition or removal of weight sections. Smaller variations may be made on some units by sliding the entire weight assembly along the beam.

The air balance units are probably the easiest adjusted, because it is only necessary to increase or decrease the air pressure at the control valve. However, because of the inherent design there would be more maintenance required for this system.

Determining Proper Balance

There are several ways to determine whether or not a pumping unit is in balance. The following methods are sufficiently accurate for practical purposes.

Engine Driven Units

1. If engine is exhausting unevenly, with heavy explosions occuring regularly on either up or down stroke and lighter explosions on the other stroke, then the unit is not properly balanced. If using a single cylinder 2-cycle engine for motive power and if this engine is exhausting on a regular cycle in synchronism with the crank, i.e., the engine will miss exploding at a certain point in the revolution of the crank and always pick up at another, then the unit is definitely out of balance. When a multicylinder engine is used, there should be two even variations in the exhaust for each revolution of the crank rather than one. The same is true for an electric motor where the "whine" will serve the same purpose as the exhaust.

2. The method of "slipping-the-clutch" is probably one of the most reliable means for determining the proper counterbalance. With constant clutch lever pressure, the crank should be watched for slowing down at the 3 and 9 o'clock positions. If the slowing down is equal at both points, the well is in proper balance. If the crank slows down more on the up stroke than on the down stroke, the well is under-counterbalanced. If more on the down stroke than on the up stroke, then the well is over-counterbalanced.

3. The recording tachometer record is very valuable for checking counterbalance effect. The most convenient point for taking readings is at the engine crank shaft, and such readings will be sufficiently accurate for the purpose intended. The tachometer, of course, will not show whether over or under counterbalanced, unless the crank position is recorded on the tape. There will be two peaks during each revolution of the crank and these high and low points should be made as nearly even as possible by an adjustment of the counterweights. The tape from the recording tachometer forms a very valuable record which may be filed for future reference. A non-recording tachometer may be used by simultaneously observing the crank positions and the tachometer readings.

The foregoing methods assume that the operation of the engine over any one cycle is not influenced by governor operation. If the governor is sensitive, the use of the foregoing methods may not be practical. However, by putting the engine on hand throttle during the test, satisfactory results can be obtained.

Electric Motor Driven Units

For electric motor driven units, there seems to be no simple means such as the above except with high slip motors the tachometer method is not satisfactory because the speed of the motor does not change with torque variations as much as with internal combustion engines. The use of an ammeter in the motor line will give an indication of the torque loads on the electric motor.

General Maintenance of Pumping Units

1. After 24 hours operation:
   - A. Re-check tightness of all bolts.
   - B. Re-check tightness of wrist pin nuts.
   - C. Re-check oil in speed reducer.
   - D. Re-adjust counterbalance, if required.
   - E. Check V-belt tightness.

2. Proper lubrication is extremely important in both the gear reducer and all structural bearing assemblies. Follow closely all lubication instructions shown in manufacturer's service manual. The oil in the reducer should be carried at the proper level and the structural bearings should be lubricated sufficiently, but not excessively.

3. The relief fittings on all sealed bearing assemblies should be checked and kept free. This check is important after painting the unit in the field.

4. Check the complete pumping unit for tightness of bolts including wrist pin nuts every three to six months.

5. Maintain proper counterbalance at all times.

6. The brake should be kept in adjustment.

7. V-belt tension should be adjusted as necessary.

8. Keep gear reducer breather cap clean.

9. The gear reducer cover gasket provides a seal against intrusion of foreign material. Replace when necessary.

10. Check wire line hanger frequently for signs of wear that could cause failure.

11. Not all pumping unit noises are an indication of serious trouble. Any sudden increase of severe noise

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should be immediately investigated and if necessary manufacturer's representative contacted. Some well condition changes will cause noises which are often misinterpeted as originating in the unit.