The Lease Pumper's Handbook

Chapter 6
Mechanical Lift

Section B

OPERATING AND SERVICING THE PUMPING UNIT

Most active oil wells are marginally producing wells that have been converted to lift systems. The percentage of wells on mechanical lift is so great that all of the wells on many leases are on pumping units. This method of artificial lift is so dependable and easy to operate that many lease pumpers prefer mechanical lift over any other artificial lift system. This section covers the operation and maintenance of a mechanical lift system.

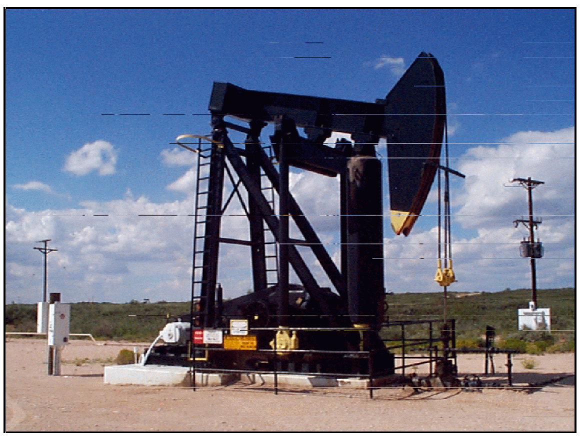

Figure 1. A pumping unit driven by an electric motor. Note the power control box on the power line pole. Two others are on the far side of the pumping unit.

B-1. Mechanical Lift with Electric Prime Movers.

Wells with electric motors as their prime movers are easily programmed to operate on full automation and easy to learn to operate. In a typical installation with electrical controls, such as that shown in Figure 1, the power line brings electricity to a spot near the location but outside of the guy line area. A fuse panel is installed and the power line is run underground, usually to the back of the pumping unit. On a post, a second electrical panel is installed with an on/off switch. An automatic control box is also attached to the post. The lease pumper must fully understand how to operate these components and be aware of problems that may develop.

B-2. Mechanical Lift with Natural Gas Engines.

Operating pumping units with natural gas engines are quite different from producing wells that utilize electrical prime movers. This is especially true when the fuel supply is gas from that well. Under these conditions, the lease pumper vents the gas not used for fuel and tries to maintain the formation back pressure as close as possible to zero. Information on this procedure is provided in Chapter 11, Section B, Engines.

Normally, the lease pumper is on the site for no more than 8 hours each day. Thus, if the pumping unit is started and stopped manually, there are a limited number of pumping schedules that can be used. The pumping unit can run around the clock, though, as will be explained later, this will not necessarily result in more oil production. A second option is for the lease pumper to start the pumping unit just before leaving the lease and shutting it off upon returning the next day. That would result in the unit running for approximately 16 hours, which again means little effective oil production. Finally, the lease pumper can run the pumping unit during normal working hours. The lease pumper could, thus, have the pumping unit run continuously during that time or could cycle the pumping unit on and off during the 8 hours.

A more efficient approach is to use an engine control. These devices allow the engine to start and stop without the lease pumper being present.

Engines offer opportunities that are not available with electric motors. The pump can be set to within 1 inch of tapping bottom. Thus, when the pump no longer pumps oil, increasing the RPM of the engine will allow the pump to tap bottom due to the rod having stretched. Once the pump has been restored, the RPM can be readjusted to prevent the pump from tapping bottom.

Pumping unit engines must be properly tuned at a level of dependable operation. A poor maintenance program will result in lost production and add a lot of duties to the lease pumper's busy schedule.

B-3. Pumping Schedules.

Determining how long to run the pump during a 24-hour period and the ideal cycling schedule can be difficult. For example, if operating a well that produces oil and water 12 hours per day leads to maximum oil production, there are a number of ways to achieve a 12-hour runtime, including:

- 12 hours on and 12 hours off
- 6 hours on and 6 hours off in two cycles
- 2 hours on and 2 hours off in six cycles
- 1 hour on and 1 hour off in 12 cycles
- 30 minutes on and 30 minutes off around the clock
- 15 minutes on and 15 minutes off around the clock

While the well is off, the liquid level builds up in the bottom of the hole in the casing. As it builds higher, the weight of the column builds up backpressure. As backpressure increases, the rate at which oil enters the well from the formation will slow until the backpressure equals the hydrostatic pressure of the formation, at which time all movement will stop. So there is an ideal amount of time to allow fluid to accumulate, for beyond that time no more oil will flow into the well. Thus, running the pump for just 20 minutes each hour, may result in the same oil production as running the pump for 12 hours each day and would require only 8 hours of runtime.

By the same token, if the system can pump the full accumulation of oil to the surface with 30 minutes of operation, there is no point in running the pump for an hour at a time.

On the other hand, if the pump is run without allowing the full accumulation of fluid, the reduced backpressure may allow a steadier flow of hydrocarbons into the well. For example, if the rate of formation flow into the well drops by approximately half each hour until the flow ceases after 18 hours and then it takes 6 hours of pump operation to remove the accumulated fluid, one pumping plan would be to run the pump 6 hours straight each day. However, by running the pump more frequently to keep the backpressure from building up, a higher formation flow rate may be maintained. For example, running the pump for 15 minutes each hour would still total 6 hours of operation each day and formation flow would not cease during the day. As a result, overall production may be higher.

There are other economic factors that may also need to be considered. In Chapter 14, Well Testing, additional information is included concerning productivity testing to determine the best way to produce a well.

B-4. Automatic Controls.

There are two general types of timing controls for pump operation. A 24-hour clock may be used to set the on and off periods during one day or a percentage timer can be used to regulate the percentage of time that the pump is on within a given period. Percentage timers are often found in the newer automatic control boxes instead of 24-hour clocks, although both still have their place and will continue to be available for special applications.

There are several styles of the 24-hour clock. Some are controllable in 15-minute on-and-off cycles, while others can be controlled for intervals of 5 minutes or less. These clocks are well suited for setting pumps to run at a specific time of day or with irregular pumping cycles.

Percentage timers are available in cycles of 15 minutes or more. Percentage timers have one control dial that allows the timer to be set to run a selected percentage of the timer cycle. Thus, if a 15-minute timer is set for a 50-percent runtime, the pumping unit will operate for 7½ minutes and then be off for 7½ minutes during each 15-minute cycle. Because there are 96 15-minute cycles in a day, the unit will run 7½ minutes through each of the 96 cycles in a day.

Similarly, if a 2-hour timer is used with the dial set for 25%, the unit will come on for 30 minutes and then turn off for 1 hour and 30 minutes, and then come on again. This cycle will be repeated 12 times per day, and the unit will run 12 times per day for a total runtime of 6 hours or 25% of a day.

B-5. Maintaining the Pumping Unit.

The first step in maintaining the pumping unit is to set up a good maintenance schedule in the lease records book and to follow it. One reason that the record book is so important is that it helps the lease pumper to use the correct maintenance procedures. For example, the typical supply store will have many types of lubricants, in various weights, with different additives, and available in tubes, buckets, and other styles of containers. For each application at the lease site, a limited number of lubricants will be appropriate to use, and often only one that is truly suitable. The lease pumper cannot be expected to remember each type of lubricant that is required and where it should be used. By maintaining complete and accurate records, the lease pumper can be assured of using the correct type and amount of lubricant and will know when equipment has been lubricated or will next require the lubricant to be changed. Further, the lease pumper can avoid mixing lubricants that may not be compatible with each other.

The daily inspection. Oil field equipment is very dependable and can operate for years between serious problems. Still, the daily inspection can extend the life of the unit by locating problems before damage has occurred. When making any inspection, the lease pumper should listen carefully with the vehicle radio volume turned completely down because the sounds a pumping unit makes can tell a lot about its condition. The inspection should also include a check for lubricating oil leaks, as well as looking on the ground for loose objects, such as bolts, nuts, and washers.

The weekly inspection. The steps of the weekly inspection include:

1. Perform the steps of the daily inspection.
2. Walk completely around the pumping unit and observe it in operation.
3. Stop at good observation points to watch assembled parts for one complete revolution, looking for unusual motion and vibration and listening for noises.

4. Check to see that the white line on the pitman arm safety pins is properly aligned. (See "Pitman arm and gearbox problems" below.)

The monthly inspection. The steps of the monthly inspection include:

1. Complete the steps of the weekly inspection.
2. Check the fluid level in the gearbox if there is evidence of a leak (Figure 2).

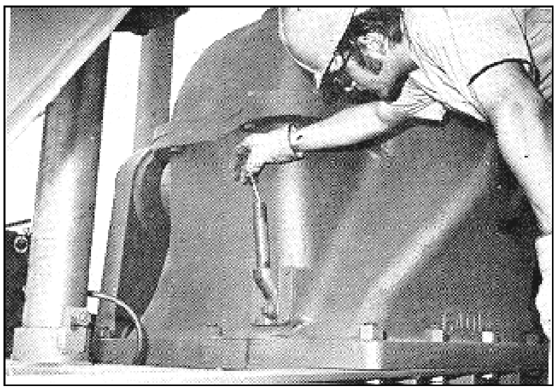

Figure 2. Checking the oil level and condition in the gearbox.
(courtesy of Lufkin Industries, Inc.)

3. Lubricate worn saddle, tail, and pitman arm bearings (Figure 3).

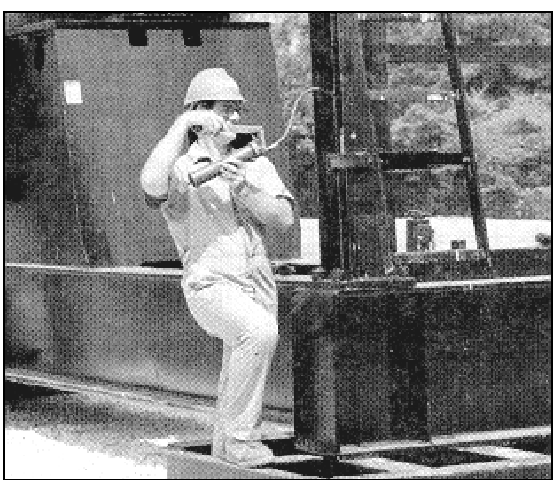

Figure 3. Lubricating the saddle and tail bearings.
(courtesy of Lufkin Industries, Inc.)

The three- and six-month inspection. The three- and six-month inspections are especially important. Some new pumping units need to be fully lubricated every six months (Figure 4). As the unit gets worn, this interval needs to be shortened to every five months and then four months and then three months. With some units, lubrication may be necessary every month, with special maintenance attention in between. A part of these inspections is performed with the pumping unit in motion, and part of it is performed with the unit shut down and the brake lever set.

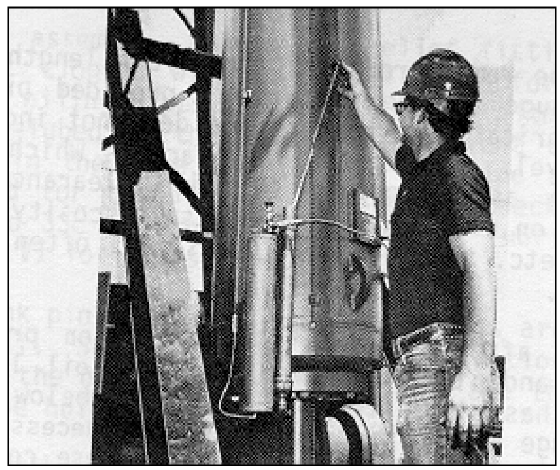

Figure 4. Checking the oil level in the air cylinder on an air-balanced unit.
(courtesy of Lufkin Industries, Inc.)

Pitman arm and gearbox problems. Two of the most damaging situations that may occur to the pumping unit are a pitman arm coming loose and the stripping of gear teeth in the gearbox.

When the stroke length of a pumping unit is changed (Figure 5), extreme care should be given to correctly cleaning, lubricating, keying, and tightening the wrist pin on the crank pin bearing. If the nut should work loose and come off, the hole in the crank will be damaged, the walking beam twisted, and the wrist pin destroyed.

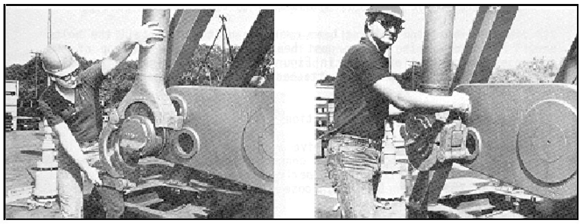

Figure 5. Changing the stroke length.
(courtesy of Lufkin Industries, Inc.)

A white line should be painted across one face of the nut from the safety pin to the counterweight, and a line drawn for several inches on the crank. This line allows the lease pumper to recognize any change in the alignment of the components, even if the crank is in motion. During the daily inspections afterward, the pumper should note the smallest changes that may indicate that the nut is loosening. In the first week after changing the stroke length, these nuts should be checked for movement every day.

When checking the oil level in the gearbox, the lease pumper should pay special attention for the presence of metal flakes in the oil. Small samples can be obtained from the lower petcock or plug. By wiping the oil on a clean cloth, any metal cuttings can usually be detected. When metal cuttings are detected, the cover should be removed, the gearbox flushed out and cleaned, and new oil added.

Periodically, but at least once per year, the gearbox cover should be removed and the interior closely examined with a flashlight. Figure 6) This is especially true of chain-driven units. Lubrication troughs should be checked to ensure that all of the bearings are receiving a sufficient amount of oil and that the oil level is high enough to engage the oil dippers and gears. The oil should be changed and the filter cleaned on a periodic basis. Gearboxes can also collect water and sludge that should be removed periodically for maximum bearing and chain or gear life.

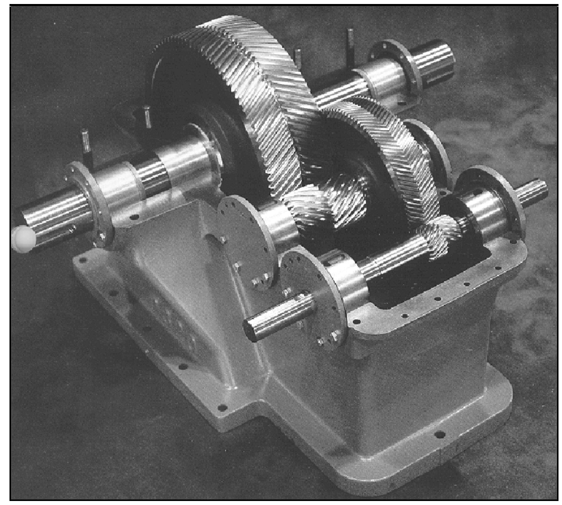

Figure 6. A gearbox with the cover removed for inspection.
(courtesy of Lufkin Industries, Inc.)

B-6. Direction of Rotation.

For conventional gear-driven, walking beam pumping units, some companies change the direction of rotation every six months or annually so that the forces that wear the gears are applied to the opposite sides of the gear teeth. This change of the direction of rotation is achieved by reversing the connection of any two wires of the three-phase motor. Consequently, this service is not possible on pumping units driven by natural gas engines. With the Mark series pumping units (see Appendix B), the pumping unit weights must be rising toward the well head as the pumping unit is running. Chain drive gearboxes also usually require that the unit counterweights move in a specific direction in order for the gearbox to receive lubrication. The direction of rotation of each pumping unit should be recorded in the pumper’s field manual so that when an electric motor is replaced, the lease pumper can tell the person replacing the motor which direction the pumping unit was rotating before the problem occurred.

B-7. Gearbox Oil.

Different styles and sizes of pumping units require different types of oil in the gearbox. There are also several types of gearboxes. These include single-gear drives, double-gear drives, and chain drives. The gears also have dippers that pick up oil on each revolution, carry it up, and pour it into a trough so that it can lubricate the four shaft bearings.

Some of the problems that are caused by poor maintenance are:

- Poor lubrication due to low oil level
- Rust as a result of water in the oil
- Starting difficulty due to low oil or overly viscous oil, especially in cold weather
- Poor lubrication due to the gearbox being overfilled, resulting in foam
- Sludge accumulation because different types of oil have been mixed, because of incorrect additives, or because the oil has aged
- Poor coverage of the gear surfaces because the oil is too thin or overheated
- Gear wear due to contaminants such as dirt and bits of metal in the oil

Most of the listed problems can be cured by a proper gearbox flush and oil change.

B-8. Typical Pumping Unit Problems.

There are many indications of problems with a pumping unit that the lease pumper must recognize and know how to correct.

Chapter 11 includes information about electricity, automated control panels, electrical problems, and engines as prime movers.

Appendix B provides a review of pumping unit maintenance information (Figure 7). This appendix includes topics such as styles and sizes of pumping units, setting and maintenance requirements, procedures for changing the stroke and balance, and other adjustments.

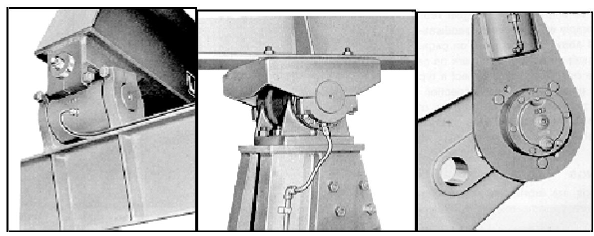

Figure 7. Well component manufacturers and suppliers can provide helpful information about equipment maintenance, such as the lubricating points shown here.

Appendix F includes mathematical calculations needed for topics such as computing belt lengths, sheave sizes, and strokes per minute.