

# Dashboard Guide to Energy Efficiency in the Oil Field

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**Whether oil prices are low or high, producers can save money by reducing or controlling their production costs. This guide contains a number of money-saving ideas based upon the experiences of various producers, field researchers, and recent tests at select oil production sites. Not all of the ideas and approaches are applicable to every situation—the variation from well-to-well and field-to-field makes such improvements an ongoing challenge.**

Nevertheless, both small and large producers should find several ideas that they can implement to further reduce or control production costs. The guide's recommendations have been culled from a variety of sources including oil producers, oil field equipment manufacturers, electric utility personnel, and those involved in oil production research. In most cases these ideas have been verified through one or more field tests conducted by established oil producers. It is hoped that these recommendations will help to maintain the viability of the domestic oil production industry here in the United States.

The guide's cost-saving ideas are organized into three categories: (1) general oil production operations, (2) surface equipment, and (3) downhole equipment.

## **Cost Saving Ideas Related to General Oil Production Operations**

### **Recommendation 1: Make Sure That Your Wells Are on the Proper Electric Utility Rate**

Electric utility rates vary considerably among utility companies. In addition, individual utilities often have different rates for different classes of customers. In

some cases, oil producers have been classified under several different customer classes, depending on the person who initiated the utility service. Some of the rates for customer classes do not reflect the way electric energy is used in oil production and may result in an incorrect (normally too high) electric rate for the oil production facility. Producers who operate wells using electric power should regularly check with the electric utility that serves their wells to ensure that they are on the appropriate electric rate schedule. When there may be more than one applicable rate, the utility company should work with the producer to help determine the most favorable rate.

In summary, if you are a producer who operates wells using electric power, remember that an electric utility can change its rates or may offer some new rate schedules, so it is a good idea to maintain regular contact with the electric utility company that supplies your wells. By receiving the most favorable electric utility rate, producers may obtain savings of up to 15% on their monthly utility bills.

### **Recommendation 2: Correct the Power Factor**

Many, but not all, electric utility rates include a penalty for a low power factor. Power factor is a measure of the ratio of the total average power consumed by a well in kilowatts (kW) to the total apparent power used in kilo-volt-amperes (kVA). Typically, electric utilities may impose a rate penalty if the power factor is below 85%. The power factor can be corrected by installing static capacitors at each well, or at the meter point if multiple wells are installed on a single electric meter.

The electric utility company that supplies the well should be able to provide some assistance with correctly sizing the power factor correction capacitors. The costs for these improvements are limited to the cost of purchasing and installing capacitors and usually, result in a payback of less than 2 years.

### **Recommendation 3: Where Possible, Connect Multiple Wells to a Single Electric Meter**

Electrically driven beam type pumps are unique in that they consume energy on the upstroke, but produce energy on the downstroke. This is because the electric motor driving the well actually overspeeds during the downstroke and operates as a generator during a portion of the pumping cycle. The electric power produced by a well generally flows back into the electrical network. Because of the rather short duration of this generated power and other considerations, electric utility companies are not willing to pay oil producers for this power, even if it flows back into the utility network. As a result, this energy is more valuable to the producer than to the electric utility, and producers should work to ensure that they utilize as much of this produced energy as possible.

In these situations, connecting multiple wells to a single electric meter can ensure that the producer maximizes the utilization of this produced energy. Because the speed of each well varies at any given time, some wells will be on the upstroke, consuming energy, and some wells will be on the downstroke, producing energy. In this case, the produced energy will be used in those wells that are consuming

energy, rather than flowing back into the grid. This can result in some net energy savings for a producer.

Simply notify the electric utility supplying the wells that you want to be on a single meter if possible. Since there is generally a utility meter charge for each meter, eliminating the extra meters will save money.

### **Cost Saving Ideas Related to Surface Equipment**

#### **Recommendation 4: Practice Good Routine Maintenance**

Many problems associated with high energy use in beam type pumping units can be attributed to the lack of proper routine maintenance of the unit. This includes such activities as inspecting and lubricating or replacing bearings as needed; dynamically balancing the pumping unit if necessary; checking the electrical conductor sizing; and correcting any high resistance connections that are discovered. In addition, it is always a good idea to adjust the stroke length of the pump when such adjustment is indicated. These basic procedures are often the most significant factors in increasing the efficiency of a beam type pumping unit.

#### **Recommendation 5: Check for Proper Motor Size**

It is quite common to find that the electric motor installed on a beam type pumping unit is oversized for the capacity of the pumping unit. This frequently results when a failed motor of the correct horsepower is replaced by an available motor that is slightly larger. Such change is seldom documented, and as a result, when the larger replacement motor fails, it is often replaced by an even larger motor.

One large independent oil producer on the West Coast inspects the motors on their wells every 3 years and typically finds that approximately 30% of the motors are oversized.

Ideally, the proper sized motor for a beam type pumping unit is the smallest motor that will still allow the unit to start under load. This value may be estimated from electric utility bills or it may be calculated based on measurements taken on the well while it is in operation. Motors that are oversized do not run efficiently and typically have a poor power factor (pf). Both of these conditions result in increase electrical costs. Additionally, when purchasing new motors, the cost of the new, right-sized motor can actually be less than the cost of replacing the worn-out motor with one of similar characteristics.

#### **Recommendation 6: Install Premium Efficiency Electric Motors**

Premium efficiency electric motors have been shown to use significantly less electric energy than conventional motors of the same horsepower rating. Producers, when replacing electric motors on their beam pumping units, should carefully consider buying premium efficiency motors. However, these premium efficiency motors generally cost more than conventional motors. It will usually take several years for the energy savings to offset the higher initial cost. And, in cases where the well is only marginally profitable and appears to be near the end of its useful

production life, the higher cost of a premium efficiency motor may not be justified.

One other factor must be taken into consideration regarding the application of premium efficiency motors. Two different types of electric motors have typically been utilized on beam type pumping units. These motors are noted by their design application code letter as specified by the National Electrical Manufacturers Association (NEMA). The traditional motor for beam type pumping units is the NEMA Design D motor. This motor slows down under load and allows the rod string to be lifted in a gentle manner.

All premium efficiency motors, however, are classified as NEMA Design B. These motors operate at a more constant speed, and when installed on a beam pump, they tend to exert more torque on the gearbox and more stress on the rod string. However, if the well is in good working order and has adequate structural/mechanical strength, than a premium efficiency NEMA Design B motor can be installed without any problems. On the other hand, older wells that are structurally/mechanically frail may not be good candidates for Design B motors. Producers who are uncertain about the strength of their equipment are advised to try this changeover on one or two pumps, observe the savings (if any), quantify the additional capital costs associated with this change, and carefully observe how their equipment operates with these NEMA Design B motors.

#### **Recommendation 7: Install Pump-Off Controllers**

When the fluid handling pumping capability of a beam pump exceeds the volume of fluid produced by a well in a given period, the beam unit does not lift a full barrel on each stroke, and as a result, pumping energy is wasted and the pumping system becomes inefficient. In such cases the well is said to be "pumping-off." Pump-off controllers are used to shut down the pump operation for set periods of time to allow the fluid in the well to accumulate so that the pump lifts a full barrel when it resumes operation.

Analyzing the operation of a given well can determine whether a pump-off situation is occurring and whether the installation of a pump-off controller is warranted. This can be done by checking the fluid level in the well at different time intervals using echo sounding equipment. This measurement should be taken from time to time since well operating characteristics can change due to underground conditions or the pumping rate of adjacent wells.

#### **Recommendation 8: Install Adjustable Speed or Variable Frequency Drives**

Adjustable speed drives (ASDs), also known as variable frequency drives (VFDs), are relatively new devices that employ solid-state electronics to control the speed of AC motors, similar to those used on beam type pumps. When it is not feasible to use a pump-off controller (see Recommendation 7) to completely stop the pump for certain periods of time it may be possible to employ an ASD to slow down the pump, thus achieving results similar to those obtained from a pump-off controller. The primary disadvantage of an ASD is its relatively high cost.

It is probably not economically feasible to use ASDs on wells of 20 horsepower or less. ASD technology may be suitable for larger wells because the cost of the ASD is a smaller percentage of the total cost of the pump and related equipment.

#### **Recommendation 9: Reverse Direction of Rotation**

In some cases the teeth on the gears in the gearbox on a beam pump unit become worn down, and there is a loss of efficiency. Depending on the design of the gearbox, it may be possible to reverse the direction of rotation of the pump motor and thus utilize the opposite sides of the gear teeth, which, generally, are not as worn. If your gearbox will allow for this operation, simply interchanging two of the three leads on the pump motor will reverse its direction.

#### **Recommendation 10: Tighten or Replace Belts**

Loose belts can reduce the efficiency of a beam pump. Tightening belts can help the pump operate more efficiently. Worn belts should be replaced with the newer, high-efficiency belts. These belts do not slip as much and work better. Higher initial costs for the belts are recovered in the energy savings they achieve.

#### **Recommendation 11: Adjust Stuffing Box**

Many operators are under the impression that the fit between the polished rod and the stuffing box (packing head) must be extremely tight. This is not the case, and if the fit is too tight, the drag on the polished rod will result in inefficient operation. The stuffing box should press against the polished rod just tight enough so that a small amount of oil is visible on the rod. The friction between the polished rod and the stuffing box should not cause the rod to become too hot to touch.

### **Cost-Saving Ideas Related to Downhole Equipment**

#### **Recommendation 12: Make Sure That the Valves on the Pump Are Working Properly**

Leaky or sticking valves significantly decrease the efficiency of a beam unit. Producers should make sure that all valves are in good working order. This is an important part of routine maintenance.

#### **Recommendation 13: Use Improved Pump Materials**

Rod strings made of newer, lightweight materials can significantly reduce the rod string weight, which decreases the lifting load on the pump, yielding considerable energy savings. The savings from a lighter weight rod string generally cannot offset its higher cost and the loss of production associated with the pump's downtime during installation, unless the pump is being shut down for other reasons. Consequently, such items are best suited for new installations or for replacing worn-out or damaged rod strings in existing installations.

#### **Recommendation 14: Use Improved Pump Designs**

Beam pumps have been developed with new materials and improved pump kinematics that are more efficient than traditional units. However, it is probably only economically viable to install these high-efficiency pumps on new wells. The

high cost of these pumps generally will not justify their installation to replace existing pumps on older wells. At this time, evaluations of the savings potential for improved pump designs are underway.

### **Summary and More Information**

Performing basic maintenance, including ensuring that the valves on the rod pump are working properly, checking for correct motor size, and working with your electric utility companies to ensure that your wells are on the appropriate rate structure are keys to maximizing cost savings in oil production at little to no cost to the producer. While savings vary considerably according to the conditions of the wells and the utility rates, it is not unusual for a producer to save 15% or more by implementing these recommendations.

For additional assistance, producers may contact the National Association of State Energy Officials at 703-299-8800. NASEO will put you in touch with an expert who can assist you in meeting your efficiency goals, including officials from your State Energy Office, the U.S. Department of Energy, the Petroleum Technology Transfer Council, and your local utility.