Electrical Accessories For Your Lease Operation - Capacitors, Bottom Hole Heater, Timed Restart, & Heating Cable

By ROY L. JAMES
Southwestern Public Service Company

USE OF CAPACITORS ON ELECTRIFIED LEASES

We are all aware of the steps being taken to decrease operating expenses to help offset reduced daily allowable of the amount of oil permitted to be produced per day. One possible way expenses can be reduced is by using capacitors on electrified leases. Advantages obtained from use of capacitors are: [1]

1. Higher voltage level
2. Smaller transformer banks required
3. Smaller conductor size required
4. Savings on rates that contain a power factor clause
5. Higher motor starting torque because of improved voltage level
6. Aids in slopping off incoming waves due to lightning or switching surges and therefore helps protect the motor windings

These advantages are the results of the capacitor reducing the amount of current that is required to operate the motor between the point where the capacitor is installed and the power source.

An example using a quarter horsepower, single phase, 120 volt motor well will emphasize how capacitors reduce line current. With motor operating at no load, the current required is 5.1 amperes. When a 50 mfd capacitor is connected, the line current is reduced to 2.9 amperes. The line losses are proportional to the square of the current. Assuming a resistance of one ohm, the I^2R losses in each of these cases would be:

without capacitors $(5.1)^2 I = 26.01$ watts

with capacitors $(2.9)^2 I = 8.41$ watts

By using a capacitor in this case it can be seen that power losses are reduced by 68 per cent. This is an exaggerated case since the power factor is very low on motors operating at a no load condition, but actual field tests on oil leases have shown a 25 per cent reduction in line current by installing capacitors.

The power factor of a motor is higher when it is fully loaded than when the motor operates the less than full load. The power factor of oil well pumping loads is very low in most cases because most oil field motors operate between 60 and 70 per cent load and some motors much less. Studies of several oil field leases showed that layouts with capacitors resulted in the most economical arrangements on the first cost basis. [1] This is possible through the savings realized in using smaller transformer banks and smaller conductor sizes.

The current required to operate a motor can be classified into two parts. One part of the current is the current that actually does the work, or useful current, and the other is called magnetizing current. The capacitor acts as a generator and furnishes the magnetizing current for the motor as well as the magnetizing current for the lines and transformers.

By the use of capacitors of the proper size the following results are possible: [2]

1. A 25 per cent reduction in transformer sizes
2. A 44 per cent reduction in line losses (I^2R losses)
3. Approximately 25 per cent reduction in voltage drop

THE SEQUENCE RESTART TIMER

The main purpose in using timed restarters is to prevent damage to transformers and distribution system that could be caused by inrush current after the power has been off on the lease. Another big advantage of timed restarters is that the wells will automatically come back on after a momentary outage.

One example of the big savings that would be realized with the use of a timed restarter is a case on a lease without timed restarters. A momentary dip or outage on the system caused all of the wells to be shutdown on this lease after the pumper had left for the day. In this case the wells would be shutdown until the pumper went around to each well and turned them back on the next day. On a large lease this loss in production would be more than enough to offset the cost of installing timed restarters. If this lease had timed restarters, all the wells would have come back on automatically.

HEATING CABLES

One of the applications of electric heating tape on oil leases would be to prevent freezing of water lines and pumps by wrapping them with this heating cable. Other applications would be wrapping the heating cable around lines handling high viscous fluid in cold weather, thereby speeding up the flow of these liquids. These tapes can be controlled automatically by thermostats.

On the types used to prevent freezing of water pipes, the thermostat is automatically set to come on when the temperature drops below 45 degrees. They are also available with thermostats that can be adjusted to control the temperature at any setting between 20° and 80° F. An example of the low cost of operation of these tapes is as follows:

An 8 ft. tape operating continuously for a period of 24 hrs. would cost less than 2 cents.

PURPOSE OF BOTTOM HOLE HEATERS

In most installations the main reason for use of bottom hole heaters is paraffin control in tubing. By heating the formation the permeability of the producing formation is restored by removal of paraffin accumulations and water blocks near the well bore. In heavy crude wells, heating of the formation increases production considerably. It reduces the viscosity of the fluid, thereby improving pump efficiency (plus other benefits) as a result of moving lower viscosity fluids.

Methods Of Paraffin Control

Mechanical methods in paraffin control are pulling the rods and cleaning and use of scrapers, knives, or hooks to clean the tubing. Another mechanical method is permament installation of scrapers on the rods. One of the problems that may be encountered in this method is in the removal of the paraffin deposits from the producing formation — in particular on stripper wells where the rate of fluid pumped is not sufficient to carry out these deposits.

Solvents are also used in paraffin control. Some of the solvents are benzol, gasoline, and commercially prepared solvents. One company has recently developed a process that makes metal parts of the well water-wet which prevents adhesion of the paraffin particles.[3] Some of the problems that may be encountered in using the solvent method are in getting the solvent at the desired place and cleaning of the rods and tubing by the solvents on its way to the desired place. In most cases the well has to be shutdown.

Thermal methods of paraffin control are:

1. Steam
2. Hot oil
3. Circulation systems using water
4. Chemical
5. In situ combustion
6. Electric heaters

Most field tests reveal that the circulation systems are not economical in wells below 2500 ft. The circulating system is in wide use is in California. The chemical process involves the use of chemicals that cause a reaction producing heat in the formation. Chemicals that have been used in this process are calcium carbide and the combination of caustic soda with aluminum.

Numerous tests have been made in use of the in situ combustion method. This method was first disclosed publicly in patents 35 years ago issued to Edison Wolcott and Frank Howard.[4] The first known attempts of this method in the United States were in Oklahoma in 1952 by Magnolia and Sinclair, each working independently 300 miles apart.

Basically this method involves the use of an air compressor supplying air to the producing formation, an ignitor in the formation to start the fire. Oil in the formation is used as the fuel. Results of this fire pushes the fluid to the producing well. Results from these tests have been encouraging in that it is a fast means of oil recovery and tests are still being continued. With further development, ways will probably be found to reduce the high cost of this method.

The first electrical oil well heater was described in patent literature dated July 4, 1865.[4] This patent was issued to George T. Perry and William S. Warner. Since then, more than 100 patents have been issued. Some of the types of electric bottom hole heaters in use are:

1. Resistant heating elements
2. Resistance heating elements in combination with a small pump
3. Use of the tubing as the heater and conductor with the casing used as return path
4. A heater that has two or more electrodes in the formation. Heating is produced by the electric current flowing through the fluid from one electrode to the other, thereby generating heat in the fluid.

At present, the resistant heating elements type is in wider use than the others. The heater described in No. 4 is a recent development of Thermalec, Inc. This unit has been field tested for a number of years and went into production only this year. This unit appears to be the answer to many of the problems in the past in the use of electric bottom hole heaters. Most electric heaters in use are rated at 5, 10, or 15 KW.

Advantages And Problems Of Electric Bottom Hole Heaters

The electric heaters are becoming more popular since they are more adaptable to the heat needs of individual wells. Use of the time cycle and different size heating elements make it easy to adjust the temperature to obtain maximum production. The heat can be applied at the point where it will do the most good — avoiding waste of heat from the point where it is generated to the point where it needs to be applied. The new shorter heaters permit their use in lower fluid levels. Other advantages are low initial and operating costs; they are also simple to install and operate.

Some of the problems that have been encountered in the use of electric bottom hole heaters have been failure of the cable caused by damage of cable while the heater was being installed. High pressures encountered in some wells at the bottom of the hole and contaminating material in contact with heaters and conductor have caused failures of splicing connections and burning out of the heating elements. Most of these problems have been solved by the use of new materials and new design of the heating elements. The cables have been improved by the use of polyvinyl cholride covered cables permitting longer lengths with few splices, better splicing techniques and better methods of clamping cable to the tubing string.

Economic Justification

Even though it is still difficult to predict the response for specific well installations, some of the factors to consider that help in determining whether or not use of bottom hole heaters would be justified economically are:

1. The viscosity temperature relationship of the crude (rule of the thumb — five to one)
2. Bottom hole temperature (less than 200°F)
3. Per cent water cut
4. Per cent sand production
5. Liner and formation plugging characteristics of the fluid (paraffin content)
6. Formation pressure
7. Type well completion
8. Thickness and characteristics of the sand
9. Depth of producing formation

In spite of these uncertainties, 80 per cent of the wells where bottom hole heaters were installed have been justified economically in the Cut Bank Field in northwestern Montana.

Results

In general, bottom hole heaters have been more attractive in shallow wells producing 15 gravity or heavier oil.[6] The average increase in production on wells of this kind in California have been from 10 to 20 barrels of oil per day. The heater payouts vary from three months on up. Best results have been obtained when the heaters have maintained temperatures of the fluid in the formation between 150 and 200°F.

Test Data From Field Tests

On five year tests on 65 wells choosen at random in the Cut Bank Field, bottom hole heaters have increased the production from 300 barrels of oil per day to 900 barrels of oil per day.[8] During the period from 1949 to 1955, 135 electrical heaters were installed in this field. Five year tests on Placerita well in California showed that in December, 1949, initial production was 189 barrels of oil per day. In December, 1950, production had declined to 20 barrels of oil per day.[7] Hot oil treatment was used with some success for a period of one year but was discontinued because too much oil was lost in the formation due to low bottom hole pressure. An electric bottom hole heater was installed and immediately the production increased from 20 barrels of oil per day to 76 barrels of oil per day.

Five years after this heater was installed the well had declined at a less than normal rate for this field with the well producing at the rate of 37 barrels of oil per day. This heater is operating on a time cycle of 30 minutes on and 30 minutes off, eight hours per day, daily. The cost of operation is $1.50 per day. The temperature of the fluid in the formation was maintained at 148°F and gravity of fluid 16°API.

Two wells in the San Joaquin Valley, Calif. increased production from 3 to 4 barrels of oil per day to from 25 to 30 barrels of oil per day after electric heaters were installed.

Results of two recent tests on wells in east Texas by Thermalec, Inc. are:

	Paraffin Well (41° Gravity)	Low Gravity Well (19.6° Gravity)
Well depth	1998	682
Casing set to	1996	682
Producing zone	1938-42	619-642
Formation	Lower Strawn	
Initial completion production	23 b/d	39 b/d
Production — well 6 months old	1.6 b/d	4.2 b/d
Effect of hot oil or steam treatment	Inc. to 8 b/d	Inc. to 12 b/d
After treatment (above) initial production achieved in	11 days	9 days
Tubing steamed or knifed every	month	
Bottom hole temp.	80°F	82°F
Bottom hole temp. with Thermalec Heater	216°F	at 190°F
Thermalec Heater operation	5.4 KW/hr-day	13 KW/hr-day
Daily Cost of operation (@ 1.5¢ per KW hr.)	$1.94	$4.68
Average daily production with Thermalec Heater	11.9 b/d	28.3 b/d
Daily increase (b/d)	10.3 b/d	24.1 b/d
Daily increase ($/d)	$31.93	$57.84
Yearly increase in barrels of oil	3,759.5	7,701.15
Yearly increase in income	$11,654.45	$18,483.60
Yearly cost of electricity	$706.16	$1,708.20
Gross yearly profit	$10,948.29	$16,775.40
Well servicing required	none	none

Other possible savings that may be realized in the use of bottom hole heaters are elimination of tank steaming before delivery and lower maintenance costs on rods and pumps.

BIBLIOGRAPHY

1. W. C. Bloomquist and J. N. Poore, "Power-Distribution Systems for Oil-Field Pumping Service"
2. J. H. Day, "Why the Trend Toward Electrified Leases"
3. Anon., The Oil and Gas Journal, p. 136, January 25, 1960
4. W. T. Nelson and J. S. McNeil, Jr., "3 Ways to Improve Oil Recovery," The Oil and Gas Journal, January 19, 1959
5. D. H. Stormont, "Bottom-Hole Heating Speeds Flow of Heavy California Oil," The Oil and Gas Journal, June 24, 1957
6. E. W. Walker, "Producing Low Gravity, Viscous Crude," World Oil, October, 1959
7. D. H. Stormont, "Bottom-Hole Heating," The Oil and Gas Journal, July 1, 1957
8. K. G. Parrent, "Bottom Hole Heaters," The Petroleum Engineer, May, 1955

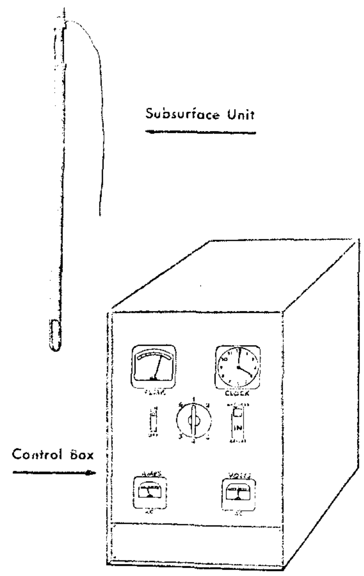

Fig. 1

Fig. 1 is a picture of the control box and electric bottom hole heater of the type using two or more electrodes. Heat is produced in the formation by electrical current flowing through the fluid from one electrode to the other.