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ELECTRIC-DRIVE SYSTEM FOR ROTARY TURBINE DRILLING

G. Kogan and N. Tikhomirov
Molotov Petroleum Trust

The expenditure of electrical energy and the power factor during drilling depend as much on a properly selected and supervised technological system of drilling as on the choice of an efficient and economical system of electric drives. Various systems are available, depending on the electrical equipment on hand.

Certain of these, clearly inefficient in energy utilization, must be employed because of the lack of essential equipment and the necessity of getting along with what happens to be available. For example, running a 2-kilovolt electric pump on a 6-kilovolt circuit involves the use of additional transformers with capacities of 300 kilovolt-amperes, 440/2,000 volts or 6/2 kilovolts, which causes complications in setting up and servicing as well as unprofitable performance because of losses and loading of the equipment.

The lack of high-power electric motors for mud pumps necessitates the use of two motors, 180 kilowatts each, on one pump which thus sharply increases electrical energy losses.

Recently, the electric industry has managed to put out new types of electrical equipment for use in drilling: specifically, electric motors of 260, 290, and 360 kilowatts; electric drilling motors of 130 kilowatts, control stations for electric drill motors of types SB-45 and SB-47, boxes of type YaZhNU-16, mobile electric drilling substations, and other kinds of equipment.

Because of this equipment, there are possibilities of operating electrical drilling equipment more efficiently than at present.

At present, a system will often be found to have the following shortcomings:

A 6,000/525 volt transformer of 320 kilovolt-amperes must operate continously not only during actual drilling, but also during preparatory and concluding operations, in order to insure the flow of a 220-volt current through a 500/220 volt transformer.

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A 10/.5 transformer, Type TM, of 10 kilovolt-amperes capacity, is not sufficient to ensure the operation of a clay-mixer, electric lighting, and a motor pumping water to the individual drills. Actually, a 14.5-kilowatt motor is installed for the clay-mixers, although the production of 23-kilowatt motors by the Plant imeni Petrov has been proposed since 1946.

Between 3 and 4 kilowatts are needed for the illumination of drilling operations. A 3- to 5-kilowatt motor is needed to pump water. From the foregoing it follows that the power capacity of the 500/220-volt transformer should not be less than 30 kilovolt-amperes.

In protecting the drilling-machine transformer with fuses, its selectivity is not always ensured; therefore, the cutting off of the transformer may also cut off the entire feeder. The power needs for all-metal mobile drilling substations and electric pumps have not yet been worked out. Such a system may be justified in rotary drilling, where the clay-pump motor and the winch-motor both run during drilling.

In turbine drilling the electric winch motors run only during raising and lowering operations.

Data on drilling-machine transformer loads during an entire well-drilling operation were obtained in a time test on the turbine-drilling of a well at the Krasnokamsk oil fields:

The average load of the drilling-machines transformer was small, while during actual drilling the transformer carried almost no load--a waste of its capacity because of intermittent running. It also became apparent that turbine-drilling (for a given well) consumed 715 hours; the operations that placed a load on the electric-drill motors consumed 828 hours; getting ready for operations and preparing the clay took 244 hours.

In seeking more dependable operation during the rapid drilling of inclined wells, it has recently been proposed that the column of the shaft be rotated more frequently, specifically, for 10 minutes every half hour. This additional work would greatly increase the need for a power transformer; with one, the entire drilling operation (for the well under consideration) would take 536 hours.

The time consumed in sinking a well by turbine drilling is divided as follows: (1) time during which the transformer is completely shut off, 31 percent; (2) time during the drilling of the well when the transformer is turned on, 55.4 percent; and (3) time consumed by auxiliary operations, 13.6 percent.

The elimination of no-load idling in the drilling machine's transformer would considerably decrease the expenditure of electrical energy and raise the power factor.

The power loss suffered from the no-load idling of a 320 kilovolt-ampere transformer amounts to about 1.89 kilowatts.

A reactive capacity of 6 percent in this transformer amounts to .06X320 or 19.2 kilovolt-amperes.

The problem of economy in electric energy can be worked out through a special system of grouping electrical turbine drilling equipment, which is free of the shortcomings of the present system and which takes into account the special problem of the loading of the drilling machine's transformer during drilling.

The systems for turbine drilling must ensure the following:

The supply of current for driving the clay mixer, individual water-supply and lighting must come from an independent 6,000/400/220-volt transformer of 30 kilovolt-amperes capacity, connected in a 6-kilovolt circuit, apart from the transformer for the drilling motor.

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To facilitate turning on and off of the drilling motor's transformer every half hour during actual drilling, a remote-control switch, connected directly to the site of drilling operations, should be devised.

The remote-control system should be simple and one that can set up on the spot; it should also work instantly and smoothly.

If the load for both drilling and recovery operations is centered in common radial feeders, the lack of selectivity resulting from the use of fuses in the drilling motor's transformers may lead to a stoppage of the feeders and loss of recovery. It is therefore expedient to set up automatic safeguards for the drilling substations. These will be in the form of the oil circuit-breakers. The remote-control switch should act upon the oil circuit-breaking mechanism at the substations.

With the electrical equipment grouped according to this plan, losses involved in the use of the drilling machine transformer will be eliminated. The important innovation in this plan is the remote-control of the oil circuit-breaking mechanism of the drilling substation. Generally, the oil circuit-breakers VM-14 and VM-16 are used for turning the drilling motor's transformer on and off. The operating mechanism is an automatic box with one or two maximum-current coils and one neutral coil. The oil circuit-breaker is ordinarily manually operated with the aid of a wheel.

To effect remote-control the hand-operated wheel is replaced by a lever (analagous to an automatic repeating switch), one end of which is secured to the lug of a KAM box, while a weight of 15-20 kilograms is attached to the other end (the amount of weight depending on the regulation of the oil circuit-breaker).

The driller at his station presses the "stop" button, which breaks the circuit of the neutral coil, causing the oil circuit-breaker to open.

When the lever with the weight is raised from its lowest position until the winding dog of the KAM box contacts the arm of the drum, the lever with the weight is again lowered, closing the oil circuit-breaker.

The weight is raised by an electric motor, which is equipped with an elastic friction clutch. A cable is secured to one end of the clutch, passed through a pulley, and fastened to the end of the weighted lever.

The motor is turned on by pressing the "start" button which is also located at the drillers' working station.

The operation of the electric motor in raising the weighted lever is governed by the terminal cut-off switch, which turns off the current on pressure of contact from the lever. Then, as the motor slows down, the friction clutch is released, and the weighted arm descends, closing the oil circuit-breaker.

The terminal cut-off is so arranged that it cuts off the current (when under pressure from the contacting lever) at the very moment that the winding-dog contacts the arm of the drum, thus ensuring the desired connection.

If the RBA drive, consisting of two maximum-current coils and one neutral coil, is used, the remote control system is not changed. The driving arm acts directly on the starting arm, while the weight, which is somewhat less, serves only for returning the driving lever to the initial position and for making contact.

The system described above is in operation at Molotovneft' where it has speeded up the work required for setting-up electric drilling equipment. The proposed remote-control system for operating the oil circuit-breaker of the drilling-motor's transformer has been tested in experiments. Since it is so simple and the parts so easily obtainable, it can be installed with the means available at any drilling location.

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