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DEMANDS ON ELECTRIC DRILLING EQUIPMENT DURING HIGH-SPEED DRILLING

Drilling winches are generally run by 95.5- and 130-kilowatt motors. The transformers are of 300 to 320 kilovolt-amperes capacity. Mud pumps are run by 210- to 275- kilowatt motors. Working with this electrical equipment, the "Ideal" mud pump is generally encased in a 6 3/4-inch jacket. The hoisting and lowering winches run at first and second speeds, rarely at third speed.

Under these power conditions a 250-kilowatt motor, a 95-kilowatt drilling motor, and a 300-kilowatt transformer were considered normal and sufficient for drilling even 1,000-meter wells. Increasing the power of the electrical equipment was not considered expedient, since it unavoidably resulted in underloading, which causes unnecessary losses and a lower power factor.

During the current year the Krasnokamskneft' has sunk one inclined and one vertical well, both productive, and is now engaged in drilling an exploratory well. Work was carried out at high speed, involving a new drilling technique and special operating conditions for mechanical and electrical drilling equipment.

The vertical well, No 53, sunk by speed turbine drilling, was finished in 29 days. The following are the essential statistics concerning this well:

It took 697.7 hours to reach a depth of 1,020 meters. The actual drilling occupied 191.73 hours as compared to the norm of 407.8 hours. Thus, the norm was surpassed by 282.6 percent. The greatest distance drilled after setting up the jig was 144 meters.

Time consumed in raising and lowering operations under general drilling conditions amounted to 100 - 200 percent of the norm. The crew on well No 53 put in a total of 84.13 hours in lowering the tool, as compared to the norm of 62.2 hours, while 94.6 hours were spent in raising the tool, as against the norm of 69 hours. It must be remarked, however, that failure to fulfill the norm in raising and lowering operations was not a result of insufficient speed in the operations themselves, but was due to the time taken up by subsidiary operations preparatory to raising and lowering.

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Even raising and lowering at third and fourth speeds was carried out rapidly. For example, 36 candles (svecha) were lowered 928 meters down the shaft at fourth speed in 2 minutes as against the norm for that speed of 2 minutes and 36 seconds; the corresponding raising of the candles was carried out in 2 minutes and 46 seconds, as against the norm of 3 minutes.

From the above figures it is clear that speed in sinking the shaft was effected by increasing the drilling speed and the speed of lowering the pipes and the tool.

The drilling speed was increased through the feeding of a great amount of clay mortar into the turbine drill, an operation made possible by fitting out the pump with 7 3/4-inch jackets.

Shortening the time for raising and lowering the tools was brought about by running the winch at third and fourth speeds. It is quite obvious that the load on the electrical equipment must have been much greater under these conditions than under the conditions in general prevalence up to this time.

Another turbine drill, No 224, cut a shaft 1,002 meters deep in 30 days. Exploratory drill No 31 cut a shaft 870 meters deep in 21 days.

For drill No 53 the following basic electrical equipment was set up: (1) an electric motor for the "Ideal" pump of 260 kilowatt-hours capacity, making 730 revolutions per minute; and (2) two 130-kilowatt winch motors. The electric motors were started from SB-45 type stations.

In the first stages of drilling under the jig, it was noticed that the electric pump motor became excessively overloaded and overheated, so that to avoid the risk of breakdown a 360-kilowatt, 6-kilovolt motor was installed.

During actual drilling, underloading of the pump motor was rarely noticed, but it was not subjected to any considerable overloading. The motor ran most often with a 15 - 25 percent overload.

The winch motors ran with a slight overload, and upon completion of 2 hours' hoisting and lowering operations the motor housing had become overheated beyond the permissible limit. The resistors in the SB-45 station became highly overheated.

Drill operators engaged in high-speed hoisting and lowering complained that regulation at the control stations was not gradual enough, causing the reduction motor to operate jerkily on starting. This made operations inconvenient and imparted a markedly spasmodic current to the soils of the electric motor and the drilling-machines transformer.

The housing of the drilling machine's transformer was heated above the permissible norm at the end of raising and lowering operations, and isolated instances of churning of the oil in the casing were observed.

At drills No 224 and 301 a 300-kilowatt motor for the mud pump and 130-kilowatt motors were installed.

Both jackets for the "Ideal" pump for drill No 224 were of the 7 3/4-inch size. The maximum distance drilled was 154 meters a day, achieved on the second day of drilling. During this time the pumping motor was becoming excessively overheated.

Measurements of load input of the electric motor showed that for an 80-atmosphere pressure, created by the mud pump, the load on the electric motor was from 60 to 65 amperes, while for 100 atmospheres the load was from 75 to 80 amperes.

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The normal current for a 300-kilowatt motor is about 38 amperes; thus, the motor was overloaded from 50 to 100 percent beyond it normal rating during that time. Such overloading of the motor resulted from the voluminous feeding of clay mortar at high pressure and, particularly, from the content of large fragments of rock in the clay mortar washed out of the well in this method of drilling.

A gradual change in the method, then, would have been needed for the protection of the motor, but to determine the power required for the sinking of well and the penetration capacity of the drill, this system was maintained daily, even at the risk of a motor breakdown. During the succeeding days, one of the 7 3/4-inch jackets was replaced by one of 6 3/4 inches to lighten the load on the motor. This greatly reduced the load on the pumping motor, lowering it to 40 - 50 amperes, but it also reduced the rate of cutting, precluding the fulfillment of the maximum possible penetration.

In succeeding stages of cutting it was not feasible to replace the 6 3/4-inch jacket with one of 7 3/4 inches, since the motor ran with an overload even with the 6 3/4-inch jacket.

Thus, it was determined at well No 224 that in case of extremely extensive cutting, accompanied by a voluminous pumping out of rock particles, the pumping motor attained a maximum power input of 500 - 600 kilowatts.

Work on exploratory well No 301 also confirmed that a 300-kilowatt pumping motor carries a load of 40 - 50 amperes.

The 300-kilowatt drilling machine transformer at well No 224 became overheated in the same manner as the one at well No 53.

It must be remarked that 300-kilovolt-amperes drilling-machine transformers are forced to run with an overload for frequent short-term periods. It is obvious that the transformer will become overloaded when the reduction motors are overloaded.

Special consideration must here be given the drilling-machine transformers produced in 1947 and 1948. These transformers are equipped with high-voltage windings because of the complex coils which make it difficult to cool overheated windings with oil. This type of winding also demonstrated very poor resistance to dynamic strain exerted on the coils during overloading.

Five transformers of this type were employed with drilling machines for periods of from 2 weeks to 1½ months, after which they all broke down. Inspection of the defective windings revealed in every case, distention and multiple ruptures, as well as carbonization of the insulation on the interior parts.

Rewinding of the coils by the local station technicians was not satisfactory, and the trust was therefore obliged at that time to rewind the high-voltage coils of the drilling-machine transformers, doing it by individual disks, as was done in the drilling-machine transformers produced previously.

It must be concluded that a 300-kilovolt-ampere transformer with complex coils is not suitable for continuous drilling nor, in particular, for high-speed drilling, since these transformers are designed for uniform loading; and short-term and sometimes heavy overloading of drilling-machine transformers is unavoidable.

The expenditure of electric energy per meter drilled during high-speed drilling proved very interesting. In the producing inclined well, No 224, 1,002 meters deep, 70 kilowatt-hours were expended in cutting one meter; and in the exploratory well, No 31, 870 meters deep, 72 kilowatt-hours were expended in cutting one meter.

The norms established for the trust are 130 kilowatt-hours per meter of cutting for wells up to 1,000 meters deep. This norm was considered very difficult to fulfill and even under the very best conditions before the introduction of speed-drilling methods the electrical energy expended approached 110 kilowatt-hours per meter drilled.

Such a marked reduction in expenditure of electrical energy in high-speed drilling is the result of the great speed in cutting attained by the drilling crews, made possible by the excellent organization of operations, the reduction of the work of electric motors during raising and lowering operations, the curtailment of the idle no-load periods in motors, and the maintenance of the most satisfactory loads for the electrical equipment.

Conclusions

1. Speed drilling increases the speed in sinking the wells, renders operations more economical, and lowers the expenditure of electric energy per meter cut.

2. The power capacity of existing electric pumping motors (180 - 300 kilowatts) is not sufficient and should be increased to 400 - 450 kilowatts. In this connection, the power capacity of mud pumps should be reconsidered.

It is necessary to strive for thorough removal of large fragments of rock from the clay mortar since these increase the load on the pump motor.

3. The capacity of 300-kilovolt-ampere transformers is not great enough; it should be increased to 400 kilovolt-amperes.

The high-voltage winding in drilling-machine transformers should be in the form of individual disks since they are better able to stand short-term overloading.

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