liability of the well head equipment. Parts of the gate unit of the shut-off element are most subjected to corrosion attack. Our analysis of gate breakdowns showed that these are caused by the phenomenon of coalescence of the friction pair material with subsequent seizures. The sulfocyaniding process has been introduced to neutralize this (process of saturating the steel surface simultaneously with nitrogen, carbon, and sulfur) [1]. This work was carried out by the PKTBkhimmash jointly with the Lepse Mechanical Engineering Factory. The efficiency of sulfocyaniding was checked in wells of the "Chernushkaneft'" Administration for Oil and Gas Extraction [2].

There was noticeable improvement in the working of the shut-off device with the use of lubricant Armatol-238 (TU 38.101812-83) which has a range of use from −50 to +120°C. With good adhesion and flow characteristics, this lubricant facilitates reliable sealing of the valve gate and effective protection against corrosion failure.

The application of all these technical solutions together led to a 30% increase in reliability of the Christmas tree and tubing head. There was substantial extension of the range of application of production devices to intensify oil production from wells operated with the use of similar well head equipment. Annual economic effect from one set of the new equipment was 500 rubles. The technical level of the new Christmas tree and tubing head in terms of its indices is consistent with that of the best analogs abroad. Qualitywise, it has been certified in the highest category.

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STAND FOR INVESTIGATING THE CHARACTERISTICS OF DOWNHOLE MOTORS

Yu. V. Sadykhov, B. I. Es'man,
R. Sh. Azizbekov, E. S. Zhidkov,
and V. S. Dymov

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At present, the advisability of lowering a turbodrill into the well bottom is determined by its successful start-up on the surface. However, the operating characteristics of the drill vary in proportion to the wear of its rubbing parts (even after adjustment of the play). For instance, there is drop in power and torque on the shaft, increase in torque expended on friction at the pivot with increase in amplitude of load pulsations [1], and there are even other factors which adversely affect the operational stability of the turbodrill.

The combined effect of these factors leads to the fact that a drill that has worked satisfactorily on the surface can be braked at the well bottom even with small loads on the bit. In view of this, the need exists for a compact stand in the borehole to facilitate modeling of the dynamic conditions of drill operation at the well bottom over the entire range of their possible variations in practice.

A stand for evaluating the actual characteristics of new and repeatedly used turbodrills directly in boreholes and under stationary conditions has been jointly developed by the Institute for Study of Problems on Deep Oil-and-Gas Deposits and the GFP Special Design Office of the Institute of Geology of the Academy of Sciences of the Azerbaidzhan SSR [2]. The design of the stand facilitates reproduction of any dynamic conditions of loading of the turbodrill corresponding to predetermined drilling conditions.

The stand (Fig. 1) consists of loading device 1 rigidly connected with brake 2 consisting of hydraulic motor 3 and spur-gear reduction gear 11. The force pipes of the loading device are connected to the pressure cavities of the hydraulic motors located along the circumference coaxially with the axis of the central wheel of the reduction gear. The reduction

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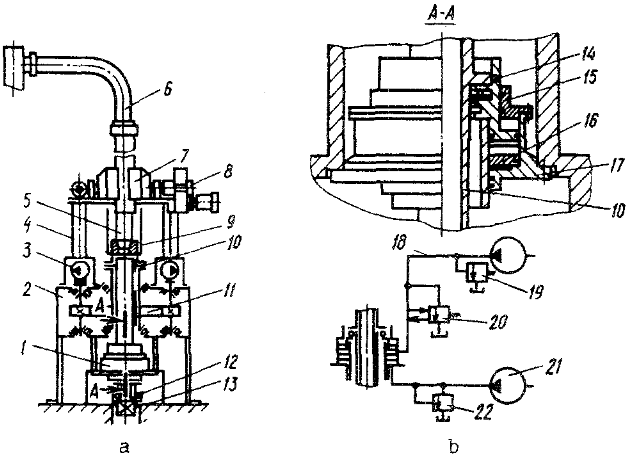

Fig. 1. Structural diagram of the stand for investigating the characteristics of downwhole motors: a) diagram of stand; b) diagram of fluid circulation system.

gear, in turn, is kinematically connected with stepped shaft 10 of square section which can move axially inside the central gear wheel. The stepped shaft is supported on thrust bearing 14 by the annular projection of top plunger and rod 15. The bottom plunger and rod 16 rests on the shoulder of this projection. The plunger and rod shaft along with hydraulic cylinder 17 are constituents of the loading device.

The force pipe 18 with pulsating pressure is connected to the cavity between the plungers and rods while force pipe 21 with constant pressure is connected to the cavity below bottom plunger 16.

Adapter 9 is fitted at the top part of the stepped shaft for connecting it with shaft 5 of the investigated downwhole motor. The motor body is fastened with adjustable clamp 7 fixed on horizontal stand 8. This stand is rigidly connected with the brake body by means of vertical columns 4.

The free play coupling 12 is mounted on the bottom part of the stepped shaft. The outer housing of coupling 12 is connected with device 13 for forced start-up of the motor.

For using the stand under borehole conditions, it is mounted on the rotary table such that device 13 goes into the square hole in the rotary table. Then, the turbodrill with adapter 9 screwed onto its spindle beforehand is introduced through adjustable clamp 7 such that the top square part of shaft 10 goes into the square hole of adapter 9. The motor body is gripped with clamp 7. To ensure stability of the downhole motor—stand system, the top part of the drill is fastened with quick-release guides mounted on the top worker's platform (not shown in Fig. 1).

The investigated motor is connected to the circulation system by means of flexible pipe 6. If the motor does not start due to the fluid flow, it is force-rotated by the rotor with the help of device 13. Reduction gear 11 connected kinematically with shaft 10 actuates hydraulic motors 3. The total power of these motors equals that consumed by the motor due to friction of the rock-breaking tool against the well walls. The motor is loaded with the required pulsating load by means of loading device 1.

This is achieved by the fact that a constant pressure corresponding to minimum axial load on the investigated motor shaft is created in the cavity below bottom plunger and rod 16 by adjusting safety valve 22. A pulsating pressure with pulsation period ranging from zero to the pressure corresponding to maximum axial load on the well bottom is created in the cavity between plunger and rod 15 and 16 by adjusting safety valve 19 and pulsator valve 20.

The important feature in the stand is the possibility of testing downhole motors at constant frequency of axial load pulsations but with differing amplitude of its variations and at constant amplitude but varying frequency of pulsations. If it is required to reproduce a loading of the turbodrill by an axial load of amplitude ranging from G_{min} to G_{max} and differing frequency of pulsations, a constant pressure p_{min} corresponding to axial load G_{min} =

$p_{min}F$ (here, F is area of plunger and rod) is created below the bottom piston. Thereafter, the pulsating pressure is created in the cavity between the pistons. In addition, the pulsator valve opening pressure is adjusted such that $p_{max} = G_{max}/F$. The pulsator valve closing pressure can be randomly varied from zero to p_{max}. In this case, amplitude of axial load pulsations will remain constant (from G_{min} to G_{max}) and frequency of pulsations will change in relation to variation in the ratio of the constant pulsator valve opening pressure and the variable pressure of its closing.

For this, the pulsator is so adjusted that for a set valve opening pressure (which ensures the set p_{max}) the set frequency of pulsations would be achieved by selecting the valve closing pressure p_c. By creating a constant pressure ranging from p_c to p_{max} below the bottom piston, the amplitude can be changed from p to p_{max} for a given constant frequency of axial load fluctuations. In this case, it is necessary that $p_c \leq p \leq p_{max}$.

The rigid connection of all units in the stand (clamp, brake unit, and loading device) sharply cuts down the time for pre- and post-test assembling and dismantling operations. This makes it possible to use the stand in boreholes for determining the serviceability of the downhole motor before lowering it into the well under conditions caused by the drilling schedule.

For using the stand as a stationary unit for recording the characteristics of downhole motors, constant pressure force pipe 18 can be connected to an independent pump.

Turbodrills of all standard sizes can be tested on the stand since all loading elements and control-measuring devices are directly connected to shaft 10 of the stand. The design of the stand consists entirely of serially manufactured standard accessories without any non-standard elements. This makes the stand very inexpensive.

Under stationary conditions, the stand makes it possible to solve the practically very important problem of the effect of pulsating loads on motor capacity of the turbodrill itself and of its individual units, first of all, its bearings.

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