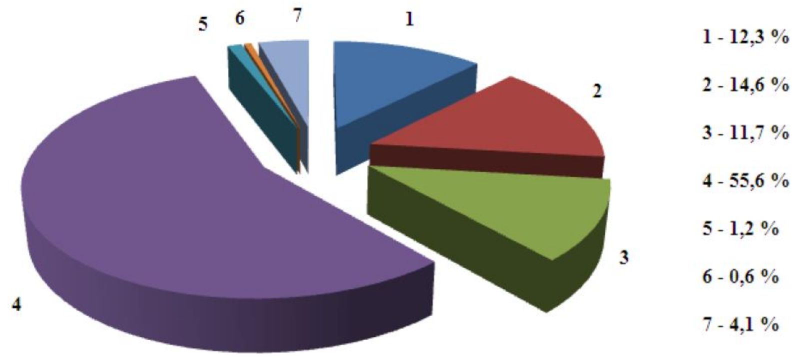

Fig. Accidental situation of electrical motor-driven compressor unit within period 2005 - 2012 in dependence of their causes: 1–failure/malfunction of electrical equipment; 2 – failure of instrumentation and control equipment systems; 3 – mechanical damage; 4 – power supply problems; 5 – administration system problems; 6 – oil system problems; 7 – operational imperfection

Based on the obtained results, failure history of electric motor-driven compressor unit, basic accident causes were:

- failure of electrical equipment*;*
- failure of instrumentation and control equipment systems*;*
- mechanical damage*;*
- power supply problems.

Above-mentioned main accident causes are largely determined by the influence of the human factor which determines the effective and safe operation of compressor unit not less than the technique. All this causes are qualified as regulated and controlled parameters by improving professional skills of service personnel and implementing technical standards.

References

1. Identificaciya neispravnostei gasoperekachivaushih agregatov po funkcional'nym priznakam / Semenov A.S I dr. // Neft I gaz. Novye tehnologii v sistemah transporta: sb. Nauch. Tr. / TyumGNGU. Tyumen', 2004. S. 82-87 [in Russian}.
2. Eremin N.V., Stepanov O.A./ Yakovlev E.I. Kompressornye stancii magistral/nyh gazoprovodov (nadezhnost' I kachestvo). Spb.: Nedra, 1995. 336 s. [in Russian]

DEVELOPMENT OF TECHNICAL AND TECHNOLOGICAL SOLUTIONS FOR SURFACE CASING DRILLING IN DULISMINSKOYE OILFIELD (IRKUTSK REGION)

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Oil and gas sector of East Siberia has been developing significantly in the Russian industry for last years, due to hydrocarbons. Oil reserves in Verkhnechonskoye field are estimated at 196 million tons, at Tolokanskoye and Yurubcheno-Tokhomskoye fields –more than 170 million tons; at Dulisminskoye oil and gas condensate field (DOGCF) – 81.5 million tons of oil and condensate, and 80 million m^3 of gas [1]. However, all hydrocarbon reserves in East Siberia are under difficult drilling conditions due to the complex geological structure of subsurface in the region.

Drilling process has shown that the surface casing drilling in the intervals of 0-300 m at Dulisminskoye field of Irkutsk region is systematically done under incompatible drilling conditions, because of exogenic rock fracturing in the interval of Litventsevskaya and Verkholenskaya suites [2].

The drilled rocks of Verkholenskaya suite are made by interbedding fractured siltstone of IV category (according to drillability), 7^{th} abrasiveness category with the density of 2650 kg/m^3; as well as claystone and highly fractured dolomites of III, V category (according to drillability)/ Also there are marls of V category (according to drillability), 4^{th} abrasiveness category and the density of 2670 kg/m^3.

The density of the above mentioned rocks in compliance with L.A. Shreyner's method varies from 20 to 142 kgs/mm^2**.**
The rocks of Litventsevskaya suite are made of fractured limestones, dolomites and gypsum. The mineral density of these rocks of the suite is 2200 – 2850 kg/m^3**;** hardness varies from 25 to 571 kgs/mm^2**.** Average abrasiveness of the rocks of this suite is 3.5.

Due to the specific geological structure and, in particular, the interbedding of rocks with contrastively different permeability and mechanical properties, the surface casing drilling in the interval of 0 – 300 meters is made with mud loss of 30 cubic meters per hour that is incredibly consuming. For example, mud loss equals to 20 cubic meters per hour began at the depth of 50 meters in well №1106, as well as in well №713 drilling was performed without mud circulation in distance of 110 - 300 meters. Also mud loss of various intensity is taken place during the surface casing drilling in the interval of 125 to 282 meters in well № 202. In a result, the total mud loss per the interval equals to 580 m^3. It is practically impossible to prevent mud loss at such depth by mud lightening.

Clogging material pumping into fractured formations failed too. As a result, the time of surface casing section installation of Dulisminskoye field was up to 20 days.

The important factor in solution of mud loss problem at Dulisminskoye field is considered not to have real operational situation in the drilling design. For example, according to pressure scheme, mud loss in the interval of 0 – 300 meters occurs with pressure of 1,34 10^{-2} MPa/m, however, mud loss of various intensity occurs even when technical water is used to sweep well. Real pressure in this case is significantly lower than the indicator in pressure scheme. Thus, the information given in the design is not suitable to use it in drilling process, and in this situation it is necessary to use other sources of data.

To solve of given problem, analysis of special technical and geological information was made by the author. [3,4,5,6,7].

In particular, it was found that it is very important to consider the drilling practice and the results of rotary-percussive drilling with blowdown in Naryksko-Ostashkinskaya area of Kemerovo region [5]. The drilling is made to produce gas from coal formations.

The interval in a rotary-percussive technique was made in the following rocks: clay, touchstone, sandstone, siltstone, mudstone and coal. The density of rocks in this interval ranges from 1300 kg/m^3 to 2730 kg/m^3. Maximum compression breaking strength of the rocks in this interval ranges from 60 kgs/cm^2 to 620 kgs/cm^2. Average abrasiveness of the rocks is 1.5. Accotding to drillability, the rocks belong to the following categories; clays – III, touchstones – IX, sandstones – V, siltstones, mudstones and coal – IV. The elastic modulus of the rocks of Litventsevskaya suite ranges from 400 kgs/mm^2 to 3200 kgs/mm^2.

Based on systematic mud loss indicators, as well as the rock structure in Narykska -Ostashkinskaya area the technical specialists gave an advice to use rotary-percussive drilling and blowdown in the interval from 0 to 150 meters. Justifying this choice, the evidences of accidents-free well drilling were given. [2].

In a process of drilling, BHA with downhole percussive drills was used in mud loss interval equals to 0-150 m. BHA for rotary-percussive drilling is given in Table.

Table

BHA, used for rotary-percussive drilling in Narykska-Ostashkinskaya area

Serial №	BHA components	External diameter, mm	Length (height), m	Mass, kg	Function
1	2	3	4	5	6
1	DTH Drill Bit 311 mm	311	0.33	105.3	Bit
2	Downhole percussive drill DTH HAMMER TD 90	196.8	1.6	238.6	Percussive drill
3	Stabilizer sub	139.7	0.38	31	Sub
1	2	3	4	5	6
4	Stabilizer	301.6	3.66	885	Stabilizer
5	HWDP sub	196.8-139.7	0.45	72	Sub
6	HWDP 139.7	139.7	9.1	893	HWDP
7	Sub	196.8-139.7	0.45	72	Sub
8	Stabilizer	301.6	3.66	885	Stabilizer
9	HWDP sub	196.8-139.7	0.45	72	Sub
10	HWDP 139.7	139.7	9.1	893	HWDP
11	Sub	196.8-139.7	0.45	72	Sub
12	Stabilizer	301.6	3.66	885	Stabilizer
13	HWDP sub	196.8-139.7	0.45	72	Sub
14	HWDP 139.7	139.7	Rest	11500	HWDP

According to operational data, air generation and pumping into wells were done with following compressors:

- Ingersoll Rand deck-based compressor with an output of 35.4 m^3/min and the operating pressure of 2.5 MPa;
- XRVS606 compressor with the capacity of 36 m^3/min and the operating pressure of 2.5 MPa;
- XRVS336 compressor with the capacity of 19.8 m^3/min and the operating pressure of 2.5 MPa;

It was proved that while drilling, in order to provide a good quality clearing of the wellbore, speed of air-water mixture flow rising should be 15 – 30 m/s. Based on these indicators; air supply rate from compressors was calculated. Maximum output of the three compressors is 91 m3/min. Speed of flow rising with such output, taking into account possible water inflow (100 m^3/day) is 19 m/s. In a case of minimum water inflow, speed increases to 23 m/s.

It was also proved by field tests, while the rotary drilling with a blowdown, the following three types of pressure loss are taken into account [5]:

- the fluid column pressure – 1 MPa,
- the bit pressure – 0.4 MPa,
- In the annulus and feeding lines pressure – 0.4 MPa.

Total pressure loss in air circulation drilling is 1.8 MPa.

Special drilling parameters were designed for interval: Bit load – not more 20 kN, bit rotating speed – 1 rotation per 0.1 meters of depth, maximum supply of compressed air – 91 m^3/min. Surface casing drilling in Narykско-Ostashkinskaya area with these parameters allows achieving accident-free drilling, and mechanical drilling speed up to 18 m/hour.

Finally, the time for surface casing drilling for wells № 13, № 15, № 17, № 19, № 25, № 27 and № 29 was on average 27 hours.

This result indicates the efficiency of fractured rocks destruction, including high drillability category rocks, with rotary-percussive drilling and blowdown.

The mentioned above facts show the possibility of using this technique at Dulisminskoye oil field with mobile drilling rigs by Sramm. We suggest using mobile drilling rig and then the standard drilling equipment. This method was informally called “advance” or “keep ahead drilling”.

The novelty and practical effect of the proposed solution is not only in the justification of the use of downhole percussive drill and air for surface casing drilling at Dulisminskoye field, but also in the development of technique, as well as optimal drilling modes, and also in the practical implementation of the “keep ahead” drilling.

As any other technical or technological solution, the implementation of blowdown requires a detailed analysis and research. An important component of the research is the results evaluation and the experience analysis of rotary-percussive drilling and blowdown. It is planned to do in solving mud loss problem at Dulisminskoye field for the nearest future.

To show other aspect of surface casing drilling at Dulisminskoye field, it should be noted that there is a disadvantage of actual G&G data for drilling wells. Thus, for example, due to various reasons, there are no data on the geophysical survey of Verkholenskaya and Litventsevskaya suites. It prevents to identify the reasons for mud loss in the interval of 0 – 300 m and make difficult the development of drilling technique involving downhole percussive drill.

Nevertheless, it can be assumed that the analysis of rock, their genesis, and sedimentation conditions allows identifying the possibilities for advance drilling

Conclusion

The mentioned analytical data of the tectonic framework in the region, lithological rocks characteristics in the well cross-section, as well as rock composition, the process of geological area formation, and the similarity of geological conditions at Dulisminskoye and Narykско-Ostashkinskaya fields in terms of rock fracturing, fossilization, and the successful experience of blowdown in Narykско-Ostashkinskaya area is considered as positive aspect for advance drilling at Dulisminskoye field.

References

1. Avraamenko M. The oil of East Siberia is hard to recover but is necessary // Continent Sibir. – Novosibirsk 2010. – №12. – P. 6-7.
2. Antropov P.Ya. USSR Geology. Volume XVIII. Irkutsk region. – M.: State scientific and technical publishing house for geology and subsoil protection literature, 1962. – P. 74-89.
3. Bronzov A.S. Well drilling using gaseous agents. – M.: Nedra, 1989. – P. 56-75.
4. Mekhtiev E.Kh. Well drilling using bottom-hole cleaning by aerated fluids. – M.: Nedra, 1980. – P. 78-93.
5. Drilling program for well №19 at Narykско-Ostashkinskaya area // Kemerovo 2011. – P. 12-16.
6. F.A. Shamshev, S.N. Tarakanov, B.B. Kudryashov. The technology and the methods of exploration drilling. – M.: Nedra, 1983. – 565 p.
7. B.B. Kudryashov, A.I. Kirsanov. The drilling of exploration wells using air. – M.: Nedra, 1990. – 263 p.

PERSPECTIVES OF SPECIALLY PROTECTED SITE NETWORKS OF TOMSK OBLAST

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Specially protected sites are one of the key tools for saving biological and landscape diversity. In recent years one can observe fragmentation of landscape due to linear building (roads, transmission lines, pipelines etc.), extension of farmlands and new field development. In these conditions protected natural sites are becoming shelters for some species of animals and plants which can otherwise be extinct.

At present there are 218 specially protected sites in Tomsk Oblast with the total area 1378,1 thousand hectares or 4,38% of Oblast area (Table). The most area is covered by the specially protected sites of regional significance among which there are the following types distinguished according to the Federal law of 14.03.1995 № FL-33 [4]: state reservations, natural monuments, botanic garden. Among the additional types accepted in accordance with the Law of Tomsk Oblast of 12.08.2005 № 134-OL [2], there are some recreation sites (see Table).