Improving the quality of core sampling from methane coal seams

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Abstract. In the article, the authors talk about ways to improve the quality of core sampling from methane coal seams in the Kuznetsk coal basin. Core sampling is carried out at the exploration wells of Naryksko-Ostashinskaya square. Methane extraction is carried out to remove gas from coal seams. Moreover, gas can be used as unconventional energy sources. Thus, safety at coal mining facilities increases, and we receive additional income for the sale of gas to end consumers. To develop a technology for extracting gas from coal seams, core sampling is carried out, and the results obtained are analyzed. Further adjustments are made to the extraction technology, the selection of technological equipment is carried out. Drilling is carried out in the following sequence: initially, a vertical well with core sampling is performed, and then a multi-hole well is drilled with a large face deviation. As a result of experimental core selection and development of improved equipment, core removal was increased from 77% to 100%. Key words: core sampling, drilling technology, coal seams.

1 Introduction

Since 2001, the Russian Federation has been developing coal-bed methane in the Kemerovo region. A research site has been built and experimental work is underway to create innovative technological solutions for the production of coal-bed methane.

Methane is an associated mineral or hydrocarbon gas that is extracted from coal seams by drilling wells. Russia has a large number of coal deposits, which have large volumes of associated hydrocarbon gas, which is the cause of most accidents in the extraction of coal from mines. In order to avoid methane explosions and at the same time use it as an alternative energy source and generate additional income, research is being carried out in the field of extracting methane from coal seams.

It is not by chance that the Kuznetsk coal basin was chosen as an experimental site for studying the issue of hydrocarbon gas (methane) production on an industrial scale, since more than 15% of the total reserves of coal-bed methane in the Russian Federation are concentrated here. Thus, it was necessary to investigate the following factors:

- the volume of natural gas reserves in the Naryksko-Ostashinskaya area up to 0.918 trillion. m3;
- horizons/depths/number of productive groups;

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- horizons (P3gr) of the Gramteinskaya suite with a working coal content ranges from 6.1-13%;
- deposit occurrence (100-160m–565m-600m-1800m).

2 Materials and methods

Scientific research is carried out by means of core selection. Prospects for estimating methane reserves in the Naryksko-Ostashinskaya area should be formed taking into account: the complexity of the geological structure of coal deposits; the size of the deposits; gas permeability of coal seams; ash content of coals; thickness of coal seams; coal content; natural gas content of coal seams; depth of occurrence of coal seams; the need to ensure the safe development of methane-coal deposits by underground mining; extraction technologies; availability of development; ecological situation of the region.

3 Results

The volumes of produced gas (methane) at the Naryksko-Ostashkinskaya area are constantly growing. For example, in 2010, 6 million m3 were produced, and in 2016 already 17 million m3.

Well construction is carried out as follows, first a vertical well is drilled, at the second stage a multilateral well with a large bottom hole deviation from the vertical at the Naryksko-Ostashkinskoye methane-coal field of Kuzbass.

Main goals:

- obtaining industrial production rates of methane from coal seams.
- refinement of production technology and selection of technological equipment for gas (methane) production from coal seams with different geological and field characteristics and transfer of resources into reserves of industrial categories with subsequent preparation of the geological, geophysical and technological basis for industrial production.

Since 2020-2021, the construction of 2 exploratory wells No. 366R and No. 431R in this area has been successfully completed.

The purpose of drilling exploration wells:

- implementation of a complex of core and geophysical studies;
- implementation of trial operation of experimental wells.

As a result, a technology was developed for drilling wells for gas production from coal seams, which was tested while drilling wells at the Naryksko-Ostashkinskoye methane-coal field.

The Naryksko-Ostashkinskoye methane-coal field is located not far from the city of Novokuznetsk, in the Prokopyevsk district of the Kemerovo region, not far from Novokuznetsk. The reliability of natural gas reserves estimates at the Naryksko-Ostashkinskoye methane-coal field largely depends on the quality of the core, one of the main requirements for which is the characterization of coal seams. In the process of carrying out work during the construction of wells, special attention was paid to the core-coal brought to the surface and its safety.

Modern core sampling technologies are a complex of various technological measures related to the organization of sampling (selection of optimal modes to achieve, in order to maximize the removal of core-coal) and core recovery, organization of work on the surface, analysis to determine open porosity and bulk density according to helium gas-volumetric method, study of the microstructure of samples, determination of the strength characteristics of rocks under uniaxial compression and ensuring the safe transportation of the core to Kemerovo.

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1. Coring projectile UKR-185/100, 9 meters long, designed by "Trias-NV" LLC (Figure 1).

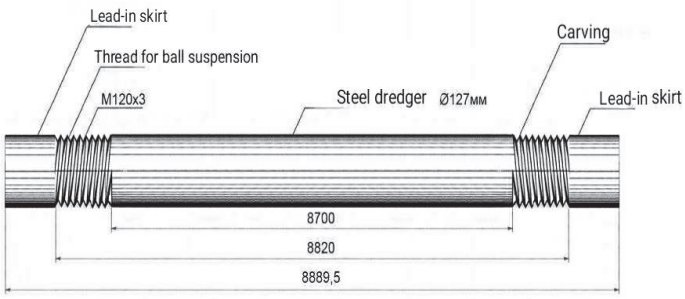

Fig. 1. Coring tool UKR-185/100 (OOO Trias-NV).

The core receiving device UKR-185/100 "Tengiz" is designed for drilling oil and gas wells with a diameter of 212.7 to 220.7 mm with core sampling with a diameter of 100 mm, both by rotary and turbine methods at a working environment temperature of not more than + 110ºC.

A feature of the UKR-185/100 system is the presence of a reusable metal core tube and a disposable fiberglass thin-walled liner. The core is lowered onto the catwalks in a steel core pipe, which minimizes the impact on the core of the steel pipe bending process

2. Disposable fiberglass primers with marks TKPS-DN114 * 3-9300 ANS, which were inserted into a steel primer divided into two parts (4-5m), manufactured by Kompozitmash LLC, Perm (Figure 2).

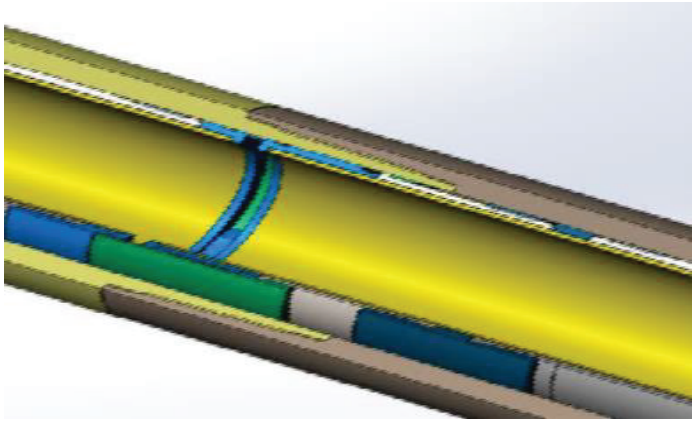

Fig. 2. Core pipe with liner (fiberglass dredger and cut-off valve).

3. Burhead for sampling of coal BS215.9/100-911 ISM, developed by the authors and manufactured by OJSC NPP Burservis, Ufa (Figure 3);

Fig. 3. Burhead for sampling of coal BS215,9 / 100-911 ISM with the system (Low invasion).

4. Type of isolating agent "ISOKOR".

Isolated core sampling fluid is a solution of a macromolecular compound in polyesters containing a crosslinking agent, characterized by high rheological properties, adhesion, lubricity and practically does not mix with water-based drilling fluid.

Drilling per run was 2 meters from each interlayer of a dual coal seam in terms of thickness, represented (coal, carbonaceous mudstone, V-VI category in hardness). 8 meters of core were taken from each well. The total coal seam penetration was 4100 meters according to "Trias-NV" LLC (Figure 4).

During the performance of core sampling, isolation technology was used, which makes it possible to obtain a core that, in terms of its parameters, is analogous to a core obtained in a well and brought to the surface. This provides an increase in the information content of the recovered core and the reliability of petrophysical data due to an increase in the removal, representativeness, safety and adequacy of the core material.

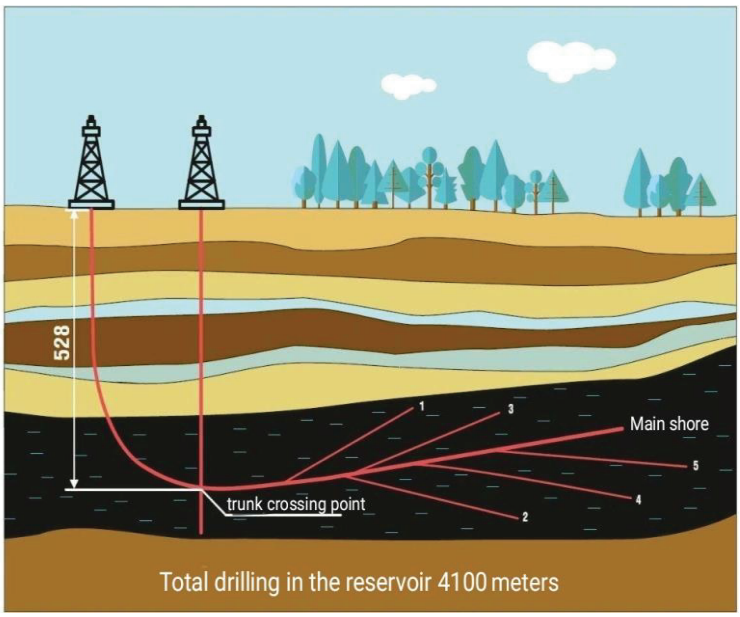

Fig. 4. Total drilling through the reservoir during well construction according to Trias-NV LLC.

- Well 431 R- drilled 7.2 m, offset was 6.9 m or 96%
- Well 366 R - drilled 8.0m, offset was 8.0 m or 100%. From the experience of selection in 2012 at the Naryksko-Ostashkinskoye methane-coal field

1. Well No. 28 from 12 layers of 2 meters drilled 24.6 m, the recovery was 16.2 or 66%
2. Well RN-20 out of 10 formations drilled 13.7 m, the recovery was 12.5 or 91.2%
3. Well RN#30-N from 9 formations drilled 18 m, recovery was 16.8 m or 94%

Laboratory analysis of the study of methane from the recovered core from the well is shown in Table 1. Coal was obtained in black, semi-gloss, with shiny streaks, the texture is banded, fractured, brittle, in the form of a trifle; pieces size: 4.5x1.5x3.5; 4.5x1.5x3.5; 4.5x3x1.

Table 1. Laboratory analysis of the core.

<table>
<tr><th colspan="2">Core output</th><th rowspan="2">Total sample weight. g.</th><th rowspan="2">Coal weight. g.</th><th rowspan="2">Breed weight. g.</th><th rowspan="2">Total sample weight</th><th colspan="3">Technical analysis of coal</th><th>Real density. g/cm3</th><th colspan="2">Gas zone</th></tr>
<tr><th>m</th><th>%</th><th>W^a. %</th><th>A^a.%</th><th>V^{daf}. %</th><th>GOST 2160</th><th colspan="2">OST 41-01-276</th></tr>
<tr><td rowspan="2">0.27</td><td rowspan="2">67</td><td rowspan="2">dry</td><td rowspan="2">580</td><td rowspan="2">0</td><td rowspan="2">580</td><td>-</td><td>-</td><td>-</td><td>-</td><td colspan="2">Methane-nitrogen</td></tr>
<tr><td>0.6</td><td>4.8</td><td>15.8</td><td>1.37</td><td colspan="2"></td></tr>
<tr><td rowspan="3" colspan="2">Weight of combustible mass. g.</td><td rowspan="3">Total volume of combustible gases. cm3</td><td colspan="2">Methane content of the sample</td><td colspan="2">Sample methane content with coefficient 1.25</td><td rowspan="3">Volume of CO_2</td><td colspan="2" rowspan="2">CO_2 content</td><td colspan="2">Plastometry</td></tr>
<tr><td colspan="2" rowspan="2">GOST1186</td></tr>
<tr><td>cm3</td><td>g/cm3 g.s.b.m.</td><td colspan="2">m3/ t c.b.m.</td><td>cm3/g</td><td>cm3/g g.s.b.m.</td><td colspan="2">Characteristics of the beetle</td></tr>
<tr><td colspan="2">548.7</td><td>656.5</td><td>1.13</td><td>1.20</td><td colspan="2">1.5</td><td>147.5</td><td>0.25</td><td>0.27</td><td>x.mm</td><td>y.mm</td></tr>
<tr><td colspan="10"></td><td>5</td><td>6</td></tr>
</table>

Drilling of experimental wells includes drilling a vertical well with coring and then drilling a multilateral well. The "chip" of drilling wells is that you need to go through the coal seam and get into a previously drilled vertical well located at a distance of 700 meters.

The vertical well is intended for extraction of methane from coal seams as a result of pumping out the formation fluid and reducing the pressure in the formation to the level required for gas desorption. A multilateral well (MLT) crosses a vertical wellbore and has a maximum drainage area due to sidetracks. At the same time, for the first time in Russia, unique navigation equipment of domestic production was used - a rotating magnetic field (RMF).

4 Discussion

When developing the concept of the multilateral wells and at the stage of developing design solutions, the results of research, the complexity of drilling wells with a large bottom hole deviation from the vertical were taken into account, the well design was selected and calculated in detail, the trajectories and tasks for calculating the coordinates and parameters of the actual well profile were developed: the main and sidetracks, taking into account geological surfaces, determination of the actual depth along the vertical of the wellbore,

control of the well trajectory during drilling and the accuracy of the implementation of the design profile of the well, prevention of intersection with the wellbore of adjacent wells, determination of the patterns of wellbore curvature, estimation of the intensity of the wellbore curvature, control of the downhole motor-deflector for correcting the process of drilling a well trajectory of the wellbore. Non-standard solutions to emerging problems were worked out, focusing on the experience of building similar wells in methane-coal deposits abroad.

Drilling is carried out in two stages. At the first one, a vertical well is drilled, which serves directly for the extraction of methane from coal seams. At the second stage, a multilateral well is built, which crosses the vertical wellbore and has a maximum drainage area due to sidetracks. All design solutions were designed taking into account the experience of building wells at methane-coal deposits in the Kuznetsk basin.

In the course of work on the construction of wells, round-the-clock monitoring was carried out. Based on the results of the work, adjustments were made to the intervals for coring. All work was carried out by Gazprom Nedra LLC.

5 Conclusion

Degassing of coal seams immediately prior to commercial coal mining is a factor that ensures the safety of further technological processes. The cost of the main production is reduced due to the use of an alternative energy source in the form of methane. The tasks set for core sampling were successfully completed and a lot of experience was gained in carrying out work - core sampling from coal methane seams. When using the considered complex of technological equipment, the core recovery was increased from 76% to 100%.

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