SOI: 1.1/TAS DOI: 10.15863/TAS
International Scientific Journal
Theoretical & Applied Science

p-ISSN: 2308-4944 (print) e-ISSN: 2409-0085 (online)

Year: 2023 Issue: 10 Volume: 126

Published: 02.10.2023 http://T-Science.org

Issue Article

Annaguly Rejepovich Deryaev
Scientific Research Institute of Natural Gas of the State Concern „Turkmengas"
Doctor of Technical Sciences, Principal researcher,
Corresponding Member of International Academy of
Theoretical and Applied Sciences,
Ashgabat, Turkmenistan
annagulyderyayew@gmail.com

PROCESS CONTROL FOR DRILLING WITH A HORIZONTAL END OF THE BARREL BY ELECTRIC DRILLING

Abstract: *The article discusses studies on the management of the drilling process of horizontal wells, as well as instructions on choosing the type of profiles for directional wells in the Western part of the oil and gas fields of Turkmenistan in order to successfully complete the projected well. When developing a profile for drilling, it is necessary to provide for the angle of meeting of the projected productive formations with the projected trajectory and the intervals of possible natural curvature at intervals. The use of these data determines the type and shape of the hole trajectory by sections, as well as the curved part of the hole, zenith angle, azimuth angle, displacement of the hole from the vertical, etc.*

For research on the management of the drilling process of horizontal wells, materials of previously drilled wells, geological characteristics were used. This paper provides a detailed analysis of the complexity of the study on the management of the process of drilling horizontal wells and their specific causes, as well as recommendations on the choice of methods for managing the process of drilling horizontal wells. This work can be used to perform the assigned tasks when drilling directional wells and for the development of deposits with complex mining and geological characteristics.

Key words: *permeability, porosity, phase, water saturation, meeting angle, deflection angle, typical profile, additional hole, apsidal horizontal, projection.*

Language: *English*

Citation: Deryaev, A. R. (2023). Process control for drilling with a horizontal end of the barrel by electric drilling. *ISJ Theoretical & Applied Science, 10 (126),* 9-15.

Soi: http://s-o-i.org/1.1/TAS-10-126-2 ***Doi***: crossref https://dx.doi.org/10.15863/TAS.2023.10.126.2

Scopus ASCC: *2209.*

Introduction

Proper management of the process of drilling wells with a directional end of the hole depends on the permeability of rocks, on natural curvature, on the angle of meeting of the productive horizon, on the displacement of the trajectory from the vertical and other indicators.

In this scientific article, we will consider in detail the influence of these parameters in the process of deepening directional wells.

Permeability of rocks. The relative permeability of a porous medium is the ratio of effective (or phase) permeability to absolute permeability.

Figure 1 shows experimental dependences of the relative permeability of sand to water (k_w) and oil (k_o) on the water saturation of the porous space [1, 2].

As can be seen from the figure, with a water saturation of more than 20%, the phase permeability of the rock for oil decreases sharply, although we still get anhydrous oil within the reservoir pressure gradients. This is explained by the fact that due to molecular surface forces, water is retained in small pores and on the surface of sand grains in the form of thin films, thereby reducing the cross-sectional area of filtration channels [3, 4]. When the water saturation reaches 80%, oil filtration stops, although there is still oil in the reservoir. Therefore, premature flooding of wells should not be allowed, it is necessary to warn (about water entering the bottom-hole zone) when opening the formation by drilling and during various repair work on the well.

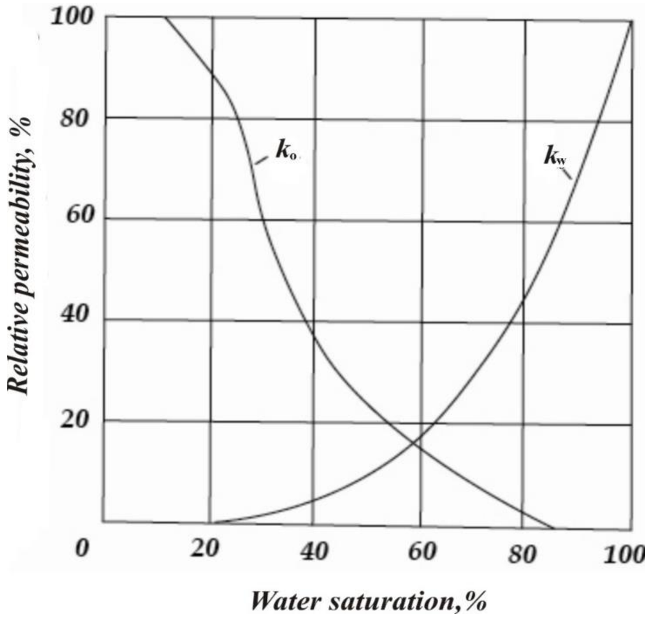


Figure 1. Graph of the dependence of the relative permeability of sand for water and oil on water saturation

Deflection of the barrel and its measurement. When designing drilling operations, the possible natural azimuthal position should be taken into account. Otherwise, the well will not cross the thickness at the intended points and the geological task may not be completed. To construct geological sections, it is necessary to know the actual spatial position of the borehole, which is shown in Figure 2.

This position is characterized at each point of the borehole by the zenith angle of the borehole **θ** and azimuth **α**.

Zenith angle - this is the angle between the vertical and the axis of the well at the measurement point. The zenith angle is located in a vertical plane passing through the axis of the well. This plane is called the apsidial plane.

The azimuth of the well is the angle between the direction to the north and the projection of the axis of the well on the horizontal plane, i.e. the line of intersection of the apsidal and horizontal planes.

Instead of the zenith angle, the angle of inclination of the well **η =90⁰ - θ** is sometimes used, which are the angle between the axis of the well and its projection on the horizontal plane [5, 6, 7].

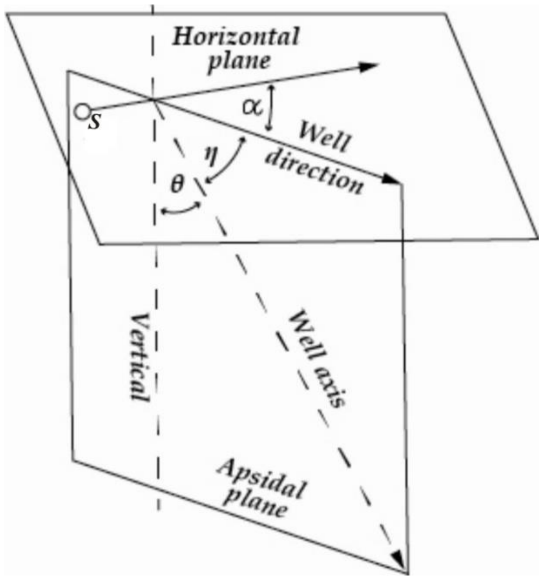


Figure 2. Elements of the spatial position of wells.

Impact Factor:

ISRA (India)	= **6.317**	**SIS** (USA)	= **0.912**	**ICV** (Poland)	= **6.630**
ISI (Dubai, UAE)	= **1.582**	**РИНЦ** (Russia)	= **3.939**	**PIF** (India)	= **1.940**
GIF (Australia)	= **0.564**	**ESJI** (KZ)	= **8.771**	**IBI** (India)	= **4.260**
JIF	= **1.500**	**SJIF** (Morocco)	= **7.184**	**OAJI** (USA)	= **0.350**

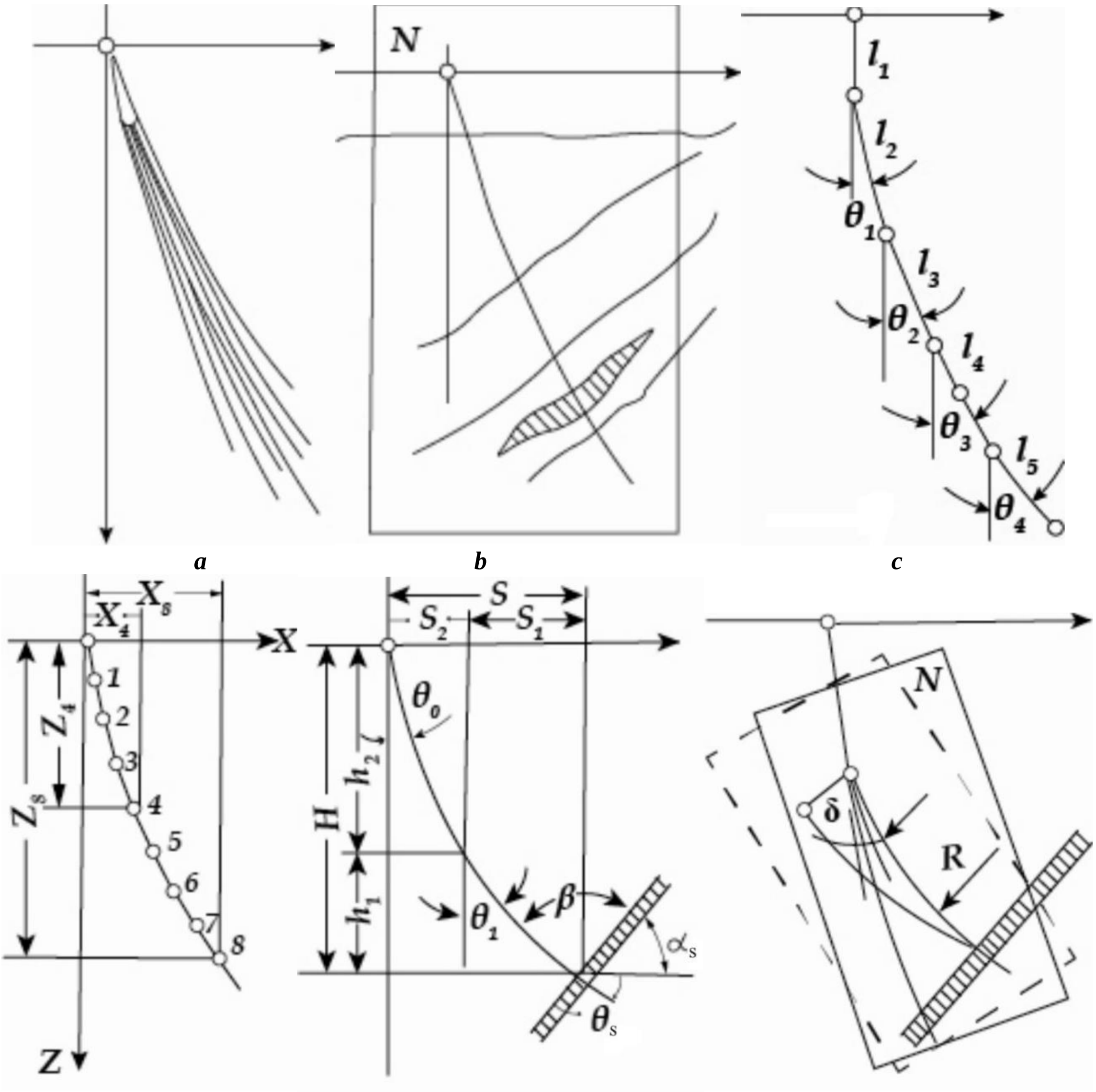
According to the values of the zenith angle and azimuth at the measurement points, the increment of coordinates is determined and the profile of the well is built on the section.

The zenith angle and azimuth of the well are measured using instruments -inclinometers.

Currently, IK-2, UMI-25 and MI-30 inclinometers are used for measurements in non-magnetic media.

When constructing design profiles, the necessary angle of meeting of the mineral by the well, the patterns of natural curvature for individual intervals of the well should be taken into account. In some cases, the position of the wellhead may be preset. If there is an azimuthal curvature, it should be taken into account in the constructions [8, 9, 10].

Using these data, the value of rectilinear and curvilinear intervals of the hole, the norms of curvature of the well at intervals, the position of the wellhead, the initial zenith angle and azimuth of the well, the length of the well along its axis are determined.



d *e* *f*

Figure 3. Schemes of construction of project profiles.

γ - meeting angle;

δ - the angle of deviation of the well from the initial direction;

a - graphical finding of a typical profile;

b- transferring a typical profile to a section;

c - point-to-point graphical profile construction;

d - building a profile based on analytically defined coordinates of points;

e - analytical method for calculating the profile;

f - building the profile of an additional hole.

To build the design profiles of wells, graphical and analytical methods are used, which is shown in Figure 3. Various variants of these methods are known. The simplest variant of the graphical method of construction is the use of a typical curve [11, 12]. Profiles of a group of wells drilled in the same geological and technical conditions are combined by the wellheads and transferred to tracing paper. The position of the middle profile in the scattering cone is determined.

This profile is accepted as a typical one (Similarly, a horizontal projection of a typical well is obtained. A typical design profile is transferred to a tracing paper sheet, the tracing paper plane is indicated by the index N) and superimposed on the section so that the mouth coincides with the surface line, the profile position relative to the vertical is preserved, and the profile itself intersects the mineral at a given point. The plan of the project well is also being built, taking into account the laws of the azimuthal direction [13, 14, 15].

Another way is that for a group of wells, the average values of angles are determined by depth intervals, and then a typical profile is constructed in the form of a polyline consisting of segments drawn at these angles.

Individual profiles for specific wells can be plotted graphically from the point of intersection of the mineral well upwards using segments, the first of which is deposited at a given meeting angle and the subsequent ones at an angle to the previous one equal to the increment of the zenith angle at this interval [16, 17, 18]. In this case, you should pay special attention to setting the meeting angle. With a meeting angle that does not correspond to those that take place on the site, the actual route may not coincide with the design one, since the angles of the meeting of the well with the rock layers located above the mineral also change [19, 20]. In addition, if the wells are drilled vertically, the resulting initial zenith angle may not be equal to zero.

The most accurate are the constructions using the analytical method. It consists in determining the coordinates of the points of the project route and constructing its profile and plan in the form of points, then connected by a smooth curve. The initial data for determining the coordinates are the average (preferably RMS) values of zenith angles and azimuths for a group of wells, taken as the basis for finding a typical curve. The calculation of coordinates is carried out similarly to calculations when constructing the actual position of wells [21, 22].

Calculations are easier and give more accurate results if an electronic computer is used to obtain coordinates. The program for calculating the coordinates of the average trajectory on a computer was developed at the Tomsk Polytechnic Institute.

If the well has a constant curvature throughout or at several intervals, and there is no azimuthal departure, you can use another version of the analytical calculation of the basic data for the construction. For the calculation, the intensity of the curvature i_0 must be known from the depth intervals *h*. The vertical depth of the intersection of the mineral H, the angle of the meeting of the formation β are set. The angle of incidence of rocks is known α_r. Zenith angle at the meeting point of the formation

$$\theta_{s.} = \alpha_{s.} + [\beta] - 90^{\circ}$$

The zenith angles at the beginning of any interval of the well, the departure of the well-laying point from the projection of the reservoir meeting point to the surface and the length of the well are determined by simple calculations.

The design of multi-barrel wells differs in some features.

The angle of inclination of the well. Figure 4 shows the relationship between the angle of inclination and the deviation of the well bottom from the vertical. With an increase in the angle of inclination, the deviation of the bottom hole from the vertical also increases. The analysis shows that when drilling inclined wells, the actual angle of inclination was scored higher than the design one, and as the deviation of the well bottom from the vertical increased, the difference between these angles increased [23]. However, these results are not an immutable regularity, as they turned out due to the fact that: 1) the profile was calculated without taking into account the specific drilling conditions; 2) drilling of an inclined well was carried out in an azimuth different from the design one; 3) work on correcting the azimuth was not carried out accurately enough; 4) when drilling a rectilinear inclined section, the angle of inclination decreased and the greater this angle was, the more intense the decrease occurred. All these shortcomings identified by the analysis can be avoided, and the difference between the design and actual tilt angles will be minimal.

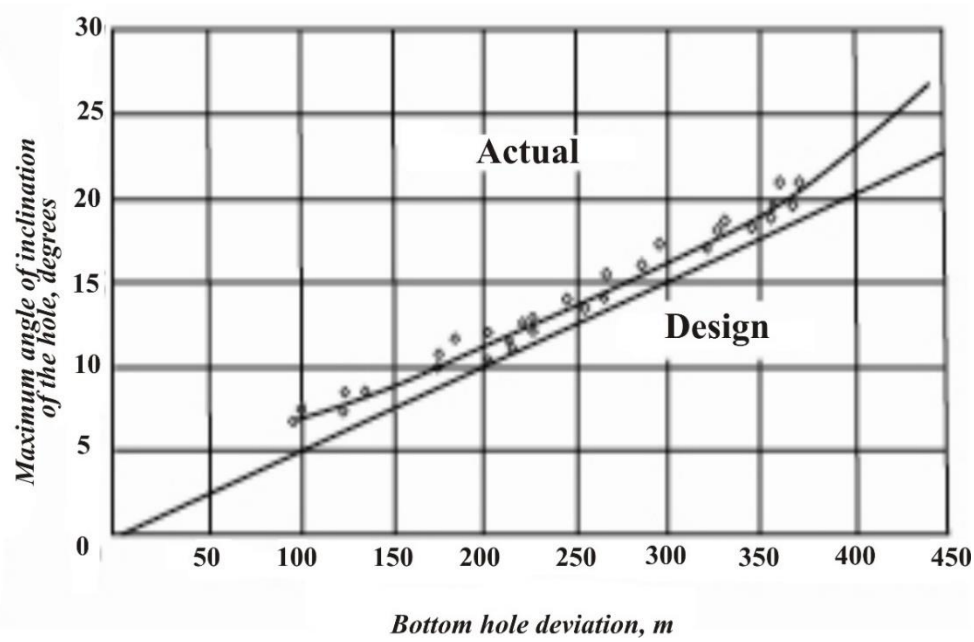


Figure 4. The relationship between the slope of the borehole and the deviation of the well bottom from the vertical

An increase in the depth of the directional well compared to the design one. Figure 5 shows the dependence of the lengthening of the borehole on the deviation of the bottom of the inclined well from the vertical.

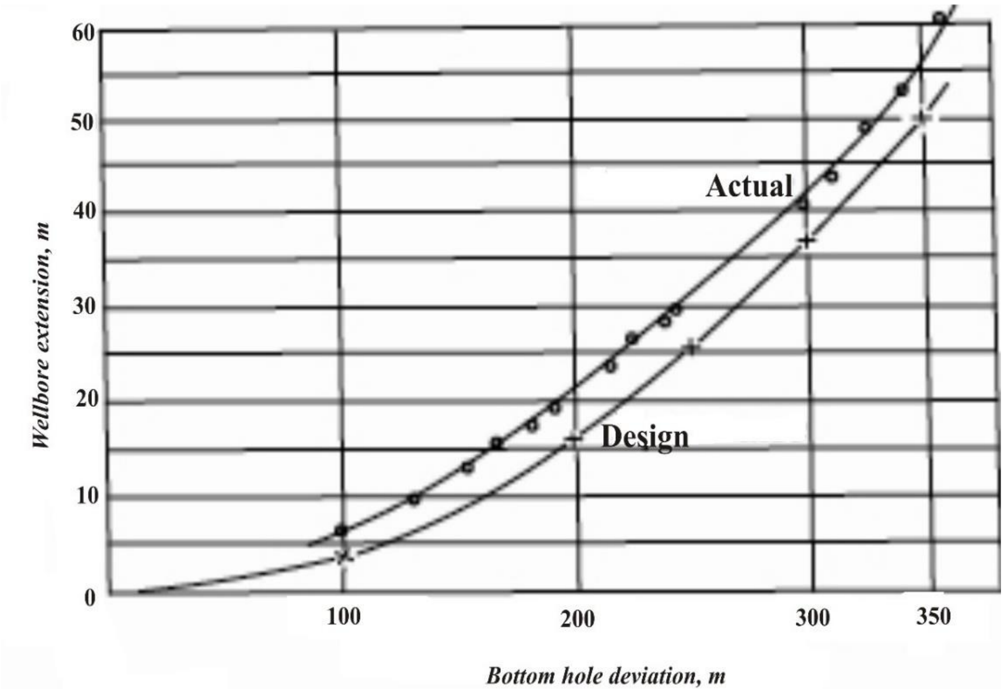


Figure 5. Dependence of the elongation of the borehole of inclined wells on the deviation of the bottom.

The above graph clearly confirms that the design elongation of the inclined borehole is 1.1-3.5%, and the actual elongation is 1.4-4% of the total depth of the well. Although this discrepancy between the design and actual elongation is not so large (4-5 m), it should be kept in mind when designing inclined wells [24]. The elongation value is of particular importance when designing a large number of directional wells. Even a minor error with a large number of wells can lead to an increase in additional penetration, and consequently to a decrease in the efficiency of directional drilling.

References:

1. Deryaev, A.R. (2012). Burenie naklonno napravlennyh skvazhin na mestorozhdeniyah Zapadnogo Turkmenistana. *"Nebitgazylmytaslama"*. Vypusk 2 (29). - Ashgabat: Turkmeniskaya Gosudarstvennaya sluzhba pechati, pp. 267-276.
2. Gulatarov, H., Deryaev, A.R., & Esedulaev, R.E. (2019). *Osobennosti tekhnologii bureniya gorizontal'nyh skvazhin sposobom elektrobureniya:* monografiya. (p.227). – Ashgabat: Nauka.
3. Deryaev, A.R. (2012). Opyt bureniya skvazhin s gorizontal'nym okonchanie stvola Zapadnom Turkmenistane. *Sbornik stat'ej instituta "Nebitgazylmytaslama"*. Vypusk 2 (29) - Ashgabat: Turkmeniskaya Gosudarstvennaya sluzhba pechati, pp. 277-285.
4. Deryaev, A.R., & Orazklychev, K. (2015) *Sposob odnovremenno-razdel'noj i sovmestnoj ekspluatacii neskol'kih produktivnyh gorizontov odnoj skvazhinoj i ustrojstvo dlya ego osushchestvleniya*. Patent № 644 ot 08.06.2015. (nomer zayavki 15/101320).
5. Deryaev, A.R., & Orazklychev, K. (2015) *Sposob odnovremenno-razdel'noj i sovmestnoj ekspluatacii neskol'kih produktivnyh gorizontov odnoj skvazhinoj i ustrojstvo dlya ego osushchestvleniya*. Patent № 643 ot 08.06.2015. (nomer zayavki 14/101317).
6. Deryaev, A.R. (2022). Zadachi issledovaniya dlya metoda odnovremennoj razdel'noj ekspluatacii mnogoplastovyh mestorozhdenij. *Innovacionnye nauchnye issledovaniya* №2-2 (16), Ufa: Nauchno-izdatel'skij centr "Vestnik nauki".pp. 43–51.
7. Deryaev, A.R., & Deryaev, C.A. (2022). *Prigotovlenie burovyh rastvorov i metody regulirovaniya ih svojstv v slozhno termogeohimicheskih usloviyah gorizontal'nogo bureniya skvazhin (na primere Turkmenistana).* "International scientific review of the problems and prospects of modern science and education". LXXXIV International correspondence scientific and practical conference. (pp. 9 –13). USA–Boston: Publishing house: «Problems of science».
8. Deryaev, A.R., Gulatarov, H., Mantrova, S.V., Dzhamiev, M. Ya. (2012). Kompleksnaya dobavka KAIR burovyh rastvorov dlya bureniya skvazhin v slozhnyh geologicheskih usloviyah. *Sbornik instituta "Nebitgazylmytaslama"* vypusk 2 (29). Ashgabat: Turkmenskaya Gosudarstvennaya sluzhba pechati, pp. 315–319.
9. Deryaev, A.R. (2022). *Vybor skvazhinnogo oborudovaniya dlya odnovremenno sovmestnogo otbora gaza iz dvuh produktivnyh plastov odnoj kolonnoj NKT*. Sbornik statej Mezhdunarodnoj nauchno-prakticheskoj konferencii "Science and technology research 2022". (pp.12-18). – Petrozavodsk: Nauchnoe izdanie: MCNP "Novaya nauka".
10. Deryaev, A.R. (2022). Features of drilling technology for dual completion, joint operation of several horizons in a multi-layer field. *"COGNITIO RERUM" scientific journal* №5 M: Academic publishing: "Scientific artel", pp. 12-21.
11. Deryaev, A.R. (2022). *Rekomendacii po burovomu rastvoru dlya bureniya sekcii 295,3 mm otkrytogo stvola naklonno-napravlennoj skvazhiny*. Sbornik statej II Mezhdunarodnoj nauchno-prakticheskoj konferencii "Nauka, obshchestvo, tekhnologii: problemy i perspektivy vzaimodejstviya v sovremennom mire". (pp.7-11). Petrozavodsk: Nauchnoe izdanie: MCNP "Novaya nauka".
12. Deryaev, A.R., Mamedov, B., & Amanov, M. (2021). *Vnedrenie receptur burovyh rastvorov dlya burenie naklonno-napravlennyh i vertikal'nyh skvazhin.* Mezhdunarodnaya nauchno-prakticheskaya konferenciya studentov, magistrov, aspirantov i doktorantov "Rynok i effektivnost' proizvodstva-18", posvyashchennaya 30-letiyu Nezavisimosti Respubliki Kazahstan. Sbornik trudov. (pp. 258–261). – Kokshetau.
13. Deryaev, A.R. (2021). Tekhnologiya bureniya skvazhin s razdel'noj ekspluataciej odnovremenno neskol'kih gorizontov na mestorozhdenii Severnyj Goturdepe. *Aktual'nye issledovaniya* №51 (78) – Belgorod: Izdatel'stvo "Agentstvo perspektivnyh nauchnyh issledovanij", pp.23–29.
14. Deryaev, A.R., Amanov, M., & Deryaev, S.A. (2020). Vskrytie i osvoenie mnogoplastovyh produktivnyh gorizontov metodom odnovremenno-razdel'noj ekspluatacii. *Nauchnyj zhurnal Aspirant i soiskatel'* №5 (119). – M: OOO Izdatel'stvo Sputnik +.pp. 23-30.
15. Deryaev, A.R., Gulatarov, H., & Mantrova, S.V. (2014). Rekomendacii po ispol'zovaniyu burovyh rastvorov. *Sbornik instituta Nefti i gaza,*

vypusk 8 – Ashgabat Turkmenskaya Gosudarstvennaya sluzhba pechati, pp. 249–259.

16. Deryaev, A.R., Gulatarov, H.G., & Zelepukin, I.F. (1998). *K teorii provedeniya gidrodinamicheskih issledovanij gorizontal'nyh neftyanyh, vodyanyh i gazovyh skvazhin*. Cbornik statej. Modelirovanie processov razrabotki gazovyh mestorozhdenij i prikladnye zadachi teoreticheskoj gazogidrodinamiki. (pp. 71–79). – A: Ylym.
17. Deryaev, A.R. (2022). Obosnovanie prinyatoj metodiki prognoza tekhnologicheskih pokazatelej razrabotki dlya gazokondensatnyh zalezhej pri osvoenii metodom odnovremennoj razdel'noj ekspluatacii. *UNIVERSUM; Tekhnicheskie nauki* №4 (97) chast' 10 – M: Izdatel'stvo: "MCNO", pp. 55-58.
18. Deryaev, A.R. (2022). *Treatment of drilling mud with "PACS-T" additive.* "Innovative approaches in the modern science" Proceedings of CXV international scientific – practical conference. International scientific journal №7 (115) – M: pp. 74–77.
19. Deryaev, A.R. (2021). Rekomendacii po ispol'zovaniyu burovyh rastvorov dlya uspeshnogo vedeniya burovyh rabot na mestorozhdenii Severnyj Goturdepe. *Aktual'nye issledovaniya*. №51 (78) – Belgorod: Izdatel'stvo "Agentstvo perspektivnyh nauchnyh issledovanij", pp.14–22.
20. Deryaev, A.R. (2022). Sovremennoe sostoyanie izuchennosti bureniya napravlennyh i mnogozabojnyh skvazhin s razdel'noj ekspluataciej odnovremenno neskol'kih gorizontov (zarubezhnyj opyt). *Sbornik statej mezhdunarodnogo nauchno-issledovatel'skogo konkursa "Akademicheskaya nauka na sluzhbe obshchestvu".* – Petrozavodsk: Nauchnoe izdanie: MCNP "Novaya nauka". pp.170-178.
21. Deryaev, A.R. (2022). Rekomendacii po kompleksnomu vnedreniyu s razdel'noj ekspluataciej odnovremenno neskol'kih gorizontov na gazovyh mestorozhdeniyah Turkmenistana. *Problemy nauki* №1 (69) – M: Izdatel'stvo "Problemy nauki", pp. 16-21.
22. Deryaev, A.R. (2022). Tekhnologicheskie i tekhnicheskie problemy svyazannye s provodkoj gorizontal'nyh skvazhin elektroburom i puti ih resheniya. *UNIVERSUM; Tekhnicheskie nauki* №1 (94) chast' 3 – M: Izdatel'stvo "MCNO", pp.46-49.
23. Gulatarov, H.G., & Deryaev, A.R. (1998). *Osobennosti bureniya naklonno-napravlennyh skvazhin elektroburom*. Cbornik statej. Modelirovanie processov razrabotki gazovyh mestorozhdenij i prikladnye zadachi teoreticheskoj gazogidrodinamiki. (pp. 62–70). – A: Ylym.
24. Deryaev, A.R., & Gulatarow, H.G. (1998). *Issledovanie konstrukcii gorizontal'noj skvazhiny dlya dobychi nefti i gaza. Sbornik statej.* Modelirovanie processov razrabotki gazovyh mestorozhdenij i prikladnye zadachi teoreticheskoj gazogidrodinamiki. (pp.49-57). A: Ylym.