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Issue **Article**

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

SELECTION AND CALCULATION OF THE CASING INTERMEDIATE TECHNICAL COLUMN OF THE DIRECTIONAL WELL

Abstract: *the article considers the design calculation and selection of casing strings for the intermediate technical column of the directional production and evaluation well for the purpose of successful drilling of well 707 at the Western Cheleken field in the coastal zones of the coastal waters of the Caspian Sea. The materials of previously drilled wells and the guidance document instructions for the calculation of casing strings for oil and gas wells, as well as safety rules in the oil and gas industry were used for the design, calculation and selection.*

This work can be used to perform the tasks set when drilling directional wells and for designing the calculation and selection of casing pipes of an intermediate technical column in extremely difficult mining and geological conditions at abnormally high reservoir pressures.

Key words: *deepening, trajectory, perforation, strength, tensile strength, shank, liner, cavernometry, roof, sole, wear, section, tightness, curvature, reservoir pressure.*

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Introduction

Casing string calculation is a set of procedures aimed at determining the dimensions, design features and other factors that may affect the quality of the well, productivity and operational efficiency. Each selected design must fully comply with the standards and safety regulations.

The casing string is calculated at the well design stage in order to immediately select the wall thickness of the pipes, the type of material, the overall diameter and take into account other characteristics. The process may vary depending on the type of column. So, for inclined gas or oil wells with corresponding casing strings, the tensile strength parameter should be taken into account (the margin is taken into account depending on what trajectory the hole has and at what angle it deepens). It is also important to take into account the pressure inside the pipe and outside, axial loads.

Calculations are made taking into account the profile at the planning stage, they should also take into account the strength characteristics of specific materials, specific tests are determined before the pipe is lowered into the well. The main calculation methods consist of taking into account the pressure difference, additional loads and properties of the cementing compound.

Basic data for the calculation of casing pipes:

- depth of descent;
- the interval of perforation;
- the degree of emptying of the column;
- reservoir pressure;
- reservoir temperature;
- indicators of cavernometry;
- drilling mud indicators.

When calculating the casing string, it is necessary to take into account the tensile forces, crushing pressure, as well as the overall compression load.

Intermediate technical columns are necessary to separate layers that are incompatible with each other during the development of the well and its deepening. Intermediate pipes include solid columns, shanks (fix only the unsettled section of the well, overlapping the previous pipe) and flyers, or liners that overlap the obstructed area and are not connected in any way with other elements. The descent of individual sections of the column and the use of shanks allows you to solve the problem of creating high-gravity columns, simplify the overall design, reduce the inner diameter of the casing and the use of shanks allows you to solve the problem of creating high-gravity columns, simplify the overall design, reduce the inner diameter of the casing, as well as get rid of cracks and reduce the consumption of materials for padding. As a result, the total cost of drilling is reduced, and the extraction of hydrocarbon resources will be more economically profitable.

A significant factor for intermediate columns is the wear of the inner surface of the pipes during the deepening of the well. As a result of wear, the strength of pipes and their connections decreases. Of course, first of all it is necessary to take measures to prevent the wear of the columns. But since it is impossible to completely eliminate wear, it has to be taken into account when calculating.

The main difficulty here arises in predicting the likely amount of wear of the column in dangerous sections. Statistical material of field observations and measurements should be used to predict wear.

The amount of pipe wear strongly depends on the intensity of the curvature of the column. In order for the predicted wear values to be sufficiently reliable, it is important to know the intensity of spatial curvature as accurately as possible. Therefore, it is desirable that the distances between adjacent measurement points with an inclinometer be no more than 5 m. This technique does not allow predicting the wear of the end sections of the intermediate columns, primarily the wellhead. Since they are subject to very severe wear, the upper section with a length of up to 50-100 m and the lower section with a length of 30 m are completed from thicker–walled pipes than it should be calculated without taking into account wear.

The intermediate casing string serves to separate zones incompatible with drilling conditions when the well is deepened to the intended depths.

Intermediate casing strings are of the following types:

solid – covering the entire wellbore from the bottom to its wellhead, regardless of the attachment of the previous interval;

shanks – for fixing only the unsettled interval of the well with the overlap of the previous casing by a certain amount;

flyers are special intermediate casing strings that serve only to overlap the complication interval and have no connection with previous or subsequent casing strings.

Sectional descent of intermediate casing strings and fastening of wells with shanks are, firstly, a practical solution to the problem of lowering heavy casing strings and, secondly, solving problems of simplifying the design of wells, reducing the diameter of casing pipes, as well as gaps between columns and walls of the well, reducing the consumption of metal and plugging materials, increasing drilling speed and reducing the cost of drilling operations.

A solid column can be replaced with a shank if, during the drilling period for the subsequent column, the previous one does not wear out to an emergency state and does not allow sealing of the wellhead in the event of a gas-oil manifestation or release. It is not recommended to make two adjacent casing strings in the form of shanks. The upper end of the shank is hermetically suspended in the previous column above its shoe at a distance of at least 100 m. If the previous column overlaps the thickness of rocks prone to plastic flow, then the upper end of the column shank should be placed above the roof of such thickness by at least 25-50 m.

In extremely rare cases, an intermediate column can be lowered into the well in the form of a "fly" (secret column) to overlap a locally complicated interval of the hole (unstable rocks, absorbing layers, etc.). Such a column has no connection with the previous casing.

In severe drilling conditions (hole curvature, a large number of hollows) and well design, special types of intermediate casing strings are provided – repeated and replaceable.

The intermediate column is calculated for excessive external pressure (crumpling) for the moment of the end of cementing and lowering the liquid level when the drilling fluid is absorbed during drilling for the next casing.

For the first 2 – 3 exploration wells in the area (in the absence of reliable initial data), it is possible to take the emptying of the column with the absorption of drilling mud up to 30 – 40%, i.e. take H_l = 0.3 .....0.4 L.

Where H_l is the depth of the liquid level in the casing, m;

When calculating pressures in directional wells, all depths are taken vertically. With the total lengthening of the column (the difference in the length of the hole and the depth of the well) by no more than 50 m, it is allowed to calculate the pressures in the same way as for vertical wells.

In deep wells, stepped (two-dimensional) columns are sometimes used (both intermediate and operational), when the upper part is completed from pipes of a larger diameter than the lower one. This makes it possible to significantly reduce hydraulic resistances when drilling for a subsequent column, use less expensive casing pipes with a lower yield strength in the column bottom-hole assembly, and place more high-performance oilfield equipment in the upper part of the production column.

Let's consider the calculation of an intermediate (technical) casing string of 244.5 mm in an obliquely directed operational evaluation well No. 707 on the Western Cheleken field.

Table 1. Data for the calculation of Ø 244.5mm technical column

Depth of descent of the intermediate technical column	L= 2100 m (2119m)
Drilling depth of the production column	L_p= 2620m (2764m)
Reservoir pressure at a depth of 2100m	$P_{res.}$ = 334 kg/cm^2
Reservoir pressure at depth	$P_{res.}$ = 445 kg/cm^2
Drilling mud density at a depth of 2100 m	$P_{dr.m}$ = kg/cm^2
The coefficient of safety margin of casing pipes	n_1 = 1,125; n_2 = 1,1; n_3 = 1,75

According to the "Approved regulations for the calculation of intermediate columns, it is possible to replace the solution with an oil and gas mixture, with the wellhead closed to a depth of H = 0.70 x 2620 = 1834 m. The height of the gas column during the liquidation of the oil and gas occurrence h = 2620 - 1834 = 786 m.

The greatest internal pressure in the casing string will occur when a well is developed from a depth of 2620 m and a sealed wellhead, which is determined by the formulas:

$$P_{int.} = P_{wellh.} = [P_{res} - 0{,}1 \cdot \gamma_0 (L-h)]/e^s,$$

where, $e^s = (2+S):(2-S)$, $10^{-4} \cdot \gamma (L-Z)$;

so, $S = 10^{-4} \cdot 0{,}60 \cdot 786 = 0{,}047$.

Then, e^s = (2+0,047): (2-0,047) = 2,047: 1,953 = 1,05;

$$P_{int.} = P_{wellh.} = [445 - 0{,}1 \cdot 1{,}0(2620-786)]/1{,}05 = 249\,\text{kgf/cm}^2;$$

The maximum internal pressure is expected when the column is pressure testing**:**

$$P_{pres.test.} = 1{,}1 \cdot P_{wellh.} = 1{,}1 \cdot 249 = 274\,\text{kgf/cm}^2;$$

We accept $P_{pres.test.}$ = 280 kgf/cm^2

The internal overpressure when the column is pressure testing on water is determined by the formula:

$$P_{int.ov.} = P_{pres.test} + 0{,}1 \cdot \gamma_o \cdot Z - P_{res};$$

At Z = 0; P_{res} = 0; P_{int} = 280 kgf / cm^2.
At Z = 2100 m; P_{res}=334 kgf / cm^2; $P_{int.}$ = 280 + 0,1·1,0 -2100 - 334 = 156 kgf / cm^2.

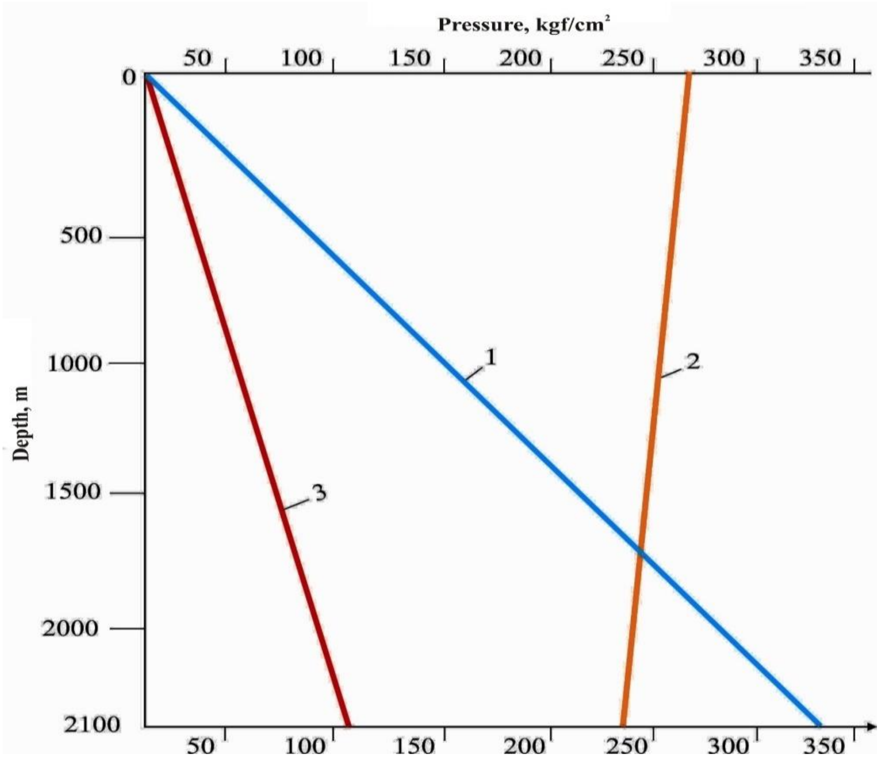

Figure 1. Calculation of excess external and internal pressures in a 244.5 mm technical column

1. Reservoir pressure
2. Internal overpressure when testing the column for tightness
3. External overpressure

The external overpressure is determined by the formula:

$$P_{ex.ov.} = P_{res.} - 0{,}1 \cdot \gamma_o \cdot Z;$$

At Z = 2100m, $P_{ex.ov.}$ = 334 - 0,1· 1,0 ·2100 = 124 kgf / cm^2.

Calculated internal overpressure when testing the column for tightness

In accordance with the above calculations and graphical constructions, casing pipes Ø 244.5 mm are planned for the descent into the well with a wall thickness of 10.03 mm, steel strength group N-80, Batress thread, with a normal coupling, according to the API standard.

We determine the value of the safety factor when calculating the external overpressure for casing pipes designed for descent:

$$n_1 = P_{cr.} : P_{ex.ov.} = 217:124 = 1{,}75 > 1{,}125;$$

We determine the value of the safety factor when calculating the internal overpressure for casing pipes designed for descent:

$$n_2 = P_T : P_{pres.test.} = 404:280 = 1{,}44 > 1{,}10;$$

We determine the value of the safety factor in the calculation of tensile strength for casing pipes designed for descent:

$$n_3 = P_{st.} : Q_{c.} = 416:125{,}7 = 3{,}31 > 1{,}75$$

Where the weight of the casing pipes in the air to be lowered to the well is:

$$Q_c = q_c \cdot L = 59{,}36 \cdot 2119 = 125{,}7t.$$

The graphical calculation of the Ø 324mm intermediate column for excessive external and internal pressures is shown in Fig.1,2.

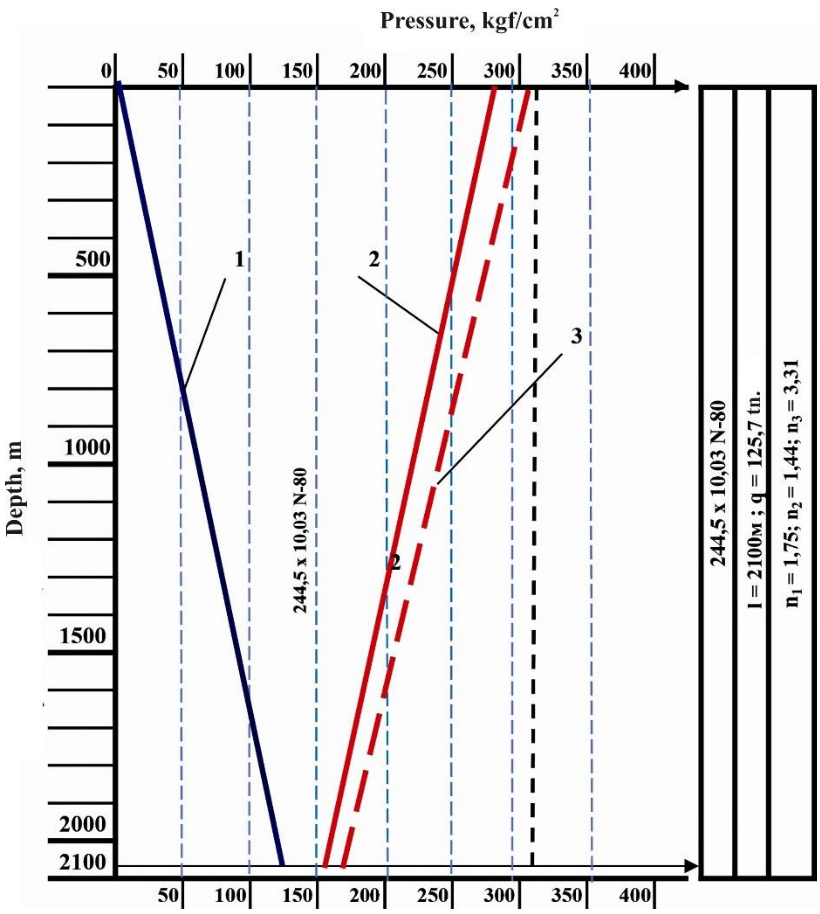

Figure 2. Calculation of 244.5 mm technical column for excessive external and internal pressure

Conclusion

The casing string is a necessary important element of a well for mining. Correctly performed calculations allow you to build an optimal design in terms of functionality and cost, which will require minimal maintenance.

References:

1. Deryayev, A.R. (2022). The design of the directional well on the Northern Goturdepe field. *"International Science Journal of Engineering & Agriculture"* Vol.1, №3 - Poland - Gdansk: Publishing: "International Science Group", pp. 110-116.
2. Deryayev, A.R. (2022). Development of well designs for their dual completion. Norwegian Journal of development of the International Science №89 - Oslo: Publishing: "Norwegian Journal of development of the International Science", pp.46-48.
3. Deryayev, A.R. (2022). *Requirements for the designs of gas wells for their development by the method of dual completion.* "International scientific innovations in human life". Proceedings of XIII International scientific and practical conference. (pp.115-120). United Kingdom - Manchester: Scientific Publishing Center «Sci-conf.com.ua».
4. Deryayev, A.R. (2022). *Analysis of design features of existing equipment complexes for dual completion gas condensate reservoirs.* "Innovations and prospects of world science". Proceedings of XI International scientific and practical conference. (pp.174-179). Canada - Vancouver: Scientific Publishing Center «Sci-conf.com.ua».
5. Deryaev, A.R. (2022). *Razrabotka konstrukcii skvazhin dlya ih odnovremennoj razdel'noj ekspluatacii.* «Nauka i obrazovanie v sociokul'turnom prostranstve sovremennogo obshchestva» sbornik naunyh trudov. (pp.50-55). Smolensk: Izdatel'stvo MNIC "Naukosfera".
6. Deryaev, A.R. (2022). Razrabotka konstrukcii skvazhin dlya mnogoplastovyh mestorozhdenij s cel'yu odnovremennoj razdel'noj ekspluatacii odnoj skvazhinoj. *Nauchnyj zhurnal SOCAR Proceedings* №1 - Baku: Izdatel'stvo: NIPI «Neftegaz», pp.94-101.
7. Deryaev, A.R. (2022). *Sostavlenie pointerval'noj programmy vybora komponovki niza buril'noj kolonny dlya bureniya pod tekhnicheskuyu kolonnu naklonno-napravlennoj skvazhiny.* Sbornik statej nauchno-prakticheskoj konferencii "Informacionnoe obespechenie nauchno-tekhnicheskij progressa: analiz problem i poisk reshenij". (pp.38-42). Ufa: Nauchnoe izdanie: NIC "Aeterna".
8. Deryaev, A.R. (2022). *Sostavlenie proektnogo profilya i programmy vybora komponovki niza buril'noj kolonny dlya bureniya naklonno-napravlennoj skvazhiny.* Materialy Sbornik nauchnyh trudov "Sovremennye obrazovatel'nye tekhnologii i aktual'nye modeli rasprostraneniya nauchnoj informacii" (Materialy Mezhdunarodnyh nauchno-prakticheskih meropriyatij). (pp.23-39). Kazan': Nauchnoe izdanie: «Obshchestvo nauki i tvorchestva».
9. Gurbanmyradov, O.A., Esedullaev, R., Durdyev, N., & Deryaev, A.R. (2018). *Gidrodinamicheskie problemy voznikayushchie pri burenie neftegazovyh skvazhin i metody ih reshenie.* Nauchnaya monografiya. (p.336). Ashgabat: Ylym.
10. Deryaev, A.R. (2022). Rekomendacii po preduprezhdeniyu oslozhnenij i avarij pri burenii naklonno-napravlennyh skvazhin. *Mezhdunarodnyj nauchnyj zhurnal «Simvol nauki»* №6-2/2022 - Ufa: Izdatel'stvo OOO "Omega sajns", pp.20-23.
11. Deryaev, A.R. (2022). *Tekhnologiya provodki skvazhin v mnogoplastovyh mestorozhdeniyah s cel'yu odnovremennoj razdel'noj ekspluatacii odnoj skvazhinoj.* Sbornik statej VI mezhdunarodnoj nauchno-prakticheskoj konferencii "Peredovoe razvitie sovremennoj nauki: opyt, problemy, prognozy." (pp.21-26). Petrozavodsk: Nauchnoe izdanie: MCNP "Novaya nauka".
12. Deryaev, A.R. (2022). *Vybor vnutriskvazhinnogo oborudovaniya dlya odnovremenno razdel'noj ekspluatacii neskol'kih gorizontov.* Sbornik statej po itogam Mezhdunarodnoj nauchno-prakticheskoj konferencii "Sovremennye problemy i perspektivnye napravleniya innovacionnogo razvitiya nauki". (pp.96-102). Sterlitamak: Nauchnoe izdanie: "Agentstvo mezhdunarodnyh issledovanij".