UDC 622.245 **DOI**: 10.17122/ngdelo-2019-3-33-37

RUNNING AND CEMENTING CASING FOR VERY LONG HORIZONTAL WELLS

КРЕПЛЕНИЕ СКВАЖИН С БОЛЬШИМИ ОТХОДАМИ ОТ ВЕРТИКАЛИ

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Considering the geological and reservoir conditions in the north-west fields of Cuba, a program is being developed for casing running and cementing long extended reach wells with a horizontal displacement up to 10,000 meters. The paper reveals the result of the main tasks, which include design of the well construction, calculation of casing strings, development of a cementing program, focused on obtaining a high-quality cementing in this type of wells. It also assesses the impact of the implementation of several proposed strategies, in the main indicators of the process of casing running and cementing.

The design of our horizontal well profile considers that the profile is in second dimension because azimuth does not suffer variations and consists of five sections: first section is vertical, then two sections with angle construction and finally a horizontal section. To make the necessary calculations of our profile, it was necessary to develop a new calculation methodology that considers the initial and final data of the classical methodology and at the same time considers the new geometric condition.

Considering the characteristics of geological formations and using the classical methodology for calculating the necessary diameters of casing strings and bits in construction are included: Conductor Pipe; Surface Casing; Intermediate Casing 1; Intermediate Casing 2 (Running in the hole in 2 stages); Production Liner — Liner and Slotted Liner Filter.

Cementing program of conductor pipe and a surface casing using a stinger is developed, also the development program for running and cementing multistage sections for the first intermediate column, in addition the development program for running and cementing of second section in the second technical column.

Key words

casing running; cementing; extended reach wells; horizontal well; two-stage cementing for extended reach wells

С учетом геолого-технических условий и пластовых давлений на месторождениях северо-запада Кубы разрабатывается программа спуска крепления обсадных колонн на скважинах с горизонтальным смещением до 10 000 м. В статье показаны результаты обоснования, проектирования и разработки предложений при выполнении основных этапов поставленной задачи. При этом были выполнены этапы, включающие проектирование конструкции скважины, расчет обсадных колонн, разработку программы цементирования, ориентированные на успешный спуск колонн и обеспечение качественного цементирования. Также оценивалась возможность реализации нескольких стратегий на основные показателей процесса спуска и цементирования обсадной колонны.

Ключевые слова

эксплуатация обсадной колонны; цементирование; скважины с расширенным радиусом действия; горизонтальная скважина; двухступенчатое цементирование для скважин с расширенным радиусом действия

Для предлагаемого проекта рассматривался двумерный профиль, поскольку азимут не подвержен колебаниям. Разработанный профиль состоит из пяти участков: вертикального, двух участков набора зенитного угла, наклонно-прямолинейного и горизонтального участков. Для произведения расчетов проектируемого профиля необходимо было разработать новую методику расчета, которая учитывает начальные и конечные условия классической методологии и одновременно учитывает новые геометрические условия.
Принимая во внимание геолого-литологические характеристики горных пород, была предложена конструкция скважины, включающая: направление; кондуктор; техническую колонну 1; техническую колонну 2 (спуск в 2 секции); эксплуатационную колонну — хвостовик; нецементируемый хвостовик — фильтр.
Разработаны программы цементирования направления и кондуктора с помощью стингера, программы ступенчатого цементирования первой технической колонны, программы спуска второй технической колонны в 2 секции и последующее цементирование секций.

Introduction

The well construction in Cuba using extended reach wells, has been a resounding success [1]. Development of these types of wells is a pressing issue for the international community. For Cuba this is of vital importance due to the geographical conditions of the country.

The Varadero Oeste 1008 horizontal well drilling enlarges satisfactorily, exceeding 6063 meters of depth, and should reach a record 8240 meters this year to become the deepest in Cuba, in the Caribbean and Latin America [2].

The task for the future is to drill wells of greater length horizontally to exploit new productive strata.

The most important oil fields in Cuba are in the northeast of the country. In this work, wells located in Bacuranao, Seboruco, Varadero were considered in order to study the fundamental geological characteristics of these fields, as well as the profile, analysis casing running and design and program of well cementing (Figure 1).

Well Profile

The design of our horizontal well profile takes into account that the profile is in second dimension because azimuth does not suffer variations and consists of five sections: first section is vertical, then two sections with angle construction and finally a horizontal section.

According to the data analyzed in general, the total horizontal displacement should be 10000 м. It is considered that true vertical depth TVD H=1710 m, usually, the starting point of the deviation (Kill of Point KOP) will be h_1=320 m, and Dog Leg Severity i_{I30}=2°/30 m and i_{II30}=2,5°/30 m for the two sections of angular construction. The length of the horizontal section $l_г$=1000 m.

To make the necessary calculations of our profile, it was impossible to directly use the classical methodology [3], since this does not include the case of profiles, where the departure is greater than the total vertical depth. In this sense, it was necessary to develop a new calculation methodology

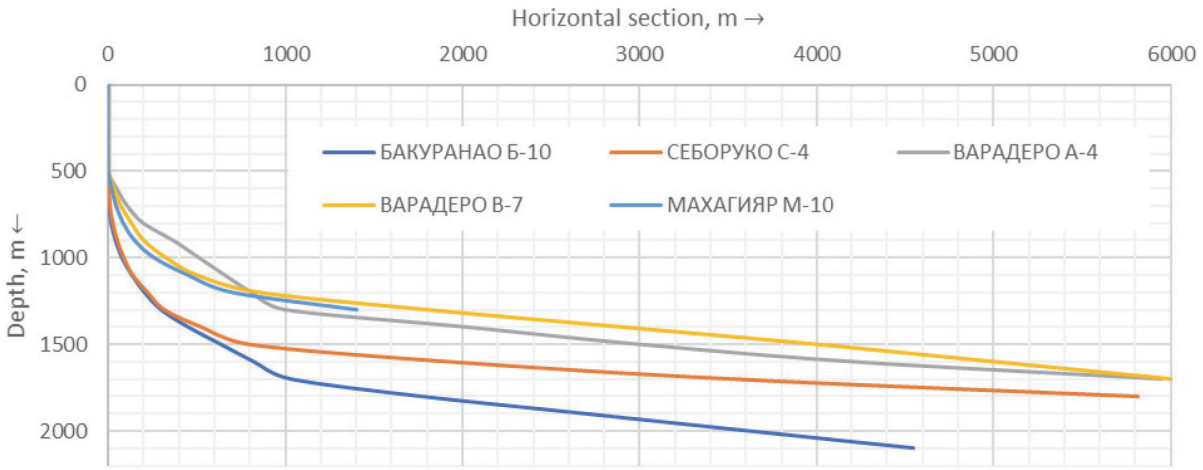

Figure 1. Vertical profile of the wells of the northeast of Cuba

that takes into account the initial and final data of the classical methodology and at the same time takes into account the new geometric condition.

After performing the appropriate calculations and checking them in the Landmark software, a well profile is proposed, the measured depth is 10,827.83 meters.

Well Construction

Considering the studied cases for our design, it is proposed to first consider the liner diameter 114,3 mm. The following dimensions were also shown: $г_{нап}$=300 м, $г_{хвост}$=$l_г$=1000 m.

The following calculations take into account the criterion of using the smallest number of casing and its length should not exceed 2500 meters in accordance with Cuban standards.

$г_{тех.1}$=$г_{тех.2}$=$г_{екс}$=2500 m;

$г_{кон}$=$L_{скв}$ — ($г_{нап}$ + $г_{тех.1}$ + $г_{тех.2}$+ гекс + $г_{хвост}$)= =10827,83–(300+3·2500+1000)=2027,83 m.

Considering the characteristics of geological formations [4] and using the classical methodology for calculating the necessary diameters of casing strings and bits [5], a design is proposed, presented in Table 1 and Figure 2.

Table 1. Well Construction

№ Intervals	Casing Strings	Casing Depth, m	Casing Diameter, mm	Bit Diameter, mm
1	Conductor Pipe	300	660,4	813
2	Surface Casing	2328	473,1	609,6
3	Intermediate Casing 1	4828	339,7	445
4	Intermediate Casing 2 Running in the hole in 2 stages	7328	244,5	311
5	Production Liner — Liner	9828	177,8	215,9
6	Slotted Liner Filter	10828	114,3	155,6

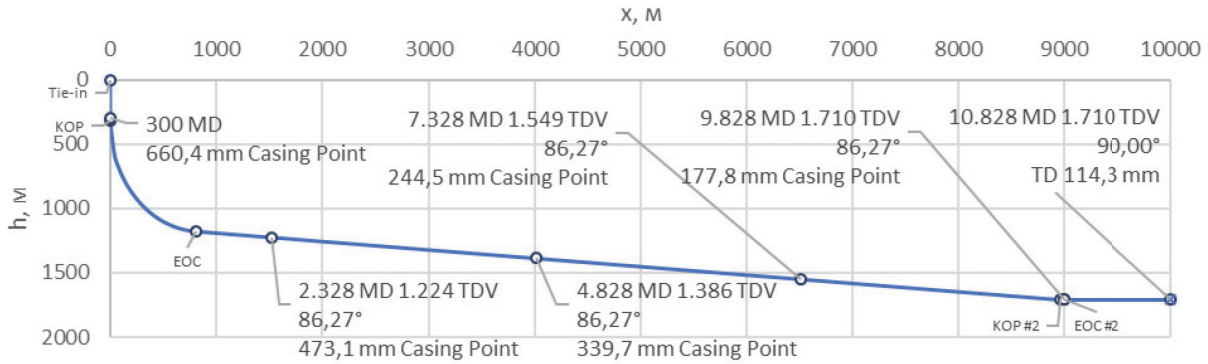

Figure 2. Proposed design

Running and Cementing Casing

To optimize the process of cementing of Conductor pipe, it is proposed to use a stinger. Thus, the volume of the displacement mud is significantly reduced, and with it the total time of the process.

Stab-In Float Collar and Shoe type 960/961 is used in the operation of cementing through a drillpipes. Stab-in Stinger type 222 is fixed and stabbed by direct descent into the receptacle valve of the equipment. Latch-down drill pipe plug with locking mechanism, type 218 is used with stinger. The plug is equipped with a locking ring (O-Rings), which is fixed in the receiving plate of cementing equipment with a check valve.

The running order of Conductor Pipe (D=660.4 mm) will be: Float Shoe БК-М 660 at a depth of 300 м; 1 Casing 26” 136# X-56; Receptacle Valve ЦКОДМ-660 + Stab-in stinger type 222; short nipple 26 ”136 # X-56; Casing 26 ”136 # X-56, and the rest.

The use of a stinger is also suggested when cementing a surface casing. The order of descent surface casing (D=473.07 mm) will be: Shoe БК-М 473 at a depth of 2327,83 м; 1 casing 18 5/8 ”87.5 # K-55 BTC; Receptacle valve ЦКОДУ -473 + Stab-in stinger type 222; short nipple 18 5/8 ”87.5 # K-55 BTC; Casing 18 5/8 ”87.5 # K-55 BTC and the rest.

Taking into account that the primary cementation of intermediate casing involves the use of a large number of cementing equipment, due to the large volume of cement slurry required, it is recommended to carry out the cementing in two stages. To do this, use the DVTool TYPE 680 manufactured by the American company

«TOP-CO». This tool is not limited to the inclination of the well, as the circulation ports can be opened hydraulically, eliminating the need for an opening plug [6].

The order of running in the hole of the first intermediate casing (D=339.73 mm) will be: Shoe БК-М 340 at a depth of 4827.83 m; 1 casing 13 3/8 ”61 # K-55 BTC; Float Collar ЦКОДУ -340; Pup Joint 13 3/8 ”61 # K-55 BTC; Baffle Collar; Casing 13 3/8 ”61 # K-55 BTC only 2627.83 m; Staging Cement Hydraulic Tools DVTool 13 3/8” L-80 TOP-CO TYPE 680; Casing 13 3/8 ”61 # K-55 BTC — only 1200 m; Casing 13 3/8 ”68 # L-80 BTC to the surface.

Considering that the weight of the second intermediate casing exceeds 0.75 of the rig capacity of the drilling rig, it is advisable running casing in two sections.

Casing running and cementing of the first section is carried out using a drill string, which is connected to the drilling string of this section by a liner hanger. In our design of liner, circulation holes are opened under the action of a pressure pulse that occurs when the wiper plugs land on the catcher sub.

In this case, after cementing the first section, it must be completed to the surface with the casing (second section). To do this, use a special tool (Tieback Sleeve), which connects the second section with the first.

The running liner order of the first section of the second intermediate casing (D=244.47 mm) [7] will be: Float Shoe БК-М 245 — at a depth of 7327.83 m; 1 casing 9 5/8 ”47 # L-80 BTC; Float Collar ЦКОДУ -245; Casing 9 5/8 ” 47 # L-80 BTC — up to hydraulic liner; Hydraulic Liner Hanger 9 5/8 "x 13 3/8" L-80 Shelfoil DYX-C + Tieback Sleeve — top 4327.83 m; Casing 9 5/8 ”47 # L-80 BTC to end in the surface.

For running in the hole and cementing the production casing [8], a hydraulic liner hanger is used, similar to the one used previously, taking into account the difference in diameters. The order of running of the production string (liner D=177.8 mm) will be: Shoe ВКМ-178 — at a depth of 9827.83 m; 1 casing 7 ”23 # K55 BTC; Float Collar ЦКОДУ -178; 1 casing 7 ”23 # K55 BTC; Check valve ball КОШ-178; Casing 7 ”23 # K55 BTC — up to hydraulic liner hanger; Hydraulic Liner Hanger 7” x 9 5/8” L-80 Shelfoil DYX-C — top 6827.83 m; Casing 7 ”23 # K55 BTC to end in the surface.

Cost effectiveness assessment

Although an assessment of economic efficiency is impossible, since a well of such measured depth has not yet been drilled in Cuba, from the point of view of volumes and time, it is possible to evaluate the effectiveness of the implementation of the proposals made. Table 2 shows the effect on volume of displacement mud and time when the stinger is used in the cementation of conductor and the surface casing.

The advantages of running and cementing the first intermediate casing in two stages and completing the second intermediate casing as liner in two sections are evident.

Table 2. Impact of using the stinger

Casing	Parameters	Volume, m^3		Time, min	
		With Stinger	Without Stinger	With Stinger	Without Stinger
Conductor Pipe	Displacement Mud	5,10	91,51	8,14	104,14
	Total	114,53	200,95	129,69	225,72
Surface Casing	Displacement Mud	40,88	364,33	25,49	206,85
	Total	430,48	756,93	171,80	353,16

Conclusion

In this work, the calculation of the profile of Extended Reach Well was performed with a horizontal displacement from the vertical of 10,000 m based on the new proposed methodology. The construction of the wells with the proposed characteristics has been justified and designed. Cementing program of conductor pipe (660.4 mm) and a surface casing (473.1 mm) using a stinger is developed, also the development program for running and cementing multistages sections for the first intermediate column (339.7 mm), in addition the development program for running and cementing of second section in the second technical column (244.5 mm) at depths of more than 3000 meters in horizontal sections.

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