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COST ANALYSIS OF DRILLING OPERATIONS OF AN OFFSHORE WELL WITH FOUR PHASES

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Abstract: The development of the production of these new fields presents many technological and logistical challenges that demand the elaboration of the well project in a safe and economical way. In this context, the drilling and completion operation of an offshore well with four phases was evaluated. From then on, parameters were defined such as: penetration rate in each drilled phase, as well as the time and cost of drilling and completion of each phase. In summary, all drilling operations were carried out in a period of approximately 40 days (946h), with a total cost of US$ 22,461,920.00.
Keywords: Oil, well design, well drilling.

INTRODUCTION

The elaboration of an oil well project is a complex one, especially with regard to the drilling operation in deep and ultra deep waters, as is the case of exploration in the pre-salt region. From the drilling point of view, the success of the operation depends heavily on the proper elaboration of the well project. To this end, it is essential to understand the environment in which the well will be drilled, analyzing the local geological formation, geopressures, drilling experiences in nearby locations, among others. As a result, the definitions of projects for cementing, completion and well integrity assurance based on these analyzes (ROCHA and AZEVEDO, 2009).

The area where the well will be drilled is the starting point for any well project. In this initial stage, the subsea geology and the wells already explored in the region are characterized. The geological analysis is crucial to define the best positioning of the wellhead and the best trajectory for the well to reach the potential producing zone. After choosing the trajectory, the geopressure study begins, which consists of calculating the pressures and tensions

in the rock formation that allows the measurement of overload, pore, collapse and fracture pressures. Such pressures can cause failures in the rock formation and determine the well's operational window, which represents the allowed range for the variation of pressure exerted by the drilling fluid in order to maintain the integrity of the well. Therefore, the operational window is defined by the maximum and minimum values of the specific mass of the drilling fluid. Furthermore, the drilling fluid has the functions of cooling the bit, transporting rock fragments, restoring the state of initial stresses on the walls of the well, among others (THOMAS, 2004).

In the planning stage of drilling an oil well, choosing the depth of the shoe to be laid is also one of the most important tasks. In general, a well is drilled in different phases by bits with different diameters. After the completion of each phase, the shoe is laid down and the casing is lowered, which will ensure that the well can withstand the maximum pressure to which it will be subjected during the drilling of the next phase. Therefore, the correct selection of the seating depth of casing shoes is a key factor for the elaboration of the well project (ROCHA et al., 2011).

In this scenario, the proper elaboration of the well project increases the safety of drilling and completion operations, in addition to minimizing the probability of compromising the integrity of the well and damage to the environment. Well project planning is essential to determine the time, cost and risks associated with the well to be drilled and completed and, consequently, to assess its technical and economic feasibility. Based on this knowledge, the present study evaluates the cost of the drilling operation performed in an offshore well with four phases and wet completion.

MATERIAL AND METHODS

The determination of the parameters of drilling time, final total cost, type of fluid of the phases, penetration rates in each phase, moment of riser descent and blowout preventer (BOP) in the floating rigs and depth of the phases (lining shoes) was performed based on the data presented in Table 1.

RESULTAS AND DISCUSSION

The subsea well analyzed has a water depth of 1500m and 3000m in depth and the investment study includes drilling, cementing and logging operations in four phases, as shown in Figure 1.

PHASE 1

The first phase started with the descent of the 30" conductor. Attached to it is the 26" drill bit, which, in this first phase, goes down blasting. The conductor is crimped 30m and does not require coating. The conductor setting lasted 25 hours and the total time (setting + sandblasting) was 37 hours and a cost of US$ 18,000.00.

PHASE 2

The second phase started with the drilling with the 26" drill bit mentioned in the first phase. The drill drilled a 670 m stage, at a penetration rate of 10 m/h, using 67 h for drilling. The fluid was circulated before ascending the drill string. Therefore, 37h were needed for the rise of the drill string, plus 25h for the descent of the casing. The coating was made with a diameter of 20". After casing, the well was cemented, followed by the installation of the BOP and descent of the risers, thus completing the drilling of the second phase.

PHASE 3

The third phase started with the descent of the 171/2" drill string, drilling a 1000 m phase,

Water blade	1500m
Final depth	4500m
Drilled depth	3000m
Floating marine rig daily for wet completion	U$ 750.000/day
Descent/Ascent of drill pipes in the maneuver (without breaking connections)	250 m/h
Descent/Ascent of drill pipes in the maneuver (breaking connections, at the end of well drilling)	100 m/h
Descent of coatings at all stages	10 joints/h
Marine BOP assembly, connection and testing	12h
Blasting of 03 coating tubes	12h
Riser descent/ascent	44 m/h
Circulations for well cleaning and fluid conditioning	3h
Penetration rates	10m/h
Cementation	3h
Cable profiling	24h
Open pit formation test	24h/test

Table 1 – Data used for the drilling project.

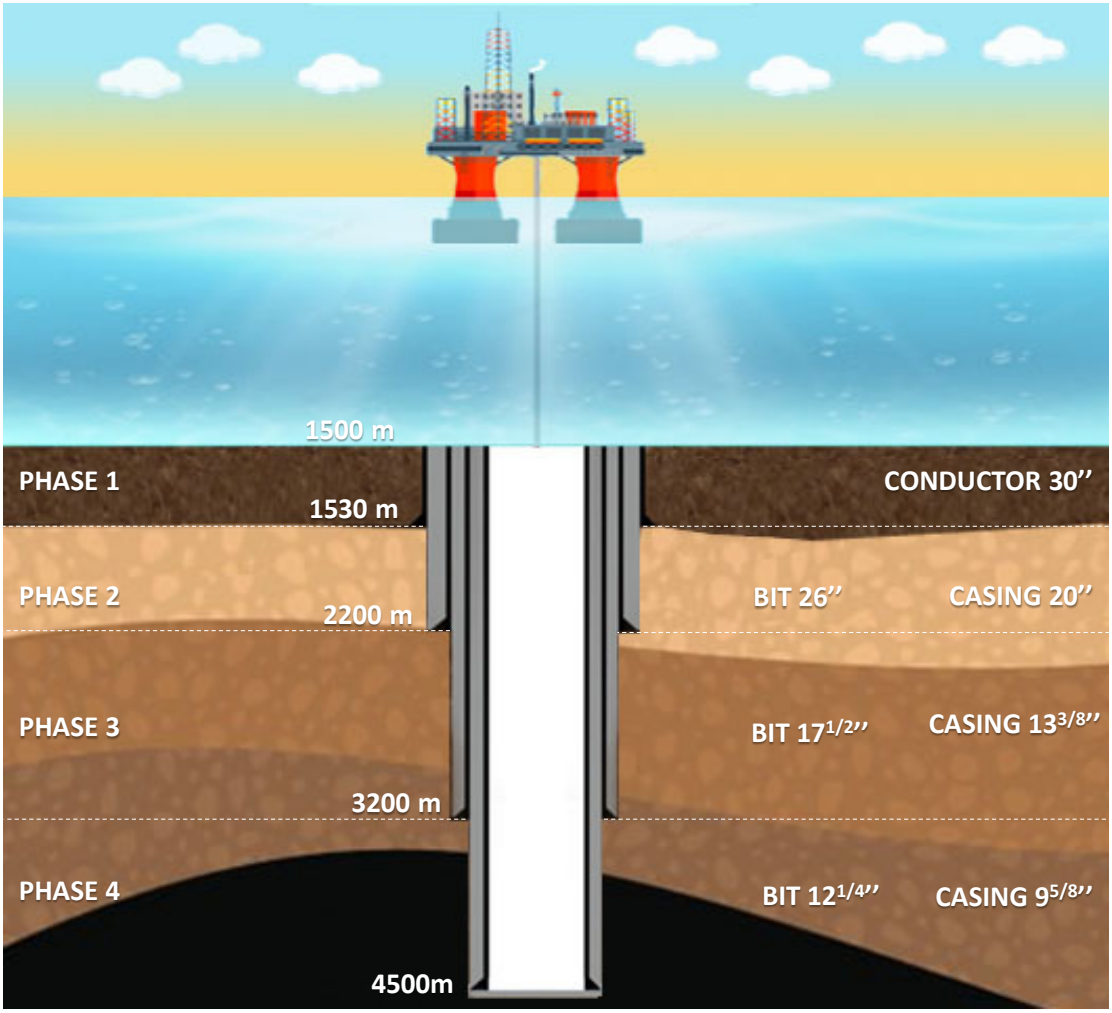

Figure 1 – Well design representation.

at a drilling rate of 10 m/h. Before starting the drilling of the third phase, it was necessary to cut the cement phase of the previous phase. After drilling, the fluid was circulated to clean the well drilled so far and the drill string was removed. The 133/8" casing was seated and cemented. It is worth mentioning that the drilling of the third and fourth phases were done using profiled during the directional drilling. The lithology profile is determined in real time and serves to evaluate the slope of the well.

PHASE 4

The fourth and final phase, as well as the third, began with the descent of the column and the process of cutting the cement. The drill bit used in this phase was 121/4", the drilled length was 1300 m, requiring the change of the drill after the initial 800 m, since the penetration rate was 8 m/h. As it was necessary to change the drill bit after 100 hours of uninterrupted work and the short maneuver for drilling more than 1000m in length, it was not necessary to carry out the short maneuver, since the column was completely removed at 800m, for the change of the drill. After the second exchange and eventual completion of the drilling, the fluid was circulated, followed by the casing of the well and subsequent cementing. The rise of the drill string in the latter case was with a break. The coating diameter was 95/8".

In short, the drilling lasted 946 hours, that is, approximately 40 days. The rig's daily rate is US$ 500,000.00, so US$ 20,000,000.00 was spent on its rent. For each cementing (material and service) the cost was US$ 60,000.00/ phase, in this case presented, 3 cementings were carried out, totaling US$ 180,000.00. The directional drilling service is US$ 720.00/h drilled, present in phases III and IV which cost, respectively, US$ 174,960.00 and US$ 344,160.00.

The drills used were 26", 171/2 and 121/4. Where, the 26" and 171/2 drills cost US$15,000.00/each*1.2 = US$18,000.00/each, and the 121/4 drill bit cost US$50,000.00*1, 2 = US$ 60,000.00. The fluids used were conventional fluid (US$ 12,000.00/phase), water-based cationic fluid (US$ 54,000.00/ phase) and oil-based paraffin fluid (US$ 120,000.00/phase).

The coating presented an investment of US$ 240.00/m, which totaled US$ 1,288,800.00, as 5,370m were coated. The logging service had an expense of US$ 60,000.00/phase and as only the final logging was done, that is, the total cost of logging was US$ 60,000.00 and fluid services was US$ 12,000, 00 The gravel treatment services had an expense of US$ 24,000.00/phase. These services were performed in 3 phases, so the total cost of gravel treatment was US$ 72,000.00.

Based on all the calculations, the costs per phase can be verified, as shown in Table 2, totaling the total costs of the oil well drilling operation with 3000m depth, crossing a water depth of 1500m.

CONCLUSION

By performing the safety and economy of operation, it is necessary, safely and to the operating conditions, throughout its life The ideal has deepened the possible problems to the depth with the lowest operating cost, start of production, personnel or damage to the environment environment to end the future of the operational field. In short, phase IV was the one with the highest investment cost, in the amount of US$ 10,720,960.00, and with a longer time of 20 days, due to its greater depth, greater complexity and the need for well logging in this step. The final cost as stages totaled US$ 2,461,920.0 and a period of 96 hours (approximately 40 days) for all phases of well completion.

PHASE	COST (US$)	TIME (h)
I	18.000,00	37
II	5.124.000,00	192
III	6.598.960,00	236
IV	10.720.960,00	480
TOTAL	**22.461.920,00**	946

Table 2 – Cost and time for each phase of the drilled well.

REFERENCES

ROCHA, L. A. S.; AZEVEDO, C. T. Projetos de poços de petróleo: geopressões e assentamento de colunas de revestimentos. Editora Interciência: Petrobras, Rio de Janeiro, v. 511, 2009.

ROCHA, L. A. S.; AZUAGA, D.; ANDRADE, R.; VIEIRA, J. L. B.; SANTOS, O. L. A. Editora Interciência: Petrobras, Rio de Janeiro, v. 511, 2011.

THOMAS, J. E. Fundamentos de Engenharia de Petróleo. Editora Interciência: Petrobras, 2004.