Restoration of the Production in a Dead Well by using Low Cost Recompletion of Sand Control

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***Abstract*— This paper proposes a cost-effective solution through a recompletion design of sand control to restart the production of a dead well named "X" (for confidential reasons). The data used to achieve the objective of this paper are the production parameters, reservoir properties and the previous completion design. The tool used to draw the new completion schematic is Power Drawn software. It is necessary to use two softwares (PowerDrawn and Pipesim), Ishikawa method and economic evaluation method. The different causes that probably contributed to the production stop in well X are given by using the Ishikawa diagram. The top sediment is obtained by using the sonic log and the clean-up is performed by using coiled tubing with a drill bit incorporated at the end. The mechanical packer is installed to isolate the formation, the pre-packed screen allows the filtration of hydrocarbons. The on-off tool ensures the installation of the mechanical packer and the minimum restriction for the passage of the equipment through the ones in place is 2.313 inches. After the installation of the recompletion, a positive return on investment is obtained and after a production time of one week. The financial aspect after installation of the recompletion shows that a recompletion of the sand control at lower cost is achieved.**

Keywords*— Sand Control, Remedial Sand Control, Completion, Power Draw, Sand Particles, Payback Period

I. Introduction

Hydrocarbons come from the decomposition of organic material (animals and plants) [1-4]. This organic material is transported by rivers and is deposited at the bottom of the seas or large continental lakes, which are the places where hydrocarbons are formed [5-9].

Their location is done by seismic reflection [10-13] and their extraction is done by drilling a well that will allow bringing the hydrocarbons to the surface through the installation of a new completion [14-18]. But during this extraction, it can happen that the production of hydrocarbons is accompanied by sand of the formation, because of an unconsolidated reservoir [19-23]. Sand control will be performed, specifically gravel pack sand control, which will aim to prevent the production of formation sand [24-28]. The dead well X is the study well. It was drilled in an unconsolidated reservoir where a sand control gravel pack was installed. But during its lifetime, we observed a production of sand despite the gravel pack in place, which may be due to a gravel pack that became defective due to poor completion, erosion of the screen, or a high production rate. All these led to shut-down the production. The goal of this paper is to restore the production of the dead well X through a recompletion of the sand control at lower cost.

To solve the problem encountered by the dead well X and achieve the goal of this paper, the following various objectives should be fulfilled: (i) Determine the different causes that probably contributed to the production stop in well X; (ii) determine the height of the sand (top sediment) in the production tubing; (iii) determine the best method for cleaning sand from the formation in the tubing; (iv) determine the area of the damaged screen; (v) select the equipment needed to do the job; and (vi) install the selected equipment that will constitute the new completion.

The research contribution of this paper is threefold: (i) Present the different causes that probably contributed to the production stop in well X; (ii) find the best method to clean the formation sand in the production tubing and the area of the damaged screen with the help of the sonic log; and (iii) select the necessary equipment to install the new completion at lower cost in order to restore the production of the dead well X.

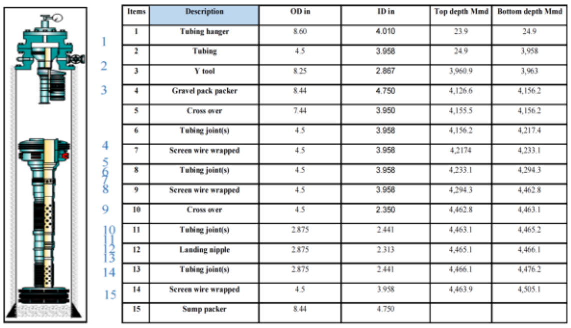
The paper is structured as follows: The first section deals with the introduction, the second section talks about the data, tools, methodology and the obtained results. The paper ends by the conclusion.

II. Material, methods and results

To preserve the confidentiality of the well data, the well will be named "X" and its location is not indicated. The well X characteristics is:

- Casing info: 9-5/8’’ 53.5#;
- Reservoir pressure: 1500 psi, temperature: 140 F;
- Lower zone perf interval: 4468-4495ft;
- Upper zone perf interval: 4302-4432ft;
- GP Packer depth: 4130ft;
- Produced fluid: Oil;
- Initial completed GP sand size: 20/40, 4ppa;
- Wire wrap screen: 12 ga.

The initial characteristics of the well X are presented in Fig. 1.



Items	Description	OD in	ID in	Top depth Mmd	Bottom depth Mmd
1	Tubing hanger	8.60	4.010	23.9	24.9
2	Tubing	4.5	3.958	24.9	3,958
3	Y tool	8.25	2.867	3,960.9	3,963
4	Gravel pack packer	8.44	4.750	4,126.6	4,156.2
5	Cross over	7.44	3.950	4,155.5	4,156.2
6	Tubing joint(s)	4.5	3.958	4,156.2	4,217.4
7	Screen wire wrapped	4.5	3.958	4,2174	4,233.1
8	Tubing joint(s)	4.5	3.958	4,233.1	4,294.3
9	Screen wire wrapped	4.5	3.958	4,294.3	4,462.8
10	Cross over	4.5	2.350	4,462.8	4,463.1
11	Tubing joint(s)	2.875	2.441	4,463.1	4,465.2
12	Landing nipple	2.875	2.313	4,465.1	4,466.1
13	Tubing joint(s)	2.875	2.441	4,466.1	4,476.2
14	Screen wire wrapped	4.5	3.958	4,463.9	4,505.1
15	Sump packer	8.44	4.750		

Fig. 1. Initial characteristics of the well X.

The Power Drawn software, Pipesim software [29], [30], Ishikawa method [31-33] and economic evaluation [34-38] are used to attain the aims of this paper. This is achieved through the selection of materials, the choice of equipment and the selection of the completion method and the description of the installation. The Ishikawa diagram of Fig. 2 shows the different causes that probably contributed to the production stop in well X.

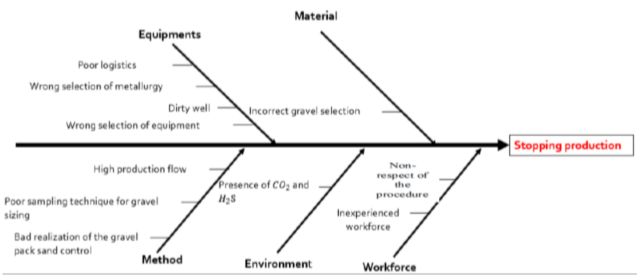


Fig. 2. Ishikawa diagram of well X.

In Fig. 2, the causes that contributed to the stop of the production in well X are:

- At the level of equipment: Poor logistics, wrong selection of metallurgy, wrong selection of equipment, dirty well;
- At the level of material: Incorrect gravel selection;
- At the level of method: High production flow, poor sampling technique for gravel sizing, bad realization of the gravel pack sand control;
- At the level of environment: Presence of CO_2 and H_2S;
- At the level of workforce: Tiredness, inexperienced workforce.

A. Selection of Materials, Choice of Equipment, the Selection of the Completion Method and the Description of the Installation

The selected screen is the pre-packed screen. The screen selected is the pre-packaged screen. It is selected because of its robustness. It is a screen that already has gravel packed in it, hence its resistance to high production flows. After the determination of the screen used it is important to know the size of the mesh on the screen. This is done according to the formula of Bellarby [39], [40] which says that: $\{gravelsize * 1/2;\ gravelsize * 2/3\}$ and the results are presented in Table 1.

Table 1. Mesh size.

Standard mesh sizes	Inch
20	0.0331
40	0.0165

0.0165/2=0.00825 Inch and 0.0165*2/3=0.0011 Inch

Since the minimum restriction is 2.313 inches, the outside diameter of the screen is 2.2625 inches and the outside diameter of the blank pipe is 2.0625 inches. The mechanical packer ensures the sealing and the insulation in the well and supports all the new completion to be installed. It is designed to be mechanically anchored to the casing. The on-off tool will allow us to mechanically install the packer in the well. The well has already a completion installed in it. We will use the alloy used by the completion in place to make the well. We note that the alloy used is steel because in this well there is no carbon dioxide and hydrogen sulfide. The realization of the procedure to remedy the sand production in well X is presented in Fig. 3.

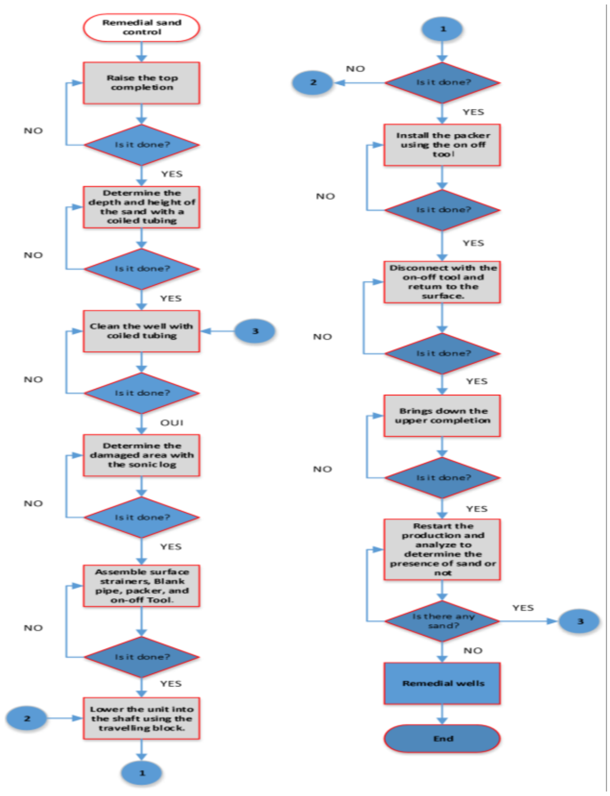


Fig. 3. Procedure for the implementation of the new completion.

The top sediments and cleaning of the filled area are presented in Fig. 4.

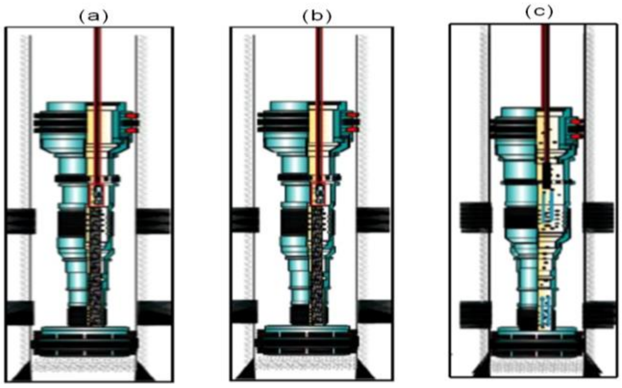


Fig. 4. (a) Determination of the sediment top, (b) cleaning of the filled area with coiled tubing and (c) realization of the circulation in order to completely clean the well.

In Fig. 4, the top sediment is determined by measuring the length of the coiled tubing extended into the well to the top of the consolidated sediment. The coiled tubing, which is equipped with a drill bit at its end, is introduced inside the tubing. The completion liquid, which is the brain, is sent through the coiled tubing. This will set the drill bit in motion and allow the drilling of the consolidated sand from the formation. The completion fluid will transport the drill cuttings to the surface through the annular space between the outer diameter of the coiled tubing and the inner diameter of the tubing. After that the well is not completely clean. A circulation is made until having at the surface nitrogen turbidity unit between 15% and 20% which are values showing the clean state of the well X. The determination of the damaged area(s) is done by using the sonic logo which emits sound waves.

Three options are considered in this paper. In option 1, the zones 1 and 2 are found damage. The plan would be to workover the upper completion, run in hole new completion made of screens, blank pipes mechanical packer connected to on-off tool along with pipe. Once the assembly reach the packer setting depth as per the completion program; perform right-hand rotation to mechanically set packer and release on-off tool. Pull out of hole the service tool, run in hole upper completion and restart production. The list of equipment to be installed in zone 1 and 2 is presented in Table 2.

Table 2. List of equipment to be installed in zone 1 and 2.

Item	Description	OD in Inch	ID in Inch	Top depth in Mmd	Bottom depth in Mmd
1	Packer	8.535	2.99	4120.6	4126.6
2	Blanker pipe	2.0625	1.326	4120.6	4158.6
3	Blanker pipe	2.0625	1.326	4158.6	4190.6
4	Blanker pipe	2.0625	1.326	4190.6	4222.6
5	Blanker pipe	2.0625	1.326	4222.6	4254.6
6	Blanker pipe	2.0625	1.326	4254.6	4286.6
7	Blanker pipe	2.0625	1.326	4286.6	4294.3
8	Screens	2.2625	1.326	4294.3	4462.8
9	Pup joint	2.0625	1.326	4462.8	4463.9
10	Screens	2.2625	1.326	4463.9	4505.1

The new completion of the well X in two zones is shown in Fig. 5.

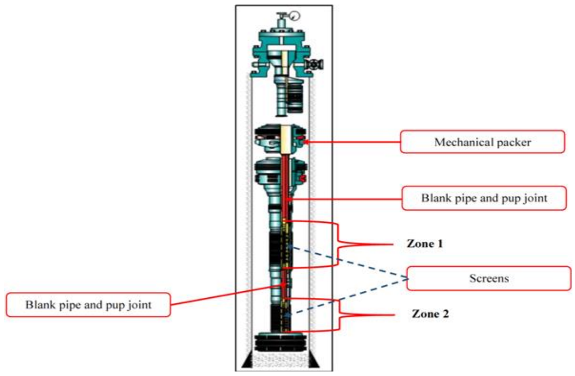


Fig. 5. New completion of the well X in two zones (zones 1 and 2).

In option 2, zone 1 is found damage, the plan would be to workover the upper completion, run in hole new completion made of screens, blank pipes mechanical packer connected to on-off tool along with pipe. Once the assembly reach the packer setting depth as per the completion program; perform right-hand rotation to mechanically set packer and release on-off tool. pull out of hole the service tool, run in hole upper completion and restart production. The list of equipment to be installed in zone 1 is presented in Table 3.

Table 3. List of equipment to be installed in zone 1.

Item	Description	OD in Inch	ID in Inch	Top depth in Mmd	Bottom depth in Mmd
1	Packer	8.535	2.99	4120.6	4126.6
2	Blanker pipe	2.0625	1.326	4120.6	4158.6
3	Blanker pipe	2.0625	1.326	4158.6	4190.6
4	Blanker pipe	2.0625	1.326	4190.6	4222.6
5	Blanker pipe	2.0625	1.326	4222.6	4254.6
6	Blanker pipe	2.0625	1.326	4254.6	4286.6
7	Pup joint	2.0625	1.326	4286.6	4294.3
8	Screens	2.2625	1.326	4294.3	4462.8
9	Pup joint	2.0625	1.326	4462.8	4463.9
10	Blanker pipe	2.0625	1.326	4463.9	4505.1

The new completion of well X in one zone is shown in Fig. 6.

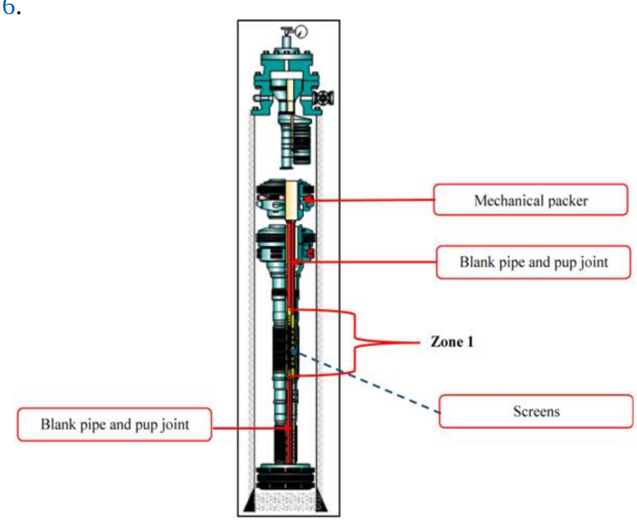


Fig. 6. New completion of well X in one zones (zone 1).

In option 3, zone 2 are found damage, the plan would be to workover the upper completion, run in hole new completion made of screens, blank pipes mechanical packer connected to on-off tool along with pipe. Once the assembly reach the packer setting depth as per the completion program;

perform right-hand rotation to mechanically set packer and release on-off tool. pull out of hole the service tool, run in hole upper completion and restart production. The list of equipment to be installed in zone 2 is presented in Table 4.

Table 4. List of equipment to be installed in zone 2.

Item	Description	OD in Inch	ID in Inch	Top depth in Mmd	Bottom depth in Mmd
1	Packer	8.535	2.99	4120.6	4126.6
2	Blanker pipe	2.0625	1.326	4120.6	4158.6
3	Blanker pipe	2.0625	1.326	4158.6	4190.6
4	Blanker pipe	2.0625	1.326	4190.6	4222.6
5	Blanker pipe	2.0625	1.326	4222.6	4254.6
6	Blanker pipe	2.0625	1.326	4254.6	4286.6
7	Blanker pipe	2.0625	1.326	4286.6	4294.3
8	Blanker pipe	2.2625	1.326	4294.3	4462.8
9	Pup joint	2.0625	1.326	4462.8	4463.9
10	Screens	2.2625	1.326	4463.9	4505.1

The new completion of well X in one zone is shown in Fig. 7.

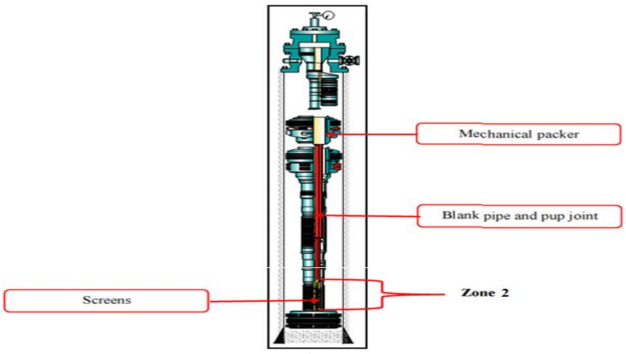


Fig. 7. New completion of well X in one zones (zone 2).

B. Economical evaluation

The project cost is estimated based on the cost of equipment and services. The cost varies depending on the remediation areas within the work and the project will be completed over a seven-day period. For zones 1 and 2 to be remedied, the cost of option 1 is presented in Table 5.

Table 5. Cost of option 1 (zones 1 and 2).

Item	Description	Total
1	Coiled tubing	
2	Pre-packed	
1	Packer	
1	On-off tool	263,650.00$
5	Blank pipe	
2	Pup joint	
1	Completion Specialist	
1	Completion Assistant	

For zone 1 to be remedied, the cost of option 2 is presented in Table 6.

Table 6. Cost of option 2 (zone 1).

Item	Description	Total
1	Coiled tubing	
2	Pre-packed	
1	Packer	
1	On-off tool	263,650.00$
5	Blank pipe	
2	Pup joint	
1	Completion Specialist	
1	Completion Assistant	

For zone 2 to be remedied, the cost of option 3 is presented in Table 7.

Table 7. Cost of option 3 (zone 2).

Item	Description	Total
1	Coiled tubing	
2	Pre-packed	
1	Packer	
1	On-off tool	256,150.00$
6	Blank pipe	
2	Pup joint	
1	Completion Specialist	
1	Completion Assistant	

The results of simulations with the help of Pipesim software after the new completion of well X is presented in Fig. 8.

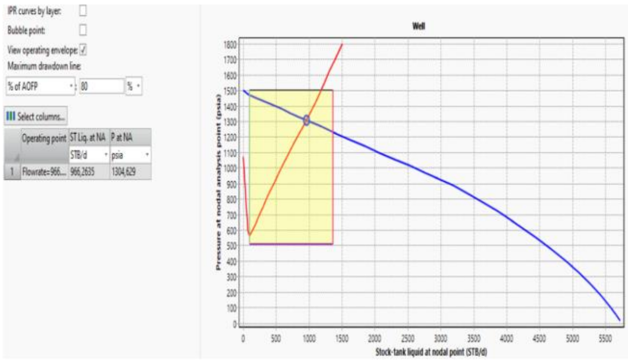


Fig. 8. Production simulation after the new completion of well X.

A production of 966.2635 bls/d is observed in Fig. 8. For a well which is dead it is a good daily production. After having proceeded to the simulation of the production and obtained the daily production, the financial analysis is proceeded to know if the well is profitable or not. For this, the payback method is used to know the period at which the client can start to make profit. Table 8 shows the financial study duly established.

In Table 8, it can be seen that the well produces zero barrels at the initial state, so we have a revenue of zero dollars. All the while knowing that the price of a barrel is 85.90$. The well after remediation is a well that has a daily production of 966.26 bls/d. Knowing that the price of a barrel is 85.90$ its daily revenue is 83002.03$. To calculate the payback period (the period when we start to make profit), the investment is taken and divide by the daily income to get the period in days. The result gives 4 days. So, after 4 days the proprietor of well X starts to make a profit. To know its profit, the calculation of its income on the 4 days of production is obtained by multiplying the number of barrels produced in 4 days by the unit price of the barrel which gives a gross income as shown in Table 8. To get the profit, the revenue obtained is subtracted it from the investment. Then, the net value of the profit obtained for the payback period is obtained. From, the financial study of Table 8, one can see that the project is profitable because the payback period is shorter than that desired by the client.

C. Discussions

The two most common techniques for corrective sand control are the mechanical method, and the chemical method [9]. In this paper, the mechanical method was adopted to solve the problem. It uses filters called screens to prevent sand particles from entering the well. The chemical method of sand control was not necessary in this paper. Because, a gravel pack sand control was already realized. Hence the impossibility to proceed to an acidification, or to the injection of a resin to dissolve the particles of sand which block the well or to consolidate the reservoir. Because the injection of acid will dissolve the sand particles in the well that is blocking it, and will put the well in production which will not prevent the well from continuing to produce sand, and the injection of a resin risks creating a skin effect that will cause

a loss of permeability. The effectiveness of this method comes from the fact that it was carried out in Angola in 2019 in the Ngouni field, which is made up of reservoirs that come from the Miocene. The wells were producing sand and to solve this, the wells were recompleted via the installation of screens through the existing completion.

Table 8. Financial Study

Well Initial State		Total	Well After Remediation			Total
Initial Flow	**Cost**		**Returned after a day of production**			
0 bls/j	85,90$	0$	**Debit**	**Cost Per Barrel**		
			966.26 bls/j	85.90$		83 002.03$
			Payback period (I/R)			**Total**
			Option	**Investments**	**Income**	
			1	263 650$	83 002.03$	4 jours
			2	256 150$	83 002.03$	4 jours
			3	256 150$	83 002.03$	4 jours
			Returned After a month of production			**Total**
			Debit	**Cost Per Barrel**		
			28 978.8 bls	85.90$		2 490 052.02$
				Profit (Income – Investments)		
			Option	**Investments**	**Income**	
			1	263 650$	2 490 052.02$	2 226 402.02$
			2	256 150$	2 490 052.02$	2 226 402.02$
			3	256 150$	2 490 052.02$	2 226 402.02$

III. CONCLUSION

The goal of this paper was to restore the production in dead well X by using a lower cost recompletion of the sand control. To solve this problem, we determined the height of the sand in the production tubing, we found the best method to clean the formation sand in the production tubing, we found the area of the damaged screen with the help of the sonic log, we selected the necessary equipment to perform the work such as: pre-packed screens and mechanical packer, we made the new completion which consists of the installation of a blank pipe and a screen. This completion method restarted the production of the well X, save time and money. But it is limited, because its use implies that the size of the equipment to be used is less than the minimum restriction which is 2.313 feet from where any equipment having a diameter higher than this value is unusable. To avoid any damage after the problem is solved, we recommend having a daily production not exceeding 6000 barrels per day; the normal value being 966.2635 barrels per day. For more safety, why not equip the wells with sensors that will inform us of the state of our screens according to the production rate in order to prevent possible corrosion?

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