American Journal of Engineering Research (AJER)
e-ISSN: 2320-0847 p-ISSN : 2320-0936
Volume-9, Issue-11, pp-88-100
www.ajer.org
Research Paper Open Access

Through-Tubing Water Shut-Off and Recompletions Utilizing Coiled Tubing Cement Packer Placement Technique

(1)Joseph, Belema, (2) Dick, I.F
(1) Robert Gordon University, Aberdeen(2)Rivers State University, Port-Harcourt, Rivers State, Nigeria.
Corresponding Author: Dick, I.F

ABSTRACT:*The most economic approach to solving the problem of increased water-cut occasioned by depleting reserve in Four selected oil wells in the REYES oil field of the Niger Delta with a view to not just optimizing the production potential but also extending the life of the Field is presented in this study. Utilizing preliminary results from reservoir saturation tool (RST) log, Reservoir performance plots and decline curve analyses, the candidate wells for intervention were selected and deployed into the chosen intervention Technique – Through-Tubing Water Shut-off and Recompletion Utilizing Coiled Tubing Cement Packer Placement. Post cement packer placement result obtained indicated an increase in daily oil production of 1,842 barrel of oil per day (bopd) with an attendant five-year life extension. Interestingly, an estimated amount of two million sixty-three thousand and forty Dollars ($2,063,040.00) is accruable from these wells for a month's production, assuming cost of crude oil per barrel is $40/bbl after the intervention. Cumulatively, the estimated AFE cost for the four wells (even though only two of the proposed four wells were actually recompleted) for the same production period amounts to one million six hundred and fifty thousand, seven hundred and thirteen dollars, eighty-one cents ($1,650,713.81) which actually proves this technique to be cost effective with a faster break-even period of a month (28 days) relative to workover with rig that has about 10months break-even period.*

KEYWORDS: *water-cut, Reyes field, cement packer, coiled tubing, recompletion, decline curve*

Date of Submission: 31-10-2020 Date of acceptance: 12-11-2020

I. INTRODUCTION

Within the Niger Delta, water drive is the predominant reservoir drive mechanism. Over the lifespan of the field, the oil production diminishes giving rise to increased water production as applicable to other fields worldwide. To increase the productive life of the field, the water had to be shut-off and other channels created to access the bypassed reserves. Figure 1 below shows the production trend of the Reyes field over time. However, the completion philosophy of this field is dual string completion equipped with safety valves, gas lift mandrels, sliding side door (SSD), 'X' nipple and 'XN' nipple.

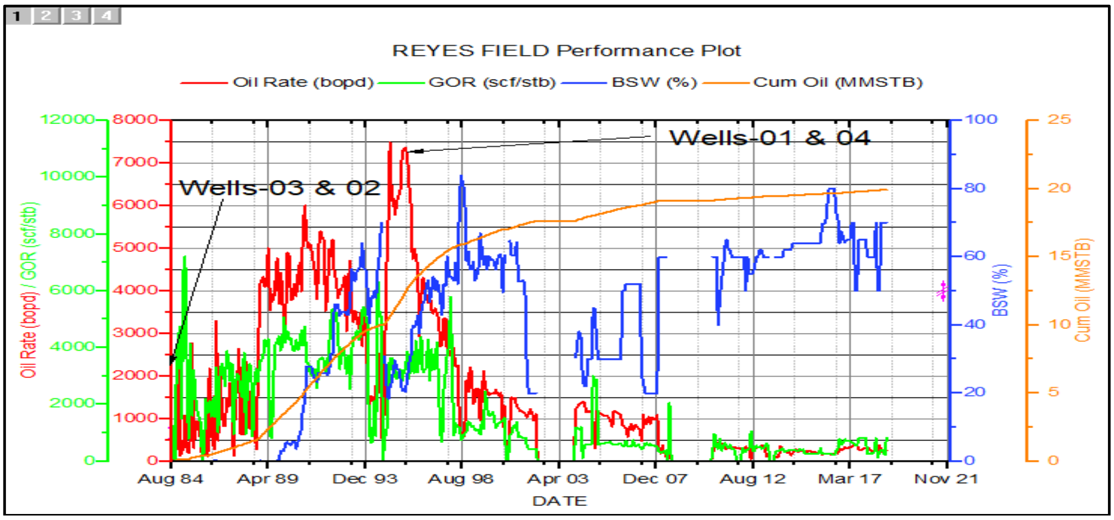

Figure 1: REYES Field Performance Plot

Reservoir water production mechanisms have been studied and identified to consist of well completions- related mechanism and reservoir- related mechanism according to the works of (1), (2) and (3).When produced water from any of the identified mechanisms is no longer economical then, water Shut-off becomes inevitable to revive the reservoir. Shutting off water means receding the production of excessive reservoir water because of its inherent problems such as: Tubing/Casing Corrosion, Scale/Salts deposition, Gas Hydrate Formation, Hydrocarbon Solids Deposition, Water Treatment Facility Constraint and Disposal of the produced water itself.

Common water Management and Control Techniques in practice include water shut off using Through tubing inflatable packer technique, Cement packer placement methods by Bull Heading Through the Production Tubing and Cement Packer Placement Technique Utilizing Coiled Tubing. While some of these are mechanical, others are chemical in nature. Early researchers that employed mechanical mechanism with plausible results were(4) and (5). Going forward, the Method of Water Shut-off using Through Tubing Inflatable Packer Technique was adopted by(6) while they were investigating the problem of water production in multiple layers of reservoir opened to production in a vertical single producer in northern Kuwait. They used a temporary straddle system of two through-tubing inflatable packer (TTIP) to isolate the top and bottom perforations. However, this technique was limited to single string completions and involves multiple runs to accomplish. In a related study, (7) while working to increase production of marginal reserves in one of CHEVRON's field, utilized cement packer placement technique by bull heading within two production packers in dual completion strings. The reserves were perforated using an oriental perforating gun with zero phase and the result showed cost effectiveness as wireline and pumping services were only required.(8) also used the same technique and recorded the associated economic gains. Larry et al in(9), while exploring an innovative through-tubing means of utilizing cement packer in isolating casing and to allow for optimal production from marginally-economical up-hole candidates suggested that, holes be punched in the tubing and a cement retainer set above the punched section. Thereafter, coiled tubing be stung into the retainer and cement pumped down through the punched holes into the annulus. The coiled tubing was later pulled out of the retainer and cement dumped on top of the retainer before the coiled tubing was pulled out of the well. This proved to be a controlled method of cement packer placement without compromising the integrity of the completions tubulars and accessories and had a 95% success rate. The process is applicable in single and dual completions with reserves above or below top packer or in between two dual packers. Indeed, apart from its efficiency, it is also more economical compared to workover operation requiring a rig.

Muhammad et al in (10) in their work investigated the problem of high water cut in the shut-in wells in the Sanga-Sanga Production Sharing Contract (PSC) fields, Onshore Mahakam Delta, East Kalimantan, Indonesia, and noted that to salvage the declining production rate and to bring on stream those idle wells, coiled tubing cement packer technique should be applied to optimize by-passed oil. The completion philosophy was such that it is either both 3-1/2-in dual string or completion with varying string sizes like 3-1/2-in x 2-3/8-in dual string completions.

In one of the cases, they utilized coiled tubing cement packer to first shut off sands ‘N’ and ‘O’ which were below two dual packers through the SS. Thereafter, coiled tubing was deployed through the LS to create an underbalance to enable perforation of ‘U’, ‘V’, and ‘T’ sand and brought to production. Plug was set in the ‘X’ nipple of the SS and the sliding side door, SSD opened to produce sands (S, R, Q, & P) as shown in figure 2 below.

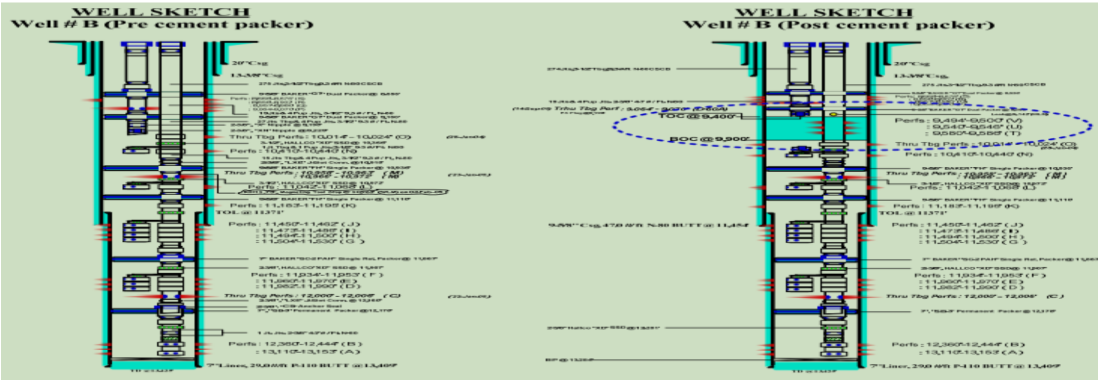

Figure 2: Pre-Cement Packer and Pose-Cement Packer Status for Well #B (10)

Longfellow et al (11) in their work while investigating the cause of packer leak and remediation plan in a dual completion utilized Coiled tubing cement packer. The well was diagnosed of mechanical failure of the long string packer during initial well completions which resulted in wellbore communication across the two strings. Here, coiled tubing was deployed through the short string and Hi-vis pill was first pumped to serve as a base thereafter; cement slurry was pumped to seal off the leak above the lower packer. The pump and pull method were used to spot the cement plug. This proved successful and economical with 90% cost reduction compared to using a workover rig. The figure 3 below shows well schematic before and after the annular packer seal remediation work was carried out.

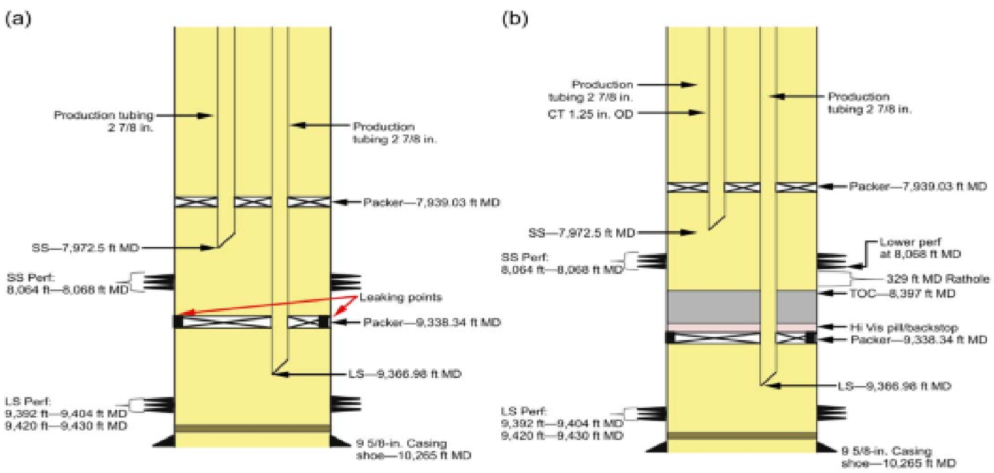

Figure 3: Before and after well intervention indicating the required secondary barrier (11)

Emmanuel et al, (12) while solving the problem of high water cut in a horizontal well Offshore Niger Delta and a means of accessing marginal reserves in high angle-deviated (72 to 80^0) wells, utilized coiled tubing cement packer placement techniques to shut off the water and reperforated shallower in order to access the required reserves. From the well schematics in figures 4 below, first, slickline was run in hole to ascertain free passage through the tubing, then gamma ray GR/casing collar locator CCL/ Temp logging to correlate depth for perforation. Two sets of bridge plugs were later run to isolate the horizontal section. The tubing sections from 6,095 to 6,105ft were punched to establish communication and circulate to clean the wellbore by flushing with inhibited seawater with surfactants. Cement retainer was then set above the punched area and thereafter; coiled tubing run in hole and stung into retainer and cement slurry pumped into the 3-1/2-in tubing/ 9-5/8-in production casing annulus. After waiting on cement to cure, the reservoir of interest was perforated and the gas lift mandrel activated to unload the well. Indeed, significant cost saving was realized by eliminating rig-based workovers.

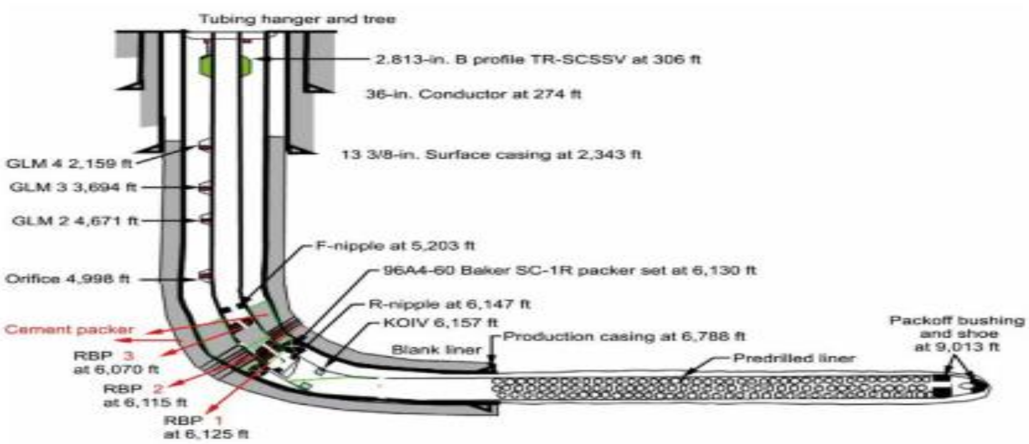

Figure 4: Well BB wellbore schematics pre (top) and post (bottom) cement packer placement (12).

While trying to create annular barrier to enhance production above existing production packer in a single string completion, (13) explored same principles undertaken by (14) and (12) to isolate the watered-out reservoir, created annular barrier and recompleted shallower reservoir in the S field, Peninsular Malaysia using cement packer placement technique utilizing coiled tubing. In this circumstance the sliding side door, SSD was used for the circulation between the tubing and casing as against punching holes which further reduced the operational cost.

II. MATERIALS AND METHODS

This study adopts the cost- effective rig-less well intervention method known as "Coiled Tubing Cement Packer Placement Techniques" to shut-off water zone. Cement Packer as the name implies is a cement plug placed between the annular void of the production tubing and casing. It creates access to bypassed reserves either above or below a single or dual production packers by providing the channel for the flow of production fluid into the production tubing. Essentially, the purpose of a cement packer is:

1) To protect the casing from the wellbore pressure.
2) To disallow the migration of gas through the casing to surface.
3) To disallow the passage of fluid into the casing through to the production tubing thus, shutting off water production.

The method is applicable, with good success story, to wells that have been shut-in for economic reasons; either because of high water cut or wells producing below their optimal potential with bypassed reserves within the wellbore. Hence, in this study channels will be created by perforation using zero-phase guns to enable access to bypassed oil, shallower down the well. For data analysis, both experimental and computational procedures are utilized and secondary sources of data are chiefly utilized due to the peculiar nature of the data needed for the analysis.

Data Acquisition

Data acquired and used for this dissertation were from an oil field in the Niger Delta, Nigeria given pseudo names. The field is called REYES and the Reservoirs are RY-01, RY-02, RY-03, and RY-04.

Reservoir performance plot showing the rate of decline of production rate with time is as indicated by the red marker; percentage increase in water cut (%) with time is as indicated by the blue marker etc. as derived from the production data and stated in the plots in figures; 5, 6, 7 & 8 below for the four wells in retrospect.

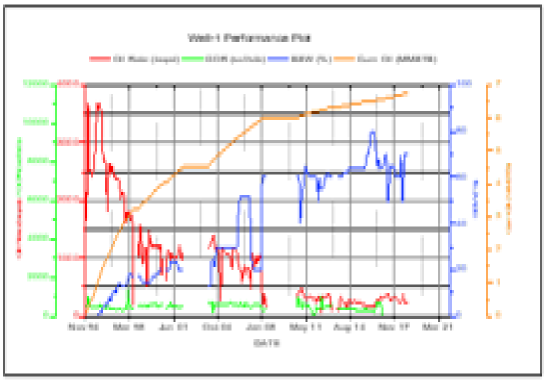

Figure 5: Well-1 Performance Plot

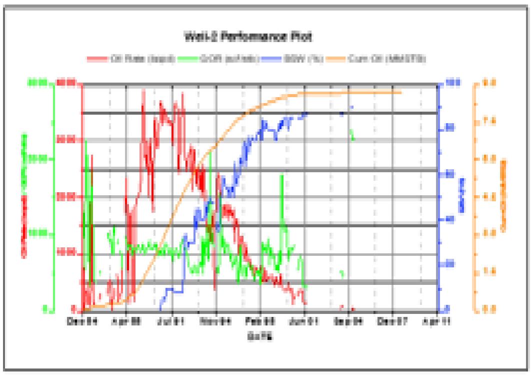

figure 6: Well-2 Performance Plot

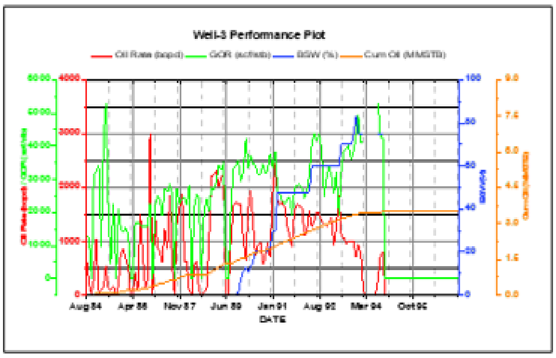

Figure 7: Well-3 Performance Plot.

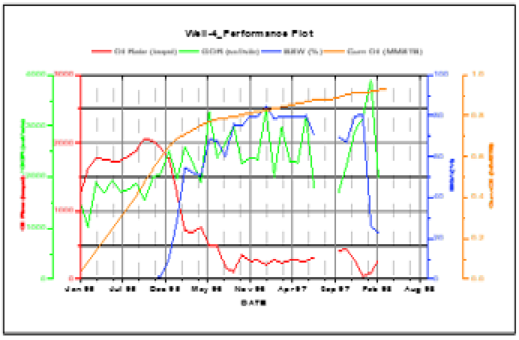

Figure 8: Well-4 Performance Plot

Production and Well Test Data

The separator was the principal equipment used for acquiring the production and well test data as shown in figure 9 below. It manipulates the stream of produced effluent based on density differences that exist between gas, oil, and water, and that causes these phases to separate.

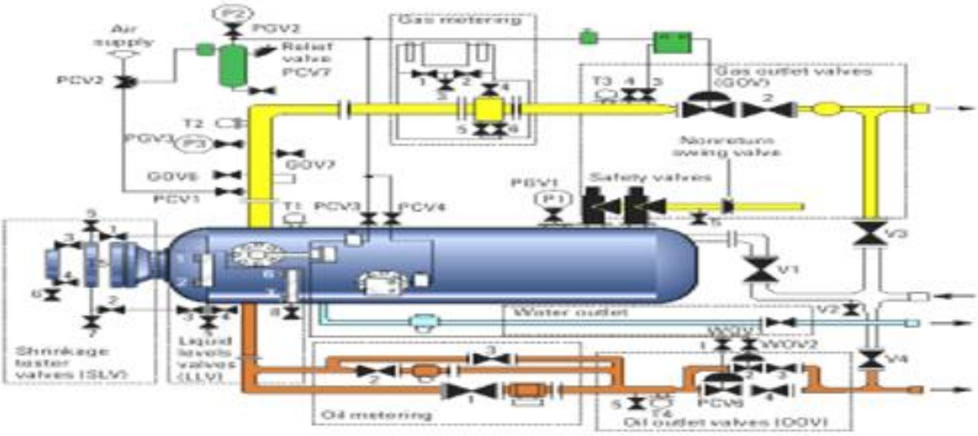

Figure 9: Three Phase Separator System (Schlumberger Well Testing Services 2000).

The open hole logs are acquired across the production zones recording any characteristic parameter of the formation traversed in the wellbore before the wellbore was cased-off by means of wireline logging tool. Some of the log characteristics are the resistance to the flow of electric current, radioactivity, acoustic properties, the wellbore diameter, wellbore pressure and temperature.

Reservoir Saturation Tool (RST) Log

Carbon oxygen log was acquired using the RST tool on wireline to establish the current oil saturation behind casing. Correlation was then made with the open hole log where the interval to perforate to recomplete from the existing wells were selected. The tool generated neutrons which interacted with the formation and the borehole, creating gamma rays. The saturation was then computed.

Decline Curve Analysis

Decline curve analysis was used to estimate the ultimate recovery as well as remaining reserves of currently producing wells on REYES field. This was done to further affirm the possibility of water shut-off on the selected wells in the reservoirs of focus in REYES field.

The DCA plot is presented in Figure 10 below. The red line on the graph indicates the trend/build up rate for water cut while the green line indicates the forecast. The beginning of the green line is the cumulative production to date while the end signifies cumulative production to abandonment water cut rate at 95 percent. The difference between beginning and end of the cumulative production is the reserves.

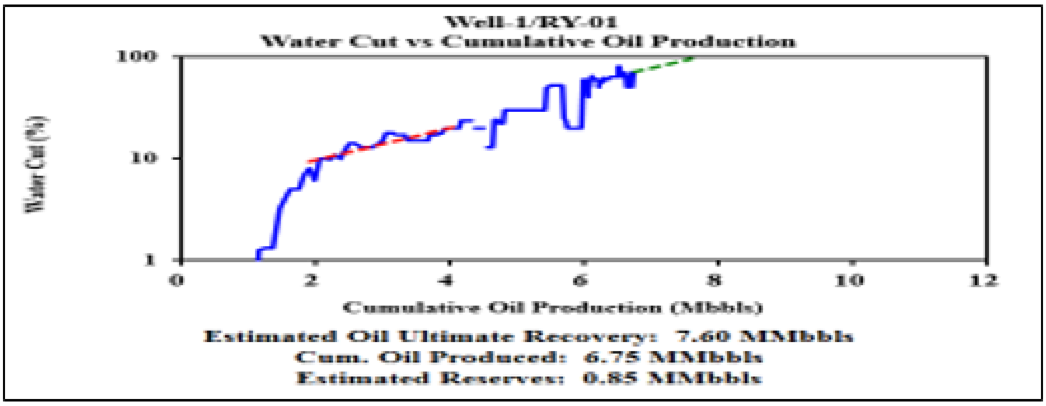

Figure 10: Well-1 Water Cut DCA Plot

Through tubing perforation gun

After the successful execution of the cement packer placement, the upper bypassed reserves were channeled into the wellbore. Perforation phasing then became important as the gun would have to go through one string into the reservoir without affecting the other string. In this circumstance, the gun phasing would be 0^o phasing achievable by 0^o-phased changes and an orienting tool. This tool is used when it is necessary to face perforations away from the adjacent tubular. The perforation gun is attached to the orienting tool and run to the desired depth of perforation. There, a signal is sent to the tool, which rotates sinusoidal, measuring the surrounding metal mass. Resultant high metal concentration points the direction of more tubular materials (showing both strings andcasing) whereas, lesser metal concentration points to the direction of less tubular materials (showing a single string and a casing). At this point, the sensor is facing the high-concentration double tubular while the shots are facing the low-metal single tubular as exemplified in figure 11 below. The explosives are then initiated to perforate the single tubular side. Figure 12 below shows the tool description of the orienting perforating tool incorporating the guns.

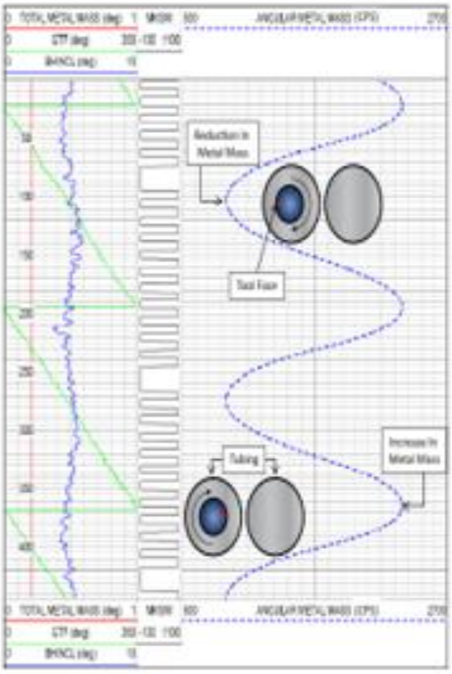

Figure 11: Angular Metal Mass Displacement (Greatwall Energy Services 2019)

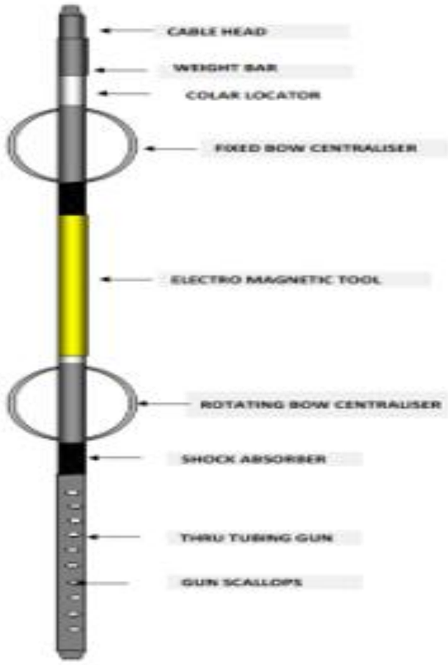

Figure 12: 1-11/16-in Magnetic Orienting through Tubing Perforation Tool w/Gun (Greatwall Energy Services 2019).

II. RESULTS AND DISCUSSIONS

Result for Well #1

Two of the selected wells based on the analysis done were successfully executed. The wells were shut-off using coiled tubing, perforated shallower based on the RST log using oriented zero phased guns and brought to production. The table 1 below is the production and well test data gathered indicating the optimal choke size, daily oil rate (Bopd), percentage water production and the gas oil ratio (scf/bbl).

Table 1: Production test data gathered for well #1 at the end of the cement packer job and recompletion.

Well Name	Date	Choke Size	Oil Rate bopd	GOR scf/bbl	Water Cut (%)	Cumm Oil MMSTB
Well #1	4 Apr 2020	32	491.8	543.0	6.0	0.0005
Well #1	5 Apr 2020	32	555.4	600.0	4.0	0.0010
Well #1	6 Apr 2020	32	588.1	720.0	4.0	0.0016
Well #1	7 Apr 2020	32	610.7	840.0	8.0	0.0022
Well #1	8 Apr 2020	32	569.8	1020.0	8.0	0.0028
Well #1	9 Apr 2020	32	521.5	1005.0	7.0	0.0033
Well #1	10 Apr 2020	32	528.1	982.0	7.0	0.0039
Well #1	11 Apr 2020	32	530.8	1024.0	7.0	0.0044
Well #1	12 Apr 2020	32	593.2	1030.0	10.0	0.0050
Well #1	13 Apr 2020	32	656.4	1031.0	10.0	0.0056
Well #1	14 Apr 2020	32	661.7	1035.0	9.0	0.0063
Well #1	15 Apr 2020	32	628.0	945.0	9.0	0.0069
Well #1	16 Apr 2020	32	628.2	948.0	10.0	0.0076
Well #1	17 Apr 2020	32	565.7	834.0	10.0	0.0081
Well #1	18 Apr 2020	32	627.0	923.0	9.4	0.0088
Well #1	19 Apr 2020	32	663.4	987.0	9.0	0.0094
Well #1	20 Apr 2020	32	618.8	904.0	9.9	0.0100
Well #1	21 Apr 2020	32	607.0	1003.0	10.0	0.0106
Well #1	22 Apr 2020	32	555.9	965.0	9.7	0.0112
Well #1	23 Apr 2020	32	620.5	1014.0	8.8	0.0118
Well #1	24 Apr 2020	32	618.7	1023.0	7.0	0.0124
Well #1	25 Apr 2020	32	650.8	1123.0	10.0	0.0131
Well #1	26 Apr 2020	32	659.3	1130.0	10.0	0.0138
Well #1	27 Apr 2020	32	673.3	1133.0	10.0	0.0144
Well #1	28 Apr 2020	32	616.0	1123.0	10.0	0.0150
Well #1	29 Apr 2020	32	611.7	1101.0	9.8	0.0157
Well #1	30 Apr 2020	32	599.0	1072.0	9.8	0.0163
Well #1	1 May 2020	32	541.2	1042.0	10.0	0.0168
Well #1	2 May 2020	32	580.5	1024.0	10.0	0.0174
Well #1	3 May 2020	32	539.6	1035.0	10.0	0.0179
Well #1	4 May 2020	32	522.4	1017.0	10.0	0.0184

From the post cement production data gathered for well #1, the production performance characteristics were plotted as shown in the figure 13 below.

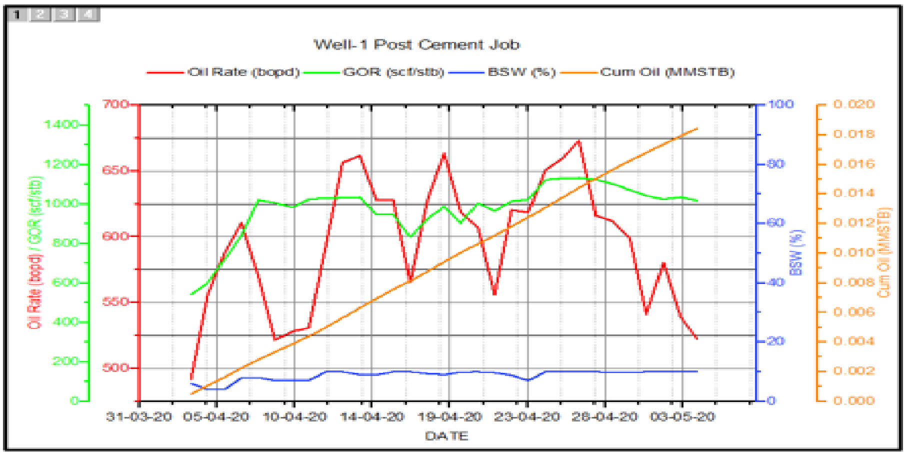

Figure 13: Well #1 Post Cement Production Performance Plot.

Figure 13 above shows a graph of date (Days) against oil rate (bopd), percentage water production (%), gas oil ratio (scf/bbl) and cumulative oil production (MMSTB) for the period of production testing; thirty-one (31) days in this scenario. The red signature indicates the daily oil production averaging 595 bopd while the water production greatly reduced to less than 10 percent as shown by the blue signatures on the graph. This result was impressive as it was within the daily anticipated production rate.This is further buttressed in figure 14 below which shows both the pre- and post- cement packer analysis. In that figure, whereas the oil rate increased from 101 bopd to 595bopd, the percent water cut decreased from 70% to 9% at the end of the cement packer job.

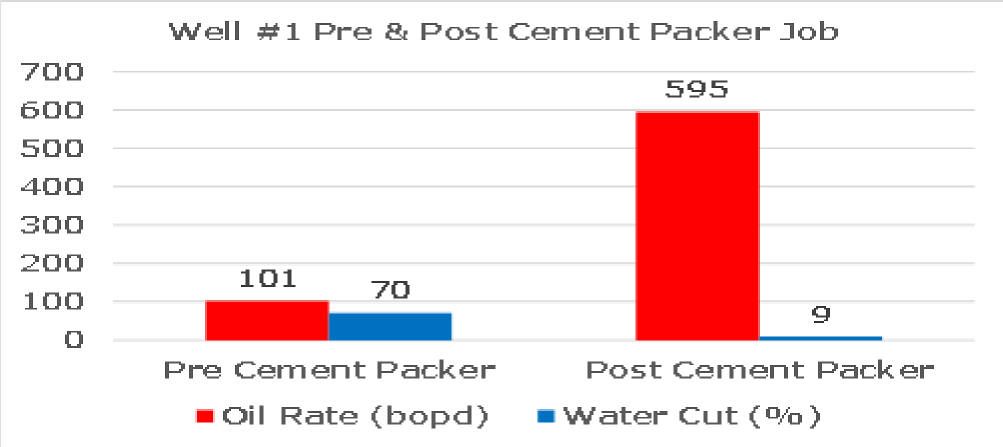

Figure 14: Well #1 Pre and Post Cement Packer Job

Result for Well #2

Table 2: Production test data gathered for well #2 at the end of the cement packer job and recompletion.

Well Name	Date	Choke Size	Oil Rate bopd	GOR scf/bbl	Water Cut (%)	Cumm Oil MMSTB
Well #2	10 May 2020	32	433.3	1200.00	4.00	0.0004
Well #2	11 May 2020	32	435.0	1097.00	4.00	0.0013
Well #2	12 May 2020	32	453.0	1224.00	4.50	0.0026
Well #2	13 May 2020	32	433.2	1084.00	3.90	0.0044
Well #2	14 May 2020	32	433.2	1073.00	4.00	0.0066
Well #2	15 May 2020	32	425.6	1045.00	6.00	0.0092
Well #2	16 May 2020	32	453.3	1132.00	7.00	0.0122
Well #2	17 May 2020	32	445.9	1043.00	6.80	0.0158
Well #2	18 May 2020	32	476.0	1201.00	7.20	0.0197
Well #2	19 May 2020	32	434.3	1032.00	7.20	0.0242
Well #2	20 May 2020	32	487.4	1311.00	8.00	0.0291
Well #2	21 May 2020	32	429.5	1296.00	8.00	0.0344
Well #2	22 May 2020	32	498.6	1308.00	8.30	0.0403
Well #2	23 May 2020	32	433.7	1026.00	7.90	0.0465
Well #2	24 May 2020	32	438.4	989.00	8.50	0.0532
Well #2	25 May 2020	32	478.0	1032.00	9.00	0.0604
Well #2	26 May 2020	32	487.8	1031.00	10.70	0.0681
Well #2	27 May 2020	32	489.3	1031.00	11.00	0.0763
Well #2	28 May 2020	32	453.0	1002.00	11.00	0.0849
Well #2	29 May 2020	32	465.0	1010.00	11.02	0.0940
Well #2	30 May 2020	32	480.0	1010.00	12.00	0.1035
Well #2	31 May 2020	32	429.8	899.00	11.87	0.1135
Well #2	1 Jun 2020	32	475.0	965.00	12.03	0.1240
Well #2	2 Jun 2020	32	475.0	1052.00	12.00	0.1349
Well #2	3 Jun 2020	32	432.0	965.00	11.00	0.1463
Well #2	4 Jun 2020	32	475.0	988.00	11.60	0.1582
Well #2	5 Jun 2020	32	413.0	876.00	10.30	0.1704
Well #2	6 Jun 2020	32	500.3	1032.00	11.73	0.1832
Well #2	7 Jun 2020	32	597.2	1124.00	12.70	0.1966
Well #2	8 Jun 2020	32	507.0	1086.00	12.05	0.2104
Well #2	9 Jun 2020	32	510.0	1089.00	12.06	0.225

Utilizing data from Table 2 above, production performance characteristics were plotted as shown in figure 15 below.

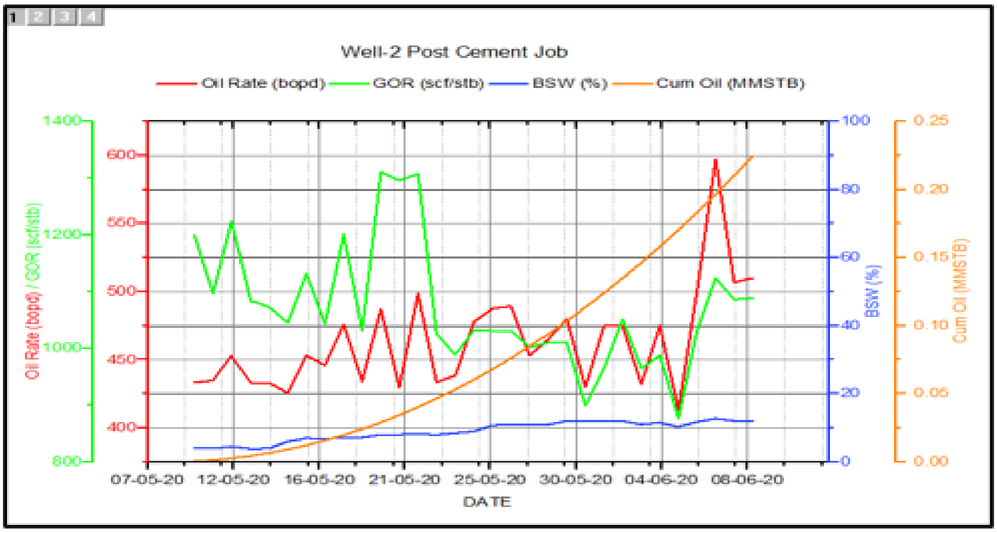

Figure 15: Well #2 Post Cement Production Performance Plot.

In figure 15, the red signature indicates daily oil production rate increasing to an average of 460 bopd with an average water cut of about 9 percent as indicated by the blue marker on the graph. This again, is further buttressed in figure 16 below that shows both the pre- and post- cement packer analysis. In that figure, whereas the oil rate increased from 17 bopd to 460bopd, the percent water cut decreased from 95% to 12% at the end of the cement packer job.

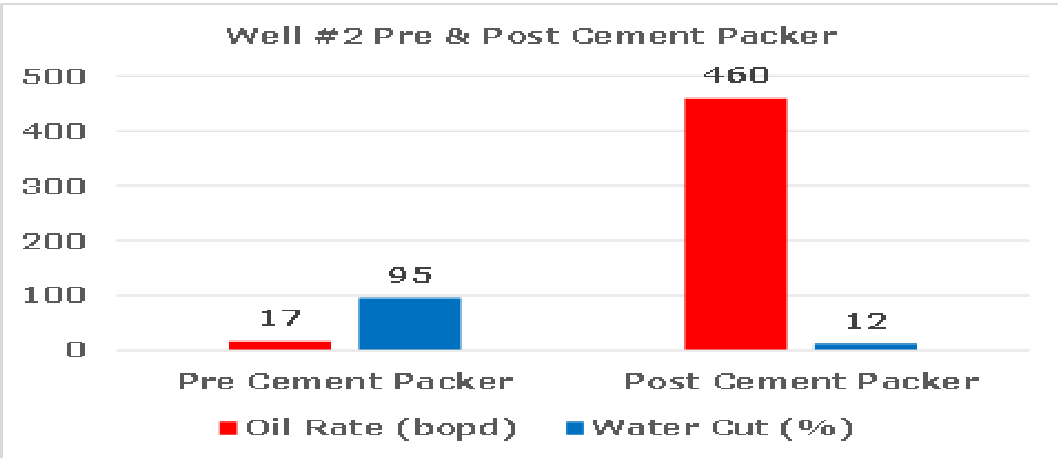

Figure 16: Well #2 Pre and Post Cement Packer Job

Cost Effectiveness of the Through Tubing Cement Packer

The Authority for Expenditure (AFE) cost for the through-tubing intervention for the proposed four wells was estimated at $ 1,650,713.81. On the contrary, the cost of the workover operation using a rig as an alternative method was estimated at $5,157,755.04 for only a single well. This is indeed, a huge cost saving using the candidate method. Cost estimate for two of the wells successfully executed using the through-tubing technique averaged at $825,356.91 and the graph below in figure 17 clearly indicates the cost saving from the through tubing cement packer placement as against utilizing a rig.

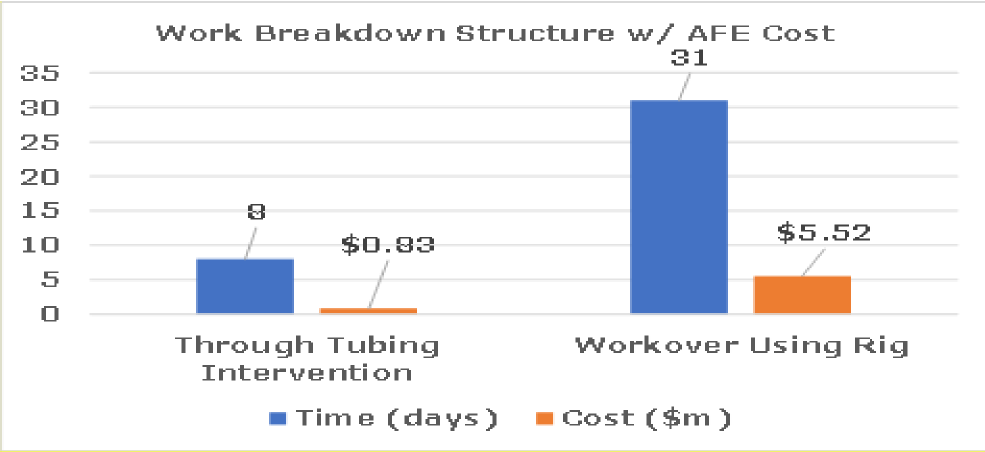

Figure 17: Work Breakdown Structure and AFE Cost Comparison Between Through Tubing intervention to Utilizing a Rig.

Breakeven Period for Through Tubing Water Shut-off vs Workover using a Rig

Table 3 below shows the break-even analysis for recompletion using the through-tubing cement packer technique and clearly the daily oil production for well #1 is 595 bopd while for well #2, it is 460 bopd. Assuming that the oil production for well #3 is 387 bopd and well #4 is 400 bopd, the daily cumulative oil production for the four wells would be 1,842 bopd and in a month (28 days), the cumulative oil production would be 51, 576 bopd. Assuming cost per barrel of crude oil to be $40/bbl implies that, in a month, the revenue would be two million sixty-three thousand and forty dollars only ($2,063,040.00). Since the AFE cost for the four wells was estimated as one million six hundred and fifty thousand, seven hundred and thirteen dollars, eighty-one cents ($1,650,713.81), it shows clearly that within a period of one month; shareholders would have broken even.

Table 3: Breakeven data for Through Tubing Water Shut-off and Recompletions

Well	AFE Cost per Well ($)	Daily Production Output (BOPD)	Expected Output in a Months (BOPD)	Cost per barrel of oil ($40)	Revenue ($)
Well #1	$412,678.45	595	16660	40	$666,400.00
Well #2	$412,678.45	460	12880	40	$515,200.00
Well #3	$412,678.45	387	10836	40	$433,440.00
Well #4	$412,678.45	400	11200	40	$448,000.00
Total	**$1,650,713.81**	**1842**	**51576**		**$2,063,040.00**

On the other hand, the break-even analysis for workover using a rig as shown on Table 4 below indicates that it will take a hundred and twenty four days to accomplish the four well and an AFE cost of twenty million, six hundred and thirty one thousand and twenty dollars and sixteen cent ($20,631,020.16) with a breakeven period of ten months (280 days) to realize a revenue of $20,630,400.00.

Table 4: Breakeven Analysis for Workover Utilizing a Rig

Well	AFE Cost per Well ($)	Daily Production Output (BOPD)	Expected Output in Ten Months (BOPD)	Cost per barrel of oil ($40)	Revenue ($)
Well #1	$5,157,755.04	595	166600	40	$6,664,000.00
Well #2	$5,157,755.04	460	128800	40	$5,152,000.00
Well #3	$5,157,755.04	387	108360	40	$4,334,400.00
Well #4	$5,157,755.04	400	112000	40	$4,480,000.00
Total	**$20,631,020.16**	**1842**	**515760**		**$20,630,400.00**

The Breakeven Analysis is further explained in the bar chart in figure 18 below where the blue bars represent the number of days it took to accomplish the various jobs. It's clear from the chart that while it took 32 days for the through tubing intervention,it took 124 days using a rig. Again, in terms of the cost, whereasit costs $1.65m for the through tubing intervention,the cost for the workover rig operation was $20.63m and this is represented by the orange-colored bars. The grey-coloredbars represent the breakeven period in days. Clearly,investors could start making profit in 28 days using the through tubing intervention as opposed to a long-waiting break-even period of 280 days; approximately ten months utilizing a rig before making profit.

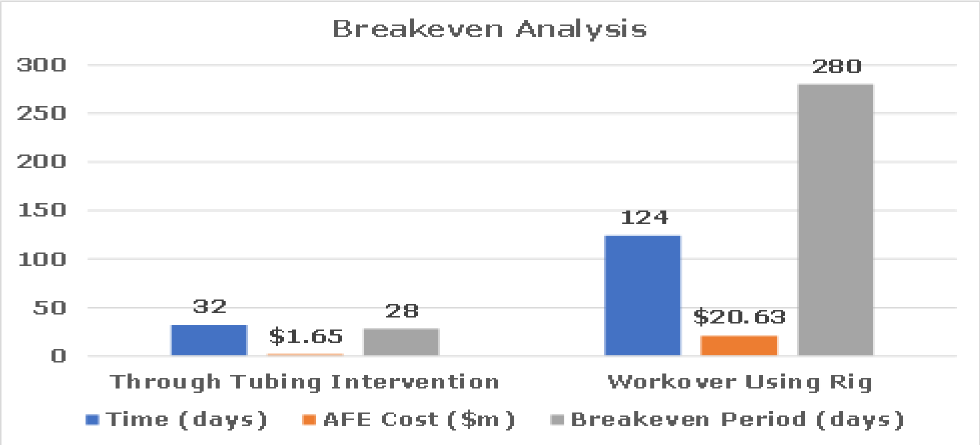

Figure 18: Breakeven Analysis: Through Tubing Intervention vs Workover using a Rig.

III. CONCLUSION

This research aimed to shutting off excess water production through tubing, by utilizing Coiled Tubing cement packer placement technique and recompletion. Based on a quantitative and experimental analysis of the production and well test data, reservoir performance plots were produced that revealed the individual reservoir behavior. From the decline curve analysis, a forecast of the available reserves was made. Reservoir saturation log, RST, was performed to ascertain the current oil-water contact thus enabling accurate identification of the section to recomplete. The watered zones were shut off and channels created by perforation using oriented gun into the by-passed reserves.

The objective to restore production by squeezing off the existing perforations through the short string and raising the perforations after the water shut-off had been achieved on well #1 & well #2. This rigless intervention has accelerated the production of the remaining attributable reserves in reservoirs (RY-01 & RY-02) through the selected wells. Well #1 oil production has been increased from 101 bopd at 70% water cut pre-cement job to 595 bopd at 9 percent water cut post-cement job. Similarly, the production of well #2 have been enhanced from the previous 17 bopdat 95% water cut pre-cement job to 460 bopd at 12 percent water cut of post-cement job production. Indeed, the results indicate that the reserved potential of the field had been harnessed with additional oil of 5MMBLLS with an increased lifespan of 5 years for the REYES field

REFERENCES

[1]. An Approximate Theory of Water Coning in Oil Production. Muskat, M and Wyckoff, R.C. 1935, Trans AIME, pp. 114, 144-161.
[2]. Van, B.D.W, et al.The effect of Capillary forces in Heterogeneous 'Flow-Units'- A streamline Approach. Dallas, Texas : SPE 22588 66th Annual Technical Conference and Exhibition , 1991.
[3]. Bailey, B. PetroWiki. PetroWiki. [Online] March 21st, 2020. https://petrowiki.org/Controlling_excess_water_production.
[4]. Influence of syneresis on Permeability Reduction by Polymer Gels. Bryant, S.L, Rabaioli, M.R and Lockhart, T.P. 1996, SPE Journal Paper 35446-PA.
[5]. Seright, R.S and Liang, J.A comparison of Different Types of Blocking Agents. Hague, Netherlands : SPE European Formation Damage Conference, 1995.
[6]. Redha, K, et al.Case study in water shutt off fluid Placement using Straddled Through-Tubing Inflatable-Packer Technique. Bahrain International Exhibition Centre, Kingdom of Bahrain : SPE 104755 15th Middle East Oil and Gas Show and Conference, 2007.
[7]. Okoto, F, et al.Recovery of Marginal Reserves Through a Cement Packer within Two Production Packers in Dual Completion Strings. Lagos, Nigeria : SPE 167530 Nigeria Annual International Conference and Exhibition , 2013.
[8]. Marvin, L.H.Innovative Through-Tubing Cement Packer Technique. Melbourne, Australia : SPE 77804 Asia Pacific Oil and Gas Conference and Exhibition, 2002.
[9]. Larry, H, et al.Innovative Through Tubing workover process utilizing a cement Packer. Dalla, USA : SPE 30510 Annual Technical Conference and Exhibition, 1995.
[10]. Muhammad, I, et al.Multi-type Application of Cement Packer: Simple and Economic Method of Accessing By-passed Reservoir Potential. Jakarta, Indonesia : SPE 108973 APE Asia Pacific Oil and Gas Conference and Exhibition , 2007.
[11]. Longfellow, O.A, et al.Annular Packer Seal Remediation through the SS in a Dual Completion using Coiled Tubing. Offshore Niger Delta . Lagos : SPE 193468 Annual International Conference and Exhibition, 2018. 193468 Annual International Conference and Exhibition.
[12]. Emmanuel, O, et al.Successful High-Angle Through-Tubing Cement Packer Deployment and Reperforation Using Coiled Tubing. Offshore Niger Delta. Lagos : SPE 193467 Annual International Conference and Exhibition, 2018.
[13]. Alham, M, et al.Accessing New Pay Intervals in the Tubing-Casing Annulus above Top Packer with Cement Packer Technology, S Field, Peninsular Malaysia. Dallas, Texas : SPE 191657 Annual Technical Conference and Exhibition, 2018.
[14]. Nowak, T.W and Patout, T.S.Rigless Multizone Recompletion using a Cement Packer with Coiled Tubing: A Case History. Calgary : SPE 35613 Gas Technology Conference , 1997.

Dick, I.F, et. al. " Through-Tubing Water Shut-Off and Recompletions Utilizing Coiled Tubing Cement Packer Placement Technique." *American Journal of Engineering Research (AJER)*, vol. 9(11), 2020, pp. 88-100.