SQUEEZE CEMENTING PLANNING USING BALANCE PLUG METHOD IN LOSS FORMATION ON "TBN-10" WELL

Wahyu Prasetyo[1,*], Lia Yunita[2]
[1,2]Petroleum Engineering, Universitas Proklamasi 45 Yogyakarta
Jalan Babarsari, Caturtunggal, Depok, Sleman, Yogyakarta 55281, Indonesia
**Email corresponding: wswahyuprasetyo@gmail.com*
Email: yunitalia478@gmail.com

How to cite : W. Praseto and L. Yunita, "Squeeze Cementing Planning using Balance Plug Method in Loss Formation On "Tbn-10" Well," *Kurvatek*, vol. 10, no. 2, pp. 199-206, 2025. doi: 10.33579/krvtk.v10i2.6246 [Online].

Abstract *—TBN-10 well in Subang field is a production well that has experienced a decline in productivity, so it was decided to close the perforation zone in layer 9C using the squeeze cementing method and open a new perforation in layer 9D. This work faces challenges in the form of a loss circulation zone in the Baturaja formation, so it is necessary to plan the appropriate cement method and composition. This study is aimed to sealing the non-productive perforated zone prior to reperforation during the recompletion process to a new formation. The squeeze cementing method is carried out using the balance plug method, accompanied by the selection of class G cement and special additives such as BAF-14L, BAR-19L, BAL-22L, BAG-17L, and BAF-26L to overcome high pressure conditions, high temperatures, and potential gas disturbances and fluid loss. The calculation of slurry volume, water head, water behind, displacement, and slurry specifications was carried out in detail resulting in a slurry requirement of 15.10 bbl. Laboratory test results showed a thickening time value of 4 hours 29 minutes at a consistency of 100 Bc and a compressive strength of 623 psi in 24 hours. Field evaluation showed that the cementing work successfully formed good isolation on the old perforation zone and allowed the opening of a new, more productive zone. This work successfully repaired the well integrity and became the basis for a workover strategy with a target of significantly increasing production from more economical layers.*

Keywords*: Balance, Loss, Squeeze , Cementing*

I. INTRODUCTION

Subang field is a field managed by Pertamina EP, one of which is in the Baturaja formation which is one of the productive carbonate formations in western Indonesia. The character of the Baturaja formation comes from the early Oligo-Miocene period which is composed of carbonate rocks (limestone/dolomite) with secondary porosity such as fractures and vuggy. This formation undergoes a dissolution process (karstification) which improves reservoir quality. The dominant type of fluid produced in this formation produces oil and formation water, sometimes dissolved gas (solution gas) is found depending on the reservoir pressure. Several wells in the Subang field use artificial lift production methods such as SRP, ESP or gas lift depending on reservoir pressure and production rate. Common production problems include water coning/water breakthrough caused by close water contact, scaling and formation damage due to carbonate properties, potential loss of circulation during drilling or cementing, common in the Baturaja carbonate formation.

TBN-10 well is one of the active production wells in the Subang field producing oil and gas hydrocarbons produced with ESP since 2019, over time the well experienced a decrease in production in 2024 due to the reservoir layer being unproductive. The technical problem of decreasing production rates is a problem that often occurs in wells that have been in production for a long time, this can be due to the potential of the reservoir that has decreased or the less than optimal artificial lift method used. The solution to this case is based on field studies and several studies, it is stated that the reservoir layer in this well still has the potential to be produced by carrying out workovers, reworking the layer in the new perforation zone and isolating it in the old perforation zone, one of the jobs is by squeeze cementing. Map of Subang field location is shown Figure 1.

Received Oct 5, 2025; Revised Nov 24, 2025; Accepted Nov 24, 2025

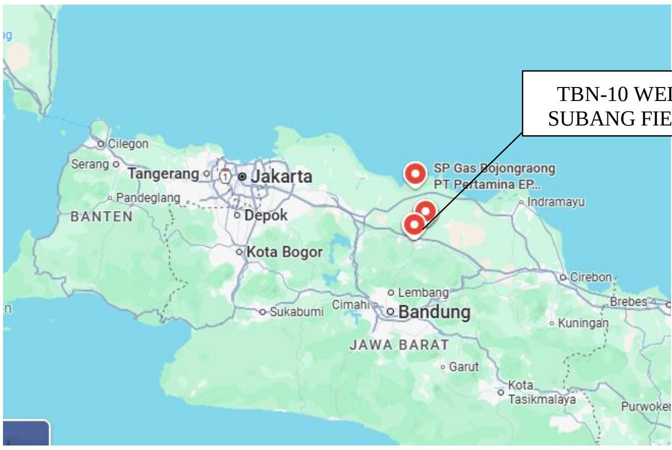

Figure 1. Location Subang Field

Squeeze cementing in general is a process where cement slurry is pumped with a specified pressure to a certain point with the aim that the slurry will occupy the zone to be squeezed. The slurry squeezed into the perforation zone will harden and occupy the area. [1][2]. Squeeze cementing can be applied during drilling operations, completion or during workover. The purpose of squeeze cementing is [3]:

1. Closing the formation that is no longer productive.
2. Repairing leaks that occur in the casing.
3. Repairing poor primary cementing.
4. Closing the loss circulation zone.

To perform squeeze cementing only requires relatively little cement but must be placed at the right point in the well. For that, good planning is needed, especially cement slurry planning, pressure determination and the use of appropriate methods/techniques so that the work is successful. This research was conducted on the TBN-10 well as research data because the 9C layer is no longer economical, besides that in this well there are other layers that are more prospective and the well conditions support the work of squeeze cementing using the balance plug method, so squeeze cementing planning is carried out to close the perforation zone in the TBN-10 well.

This balance plug cementing technique is usually carried out on formations that require low pressure or in cases of loss zone wells. Tubing and drill pipes are lowered into the wellbore at a predetermined depth for cementing. [4]. A properly designed squeeze cementing operation will seal the gap between the formation and the casing. After hardening, the cement forms an impenetrable solid.[5]

Salt water from the formation is first pumped until it fills the casing through the tubing to clean the well. Then the slurry is placed into the perforation interval through the tubing by pumping a spacer or fresh water in front (water head) and behind (water behind) the slurry so that the slurry is not contaminated by salt water or mud. The volume of water head required is 20 bbl, then the volume of water behind required is 1.66 bbl, the volume of slurry required is 15.10 bbl. During the cement slurry placement process, the casing valve at the wellhead is opened. Cement slurry is pumped into the target zone which will be closed until the height is the same between inside and outside the tubing (balance plug). Then the tubing or string is slowly lifted upwards leaving the cement slurry at a predetermined height until it is above the height of the spacer, then reverse circulation is carried out, namely recirculating salt water from the casing into the tubing. Reverse circulation is carried out to clean the remaining slurry that is still stuck to the tubing and remove it through the tubing by pumping salt water from the casing into the tubing. Salt water is pumped again through the tubing to provide pressure to the slurry until the predetermined pressure is reached with the aim of inserting the slurry into the perforation zone to be closed. After the squeeze target is reached, the pressure is held by closing all valves with the aim of keeping the force constant to hold the pressure in the casing until the cement hardens. The waiting on cement process is carried out for 24 hours for the maximum cement hardening capacity or based on laboratory test samples. The selection of cement is carried out based on cementing needs. The cement used in the cementing operation of an oil well is usually classified according to API standards.[6]

The classification of cement from API consists of cement classes A, B, C, D, E, F, G, H. The classification of cement classes is based on the ability of cement according to well needs because it affects pressure, temperature, depth, permeability and viscosity. The cement that is often used is class G because it is more flexible to use in various well conditions by adding a composition of several additives as needed. Some of the functions of additives include [6]:

1. Prevent circulation loss.
2. Increase cement strength.
3. Accelerate/slow down cement hardening time.
4. Increase/decrease cement specific gravity.
5. Increase durability.

Before the planning is applied to the well, an injectivity test is carried out to see whether the planning is feasible to apply. Some of the functions of the injectivity test process include:

1. Estimating the pressure when squeezing is done.
2. Estimating the volume of slurry used.
3. Ensuring that the perforation zone is open and ready to be occupied by fluid.
4. Obtaining an estimate of the cement slurry injection rate.

II. METHODS

The research method uses a descriptive method, namely a research method that provides a complete picture of the object being studied by describing various variables and calculation processes related to the problem and unit being studied. The data used are well data such as well depth, casing dimensions, tubing, DP, perforation, BHST, cement classification based on API standards and cementing additives (Figure 2).

API Class	Mixing Water Gals/Sk	Slurry Water Lb/Gals	Well Depth (A) (Feet)	Static (Temp ºF)
A	5,2	15,6	0-6.000	80-170
B	5,2	15,6	0-6.000	80-170
C	6,3	14,8	0-6.000	80-170
D	4,3	16,4	10.000-14.000	170-230
E	4,3	16,4	10.000-14.000	170-230
F	4,3	16,4	10.000-14.000	230-320
G	5,0	15,8	0-8.000	80-200
H	4,3	16,4	0-8.000	80-200
(A)Kedalaman berdasarkan daftar simulasi sumur casing API				

Figure 2. Cement Classification Based on API

The data processing process begins with determining the cement used based on the well profile and cement classification, calculating the volume of cement during tubing out and tubing in, then calculating the volume of water head, water behind and displacement show Figure 3.

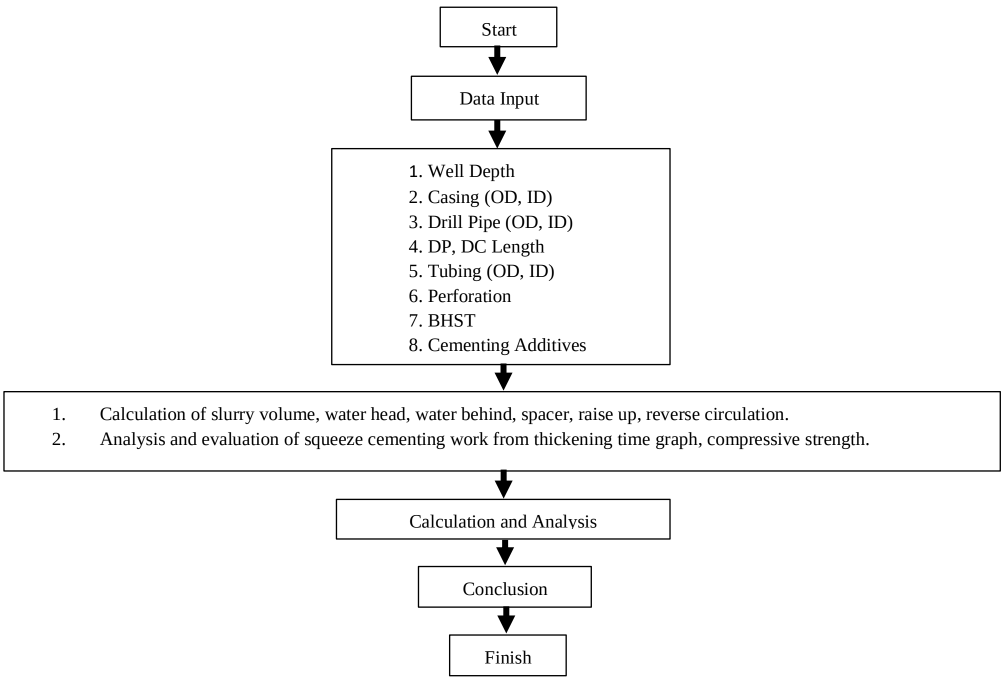

Figure 3. Research Flow Chart

The calculation was done using Microsoft Excel software. Because the TBN-10 well experienced a loss circulation zone case, to overcome this before squeeze cementing was carried out, namely by creating a zone plug system with high viscosity slurry specifications, after the loss circulation was overcome, squeeze cementing was carried out in the perforation zone and cementing had passed the waiting on cement period for 24 hours, the cementing results were evaluated using thickening time and compressive strength data by applying pressure to the hardened cement. To calculate the slurry volume, it can be calculated using the equation below [7]. Slurry Job Squeeze Cementing is calculated using the equations below:

Capacity When Tubing In:

- Cement Height Calculation When Tubing Inside (TOC'')

  $$\text{High Cement (MTR)} = \frac{313.745 \text{ x Volume Total Squeeze}}{(\text{ID Casing}^2 - \text{OD Tubing}^2) + (\text{ID Tubing}^2)} \quad (1)$$

- Waterhead Height Calculation 20 bbl

  $$\text{Waterhead Tubing Height (MTR)} = \frac{\text{Volume WB Tubing x } 313.745}{(\text{ID Tubing}^2)} \quad (2)$$

  $$\text{DP Waterhead Height (MTR)} = \frac{\text{Volume WB DP x } 313.745}{(\text{ID DP}^2)} \quad (3)$$

- Water Behind Volume Calculation

  $$\text{Volume of Water Behind Tubing (BBL)} = \frac{\text{ID Tubing}^2}{313.745 \text{ x Height Waterhead}} \quad (4)$$

  $$\text{Volume of Water Behind DP (BBL)} = \frac{\text{ID DP}^2}{313.745 \text{ x Height Waterhead}} \quad (5)$$

- Displacement Volume Calculation

  $$\text{Volume Displacement (BBL)} = \frac{\text{ID Tubing}^2}{313.745 \text{ x Height Displacement}} \quad (6)$$

  $$\text{DP Displacement Height 2 7/8 (MTR)} = \frac{\text{Disp Volume DP } 2\frac{7}{8} \text{ x } 313.745}{\text{ID DP}^2} \quad (7)$$

Capacity When Tubing Out:

- Calculation of Cement Height When Tubing Assembly is Lifted (TOC')

  $$\text{X (MTR)} = \frac{\text{Volume Total Squeeze x } 313.745}{\text{ID Casing}^2} \quad (8)$$

- Calculation of Cement Height After Squeeze

  $$\text{Slurry Height (MTR)} = \frac{\text{Vol Total Squeeze} - \text{Vol Squeeze x } 313.745}{\text{ID Casing}^2} \quad (9)$$

- Calculation of Number of Cement Bags

  $$\text{Sak} = \frac{\text{Vol Total Squeeze x } 5.614}{\text{Yield}} \quad (10)$$

  BBL = Total Sak x Yield x 0.1781 (11)

- Calculation of Estimated Rise Up/POOH Tubing After Pumping
  = Open End (MTR) – Last Height WH/WB (12)
- Calculation of Estimated Squeeze Volume Based on
  Gun Perfo Type and Loss Level = Perforation x 0.1874 x 2 x 3.281
  x Faktor Loss (13)
- Calculation of Estimated Squeeze Volume Based on Injection Rate

  $$\text{X (BBL)} = \frac{11000 \text{ x Rate}}{\text{Pressure x Yield x } 0.1781} \quad (14)$$

- Calculation of Maximum Squeeze Pressure
  X (PSI) = Max Frac Pressure – Total Hydrostatic Pressure (15)
- Calculation of Maximum Frac Pressure
  X (PSI) = Frac Gradient x Total Depth x 3.281 (16)
- Calculation of Total Hydrostatic Pressure
  = Hydrostatic cement + Hydrostatic WH/WB + Hydrostatic Displace (17)
- Calculation of Hydrostatic Cement
  = 0.052 x (Height MTR OE-Height MTR TOC') x Density x 3.281 (18)
- Calculation Hydrostatic WH/WB
  X (PSI) = 0.052 x (Height MTR DP 2 7/8-Height MTR WH/WB) x
  SG Water (1) x Water Density (8.34) x 3.281 (19)
- Calculation Displace
  = 0.052 x Height Displace x SG Water (1) x Water Density (8.34) x 3.281 (20)

III. RESULTS AND DISCUSSION

The method used to analyze cement bonding quality is the Ultrasonic Imager Tool (USIT). The USIT can interpret the condition of the cement, casing, and the type of material (liquid and gas) behind the casing. Next, squeeze cementing is designed to improve poor cement bonding quality [8]. The balance plug method will be used in the implementation of squeeze cementing of this well. This method was chosen because it is more economical, more practical and requires a relatively minimal amount of equipment. The main equipment needed includes a cementing unit, rig unit, and production tubing [9]. The background for doing squeeze cementing is to repair primary cement or to close productive zones that are no longer economic [10]. This technique emphasizes the balance between pressure from the formation and pressure from the surface, while still considering the strength of the casing and the resistance of the formation to pressure, so that no fractures occur when the slurry is forced into the perforation zone [11]. Before implementing the squeeze cementing operation, it is necessary to identify and analyze the cementing parameters that will be used. This is important for compiling work steps and performing technical calculations on the TBN-10 well, based on perforation data and each well profile.

Based on the cementing material requirements for this work, class G cement is used because this cement has high pressure and temperature resistance, is flexible at well depth, is easily adjusted with the desired additives, good cementing evaluation results with formation/casing, and is resistant to the effects of formation water. Additives used in slurry mixing in squeeze cementing work include (BAF-14L) containing organic salts used to reduce slurry viscosity, (BAR-19L) slowing down the hardening of cement suspension at high temperatures, (BAL-22L) controlling cement fluid loss and maintaining slurry in stable conditions, (BAG-17L) used as a gas controller with this material strengthening the binding of cement slurry, (BAF-26L) preventing air from being trapped in the slurry during mixing. Because the TBN-10 well formation experiences a loss zone, before squeeze cementing is carried out, the necessary additives are used, namely (BAX-10) to reduce the increase in viscosity in cement due to bacterial activity, (KCL) to stabilize the clay/shale formation so that it does not expand when in contact with slurry, (BGA-05) to reduce control of filtrate loss because the gel closes the pores of the formation, (BBF-01L) to extend viscosity stability during pumping time, (BXL-01) to increase the thermal stability of the slurry to high temperatures.

A. Slurry Job Squeeze Cementing Planning Results

Below are the calculation results of the planning of slurry volume, WH/WB volume, displacement volume in squeeze cementing work to close the perforation zone with the target of re-working the layer.[8]

Table 1. Slurry Volume Calculation Results when Tubing In

Parameter	Nilai		Parameter	Nilai	
Tubing 2 7/8'' Cap	0.0325 Cuft/Ft	0.0058 Bbl/Ft	DP 2 7/8'' Cap	0.0252 Cuft/Ft	0.0045 Bbl/Ft
Casing 7'' – Tubing 2 7/8'' Cap	0.1697 Cuft/Ft	0.0302 Bbl/Ft	Casing 7''-DP 2 7/8'' Cap	0.1697 Cuft/Ft	0.0302 Bbl/Ft
Casing 9 5/8'' – Tubing 2 7/8'' Cap	0.3806 Cuft/Ft	0.0678 Bbl/Ft	Casing 9 5/8-DP 2 7/8'' Cap	0.3806 Cuft/Ft	0.0678 Bbl/Ft
Tubing 2 7/8'' + (Casing 7''-Tubing 2 7/8'')	0.2022 Cuft/Ft	0.0360 Bbl/Ft	Tubing 2 7/8 + (Casing 9 5/8''-Tubing 2 7/8'')	0.4131 Cuft/Ft	0.0736 Bbl/Ft
Slurry Height	123.52 m		=	14.60 Bbl	

Table 2. Water Head Volume Calculation Results

Parameter	Nilai		
WH Height at 7'' Casing-Tubing 2 7/8''	3.50 m	=	0.35 Bbl
WH Height at 9 5/8'' Casing-Tubing 2 7/8''	68.90 m	=	15.33 Bbl
WH Height at 9 5/8'' Casing-DP 2 7/8''	19.50 m	=	4.33 Bbl
Total	91.90 m	=	20.00 Bbl

Table 3. Results of Water Behind Volume Calculation

Parameter	Nilai		
WH Height at Tubing 2 7/8''	72.40 m	=	1.37 Bbl
WH Height at DP 2 7/8''	19.50 m	=	0.29 Bbl
Total	91.90 m	=	1.66 Bbl

Table 4. Results of Volume Displacement Calculation

Parameter	Nilai
Disp Volume Tubing 2 7/8''	0.37 Bbl
Disp Volume DP 2 7/8''	26.48 Bbl
Disp Volume Total	26.85 Bbl

Table 5. Slurry Volume Calculation Results when Tubing Out

Parameter	Nilai		Nilai		Total
Casing Capacity 7''	0.2148 Cuft/Ft	X	67.37 m	=	47.48 Cuft
Squeeze Volume	6.64 Bbl	=	52.90 m	=	37.28 Cuft
Total Volume			120.27 m	=	84.77 Cuft
					15.10 Bbl
Dead Volume					0.5 Bbl

Table 6. Slurry Specification Calculation Results

Parameter	Nilai	Satuan	Nilai	Satuan
Excess	0	Sack		
Slurry Volume	84.77	Cuft		
Sack of Cement	49	Sack		
Density	13.8	Ppg		
Yield	1.73	Cuft/Sx		
Water	5.76	GPS	6.7	Bbl
Total Mixing Fluid	9.37	GPS	10.9	Bbl

B. Evaluation of Job Squeeze Cementing Results

After the squeeze cementing work is carried out, to ensure whether the work results have been successful, an evaluation or testing of the cementing results is carried out, one of the tests carried out is the thickening time test to determine the working time before the cement slurry begins to thicken and can no longer be pumped, compressive strength testing to determine the waiting on cement time, namely the waiting time before the well can continue operations and to determine the ability of the hardened cement to withstand pressure from the formation.

TEST RESULT :

Thickening Time @ 206 deg. F : 4 hours 29 minutes at 100 Bc
Fluid Loss @ 206 deg. F : 22 cc/30 minutes/1000 psi
Free Water @ 206 deg. F : 0 % by volume

Rheology (R1,B1,F=1), RPM	300	200	100	6	3	Pv	Yp
@ Ambient Temp.	35	28	21	13	12	**21.0**	**14.0**
@ B.H.C.T	22	16	13	8	6	**13.5**	**8.5**

Comp. Strength @ 247 de s : 623 psi after 24 hours

Figure 3. Laboratory Test Results

Based on the image above is the result of the slurry test in the laboratory from several parameters, namely, thickening time, fluid loss, free water, rheology and compressive strength. The results of the thickening time were obtained with a time of 4 hours 29 minutes at 100 Bc with a compressive strength of 623 psi for 24 hours.

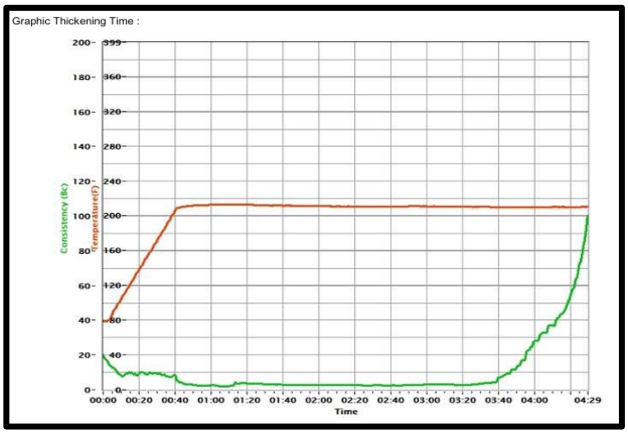

Figure 4. Thickening Time

The image above is a graph showing the results of the thickening time test. From the graph it is analyzed that the temperature from the first 40 minutes rose to 210°F then stabilized until 04.30, this indicates that the well conditions are stable and under control, there is no premature thickening, the slurry consistency remains below 40 Bc for the first 4 hours before reaching the critical point of thickening time at 70 Bc and begins to increase sharply at 04.20 reaching >70 Bc which means the slurry has a working time of 4.5 hours which is sufficient to pump the slurry to the target zone and adjust the squeeze pressure.

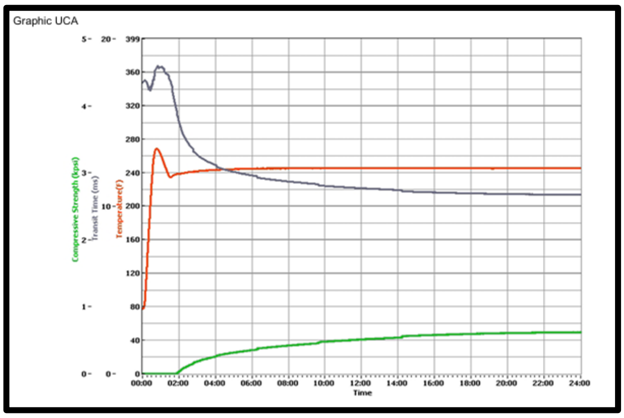

Figure 5. Compressive Strength

The image above is the result of the compressive strength test where the compressive strength begins to form after the first 2 hours at 02.00, the strength of 500 psi after 10 hours there is a steady increase to 623 psi at 24 hours, the temperature at 02.00 reaches 240°F and is stable until the end shows that the laboratory simulation is quite representative of BHST, at the initial high transit time there is a decrease at 02.00 then stable which indicates the beginning of the initial hardening set. The behavior of transit time with a consistent initial set shows good slurry quality and additive design. Based on these parameters, the cement managed to reach 500 psi in 10 hours in accordance with industry regulations as the minimum strength before carrying out further work, at 24 hours the maximum compressive strength of 800 psi is sufficient for sealing and withstanding formation pressure. It can be concluded that the results of cementing for closing the perforation zone in the TBN-10 well have hardened well.

IV. CONCLUSION

This study designs the slurry requirements for the squeeze cementing operation using the balance plug method in well TBN-10 aimed at sealing the non-productive perforated zone prior to reperforation during the recompletion process to a new formation. Loss circulation zone, a slurry volume of 20 bbl was required within the plug interval of 1930.6-2040 mMD. The operation was considered successful as only a minimal amount of slurry was lost into the formation. P erforated zone was sealed at a depth of 2002-2008 mMD in layer 9C, with a calculated slurry volume of 6.64 bbl successfully squeezed at a low pressure of 600 psi from a total planned volume of 15.10 bbl. Balance plug length while the workstring was in the well reached

91.9 meters, with a slurry column height of 123.52 meters. After pulling out of hole (POOH) for 10 stands, the slurry height was reduced to 120.26 meters.

The squeeze cementing operation using the balance plug method proceeded successfully. A total of 6.64 bbl of slurry entered the perforation zone, while the remaining 8.46 bbl formed the fluid column from the planned total of 15.10 bbl. This remaining volume is sufficient to fill the fluid column below the target zone and up to the casing. The waterhead ahead of the cement, acting as a spacer was 20 bbl, the water behind the cement was 1.66 bbl and the displacement volume used as a pusher and fluid cleaner was 26.85 bbl. The thickening time chart indicated that the slurry consistency remained below 40 bc during the initial 4 hours, meaning premature thickening did not occur before reaching the critical point of 70 bc. A working time of 4.5 hours was deemed sufficient for pumping into the target zone and adjusting the squeeze pressure. The evaluation of the squeeze cementing job based on the compressive strength chart showed stable temperature and transit time, indicating the onset of cement setting. The cement reached a strength 0f 500 psi within 10 hours, regulation the industry minimum requirement before proceeding with further operations and achieved a maximum strength of 800 psi, sufficient for sealing and holding the formation

ACKNOWLEDGEMENTS

Thank you to PT. Bukit Apit Persada for Supporting this research

REFERENCES

[1] F. Azzahra, Planning Squeeze Cementing on AZR-26 Well TAF-3.1 Layer. Institut Technology Sains Bandung, 2023.
[2] R. Abdullah and E. Prastio, "Analisa Pekerjaan Squeeze Cementing dengan Metode Balance Plug Berdasarkan Data CBL & VDL pada Sumur "GZ" Lapangan "BHARA"," *Jurnal Offshore: Oil, Production Facilities and Renewable Energy*,vol. 6, no. 1, pp. 21-28, 2022.
[3] R. Rubiandini, Teknik Operasi Pemboran. Bandung: Penerbit ITB, 2000.
[4] A. Priambodo, C. Julianto, M. R. Nugroho, and H. Tulloh, "Studi Perencanaan dan Pelaksanaan Squeeze Cementing Metode Bradenhead Squeeze untuk Water Shut Off pada Sumur Minyak dengan Water Cut Tinggi," In Prosiding Seminar Nasional Sains dan Teknologi Terapan, vol. 1, no. 1, pp. 403-410, September 2020.
[5] F. Firdaus, "Evaluasi Pekerjaan Squeeze Cementing dengan Metode Hesitate pada Sumur Minyak," Other thesis, Universitas Islam Riau, 2021.
[6] API RP 10B-2, Recommended Practice for Testing Well Cements, 2013.
[7] Ricardo Ricci, "Analisis Squeze Cementing dengna Menggunakan Metode Balance Plug pada Formation Loss di Lapangan RC Sumur X," Universitas Islam Riau, 2019.
[8] F. Fitrianti, "Analisis Kualitas Bonding Cement di Zona Produktif Sumur BA 147 Menggunakan Ultra Sonic Imager Tool (USIT) Log di Lapangan BOB PT Bumi Siak Pusako-Pertamina Hulu," *Journal of Earth Energy Engineering*, vol. 4, no. 2, pp. 29-43, 2015.
[9] E. Prasetyo, T. Arief, and U. A. Prabu, "Perencanaan Squeeze Cementing Metode Balance Plug pada Sumur 'X' dan Sumur 'Y' di Lapangan Ogan PT. Pertamina Ep Asset 2 Prabumulih," *Jurnal Ilmu Teknik Sriwijaya*, pp. 1-9, 2019.
[10] W. Oktrayani, "Desain Perencanaan Aplikasi Squeeze Cementing dengan Menggunakan Hydraulic Workover Unit Snubbing 150K dengan Metode Arrow Set Packer," Doctoral dissertation, Universitas Islam Riau, 2022.
[11] A. K. Ali and M. Ali, "Carbonate Permeable Zone Cementing Practices and Challenges," In SPE Gas & Oil Technology Showcase and Conference (p. D031S040R005). SPE, 2023.