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Unlocking Unproduced Reservoirs at Existing Gravel Pack Zone Using Straddle Screen: A Success Stories and Lesson Learnt at the Handil Field, Mahakam Block, East Kalimantan, Indonesia

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Abstract. Handil Field is a one of field in the Mahakam block which has various types of completion. Gravel Pack Completion is a robust solution to produce shallow reservoirs while also preventing sand from the formation to come out to the wellbore. Occasionally found on gravel pack completion wells, there are several reservoirs on the same Gravel Pack Zone. Due to reservoir properties impairment, not all of these reservoirs can be treated with gravel pack. Therefore, perforation and gravel pack treatment only performed for reservoirs with the highest reserves and also with same reservoir properties. After several years, to increase the production, there is a necessity to unlock unperforated and untreated reservoirs at gravel pack zone to produce the reserves safely. Previous method to unlock these reservoirs is by performing squeeze cementing to isolate previous producing reservoirs; perforation at new reservoirs target and then performing chemical sand control (SCON). This method is considered quite complex, takes a long time; and required high costs. The Straddle Screen is an innovative screen installation, without squeeze cementing, in the hope of producing the existing gravel pack zone in a commingle with the newly opened reservoir in the same zone. Additional perforation in the existing gravel pack zone using straddle screen have been carried out in 6 new reservoirs, in 6 wells in the Handil Field. This paper has the objectives: perform a comparative analysis of operating costs between squeeze cementing versus Straddle Screen installation; and analyze the results of the implementation of the Straddle Screen in Handil Field, Mahakam Block. The procedure begins with collecting well and reservoirs data; determine the type of perforation, type of screen, the installation of the straddle screen; and ends by evaluating the results of the work. Additional perforation work in the compared to the squeeze cementing job with SCON. By the duration, the straddle screens have a duration of only 2 – 3 days, compared to squeeze cementing work with SCON which has a duration of 14 days. From a total of 6 completed works, it was found that the reservoir production succeeded in producing hydrocarbons without any sand. Carrying out direct perforation and install straddle screens has proven to be able to produce even with small stakes, which was previously uneconomical if it had to be done with cementing and SCON operations, especially in existing gravel existing gravel pack zone without squeeze cementing succeeded in opening reserves with a total of 140.000 bbls and 0.08 BCF from 6 reservoirs, and proven has cost saving up to USD 300,000 per job when pack zones.

Keyword(s): Squeeze Cementing; Gravel Pack; Handil; Mahakam; Perforation; Straddle Screen

1 Introduction

Handil is a mature oil field located at the Mahakam Delta, East Kalimantan, Borneo, Indonesia that consist of 217 active wells that completed with varieties completion types that has been discovered since 1974.

Handil field now have around 11,000 BOPD and 44 MMSCFD production. Due to the formation characteristics, sand is produced along with reservoir fluids. Sand production is unexpected fluid that comes from the well that can cause downhole equipment failure, such as erosion, collapse, production loss, and surface facility downtime to disposal of the sand at surface (Yudis, P. et al, 2021).

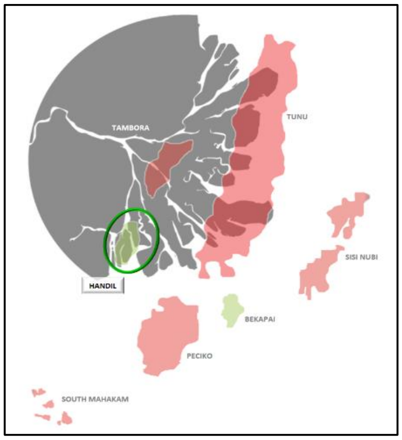


Figure 1. Mahakam Block, East Kalimantan

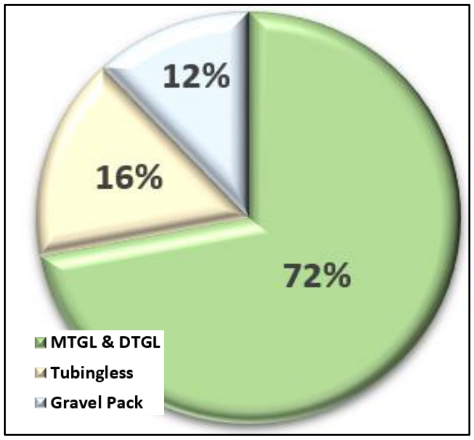


Figure 2. Handil Field Completion Mapping

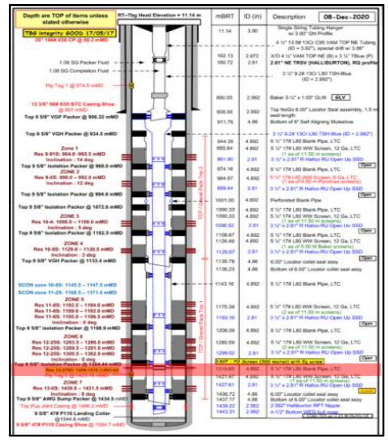


Figure 3. Example of GP Well at Handil Field

Figure 2 above is the distribution of the types of completions in Handil Field which of a total of 217 active wells, 12 percent are gravel pack wells. For example, the completion of the gravel pack, which is in Figure 3 where there are several zones that can be produced in the Gravel Pack by opening or closing the Sliding Side Door (SSD) on the completion. Along with the rate of production decline, in addition to producing existing reservoirs and looking for new reserves with large reserves, the company is currently also aiming to produce reserves with limited reserves, some of which are reservoirs in the existing gravel pack, for example, given a red line in Figure 3 above.

The unproduced reservoir, which is in the same zone as the existing gravel pack zone, was not initially produced due to one of the reasons being the contras-permeability between zones, so there will be permeability impairment where there will be an uneven distribution of proppant; and another reason is because there are small stakes so it is not economical to be treated with a gravel pack at the same time.

2 Previous Solution

Since 2018, one way to produce shallow reservoirs located in the Gravel Pack zone can be done by squeeze cementing in the gravel pack zone, which is then followed by perforating the intended reservoir and performing Sand Consolidation (SCON) afterwards due to sand problems that are bound to occur. in shallow reservoirs. Sand Consolidation is a chemical sand control in the form of resin, which we pump to a sand reservoir where after the resin hardens again it will hold the sand from being produced (Setiadi, R. et al., 2022).

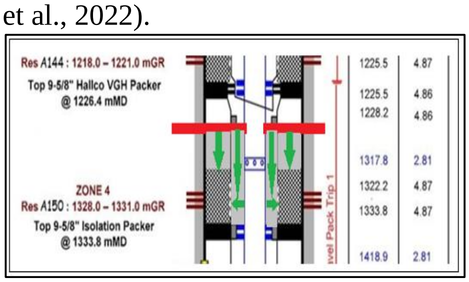


Figure 4. Squeeze Cementing and SCON Application

Figure 5. Barge and CT Unit to Perform Squeeze Cementing and SCON

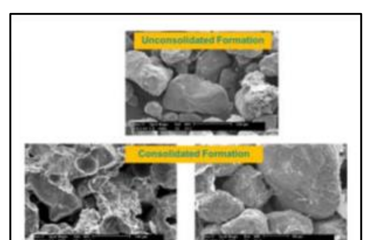


Figure 6. Sand "Glue-ing" with SCON

The picture above is an illustration of the squeeze cementing work that is commonly done to produce zones that are in the existing gravel pack zone. In this operation, a drill out of cement will be carried out to gain access back to the reservoir to be addressed which will require a greater duration and cost for this operation. Therefore, due to the limitation of stakes from the reservoir to be opened, a reliable, practical, fast, and economical method is needed in order to produce these reservoirs safely and optimally.

This paper will explain the reviews and lessons learned from the implementation of Straddle Screen on several Gravel Pack wells in Handil Field, with the hope of getting conclusions that can be used for similar work in the future.

3 Straddle Screen Overview

There are several sand control techniques applied at Delta Mahakam, such as Cased Hole Single Trip Multi Zone Gravel Pack (CH-STMZ-SP), Open Hole Stand Alone Screen (OH-SAS), Chemical Sand Consolidation (SCON), and Thru Tubing Screen (Straddle Screen) (Setiadi, R. et al., 2022).

Table 1. Sand Control Criteria in Mahakam Block

No.	Items	Methodology		
		CH-STMZ-GP	**SCON**	**Thru Tubing Screen**
1.	Economic Limits	>1.3 BCF	>0.6 BCF	• Ceramic Screen (0.12 – 0.6 BCF) • High Erosion Screen (0.05 – 0.12 BCF) • Premium Screen (0.02 – 0.05 BCF)
2.	Production Limits	7 MMSCFD	2.5 MMSCFD	1 MMSCFD
3.	Operational Means	Rig / HWU	Coiled Tubing Barge	Slickline Barge
4.	Operational Duration	7 – 10 days	7 days (include curing time)	2 – 3 days
5.	Risk	Limited number of zone in single trip deployment	• Flammable chemical • Resin failure due to massive water production	Screen Erosion and Plugging Issue

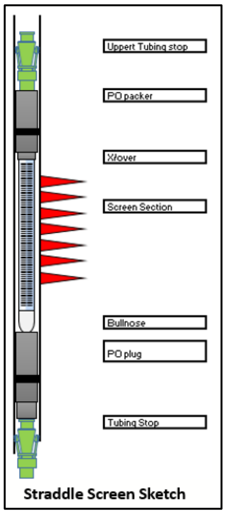


Figure 7. Straddle Screen Sketch

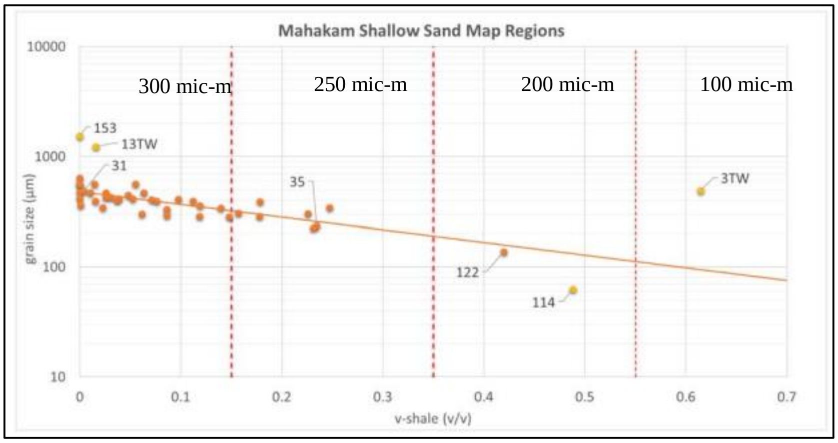
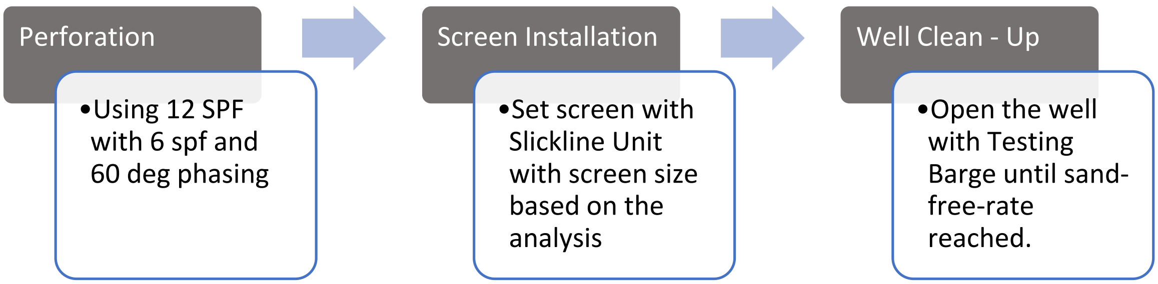


Figure 8 Sand Screen Size Selection (Setiadi, R. et al, 2022).

Straddle Screen is a screen that is installed using a Slickline unit, which is installed directly in front of an open reservoir. The Straddle Screen arrangement from bottom to top consists of Lower Tubing Stop – Lower Pack Off – Screen – Upper Pack Off – Upper Tubing Stop. Currently, the determination of the screen size to be used depends on the average volume of shale in the reservoir which has been discussed in a separate study (Setiadi, R. et al, 2022).

4 Intervention Operation Sequences

The following are the stages of the well intervention operation to open the reservoir in the existing gravel pack zone with the installation of a Straddle Screen:



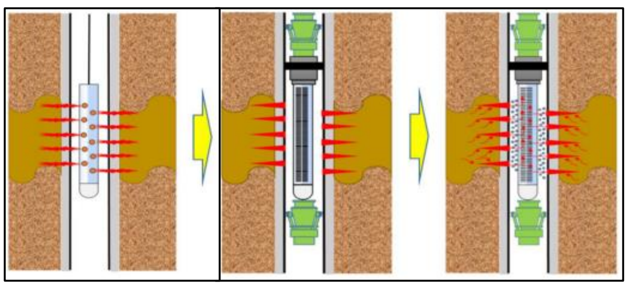


Figure 9. Well Intervention Operations Sequences

Figure 10. Slickline Eline Barge

5 Result and Discussion

Straddle Screen installation has been carried out on 6 wells with different reservoirs according to the following data:

Table 2. Wells Candidate

Well	H-QA-360	H-HC-346.T1	H-Q-354	H-Q-356	H-X-357	H-QA-351
Res. Target	11-2aS0	12-0aS2	13-5aS2	10-8aS0	9-5aS0	13-5aS
SSD Zone Number	5	3	4	4	1	4
Existing SSD Zone Condition	Close	Close	Close	Close	Close	Close
Critical Sand Risk	Yes	Yes	Yes	Yes	Yes	Yes
Stakes	27 kbbo	0.08 BCF	25 kbbo	46 kbbo	37 kbbo	15 kbbo
Est. Gain	80	1.5	113	163	100	100
Gravel Pack Zone	Yes	Yes	Yes	Yes	Yes	Yes
Interval Perf (m)	2	3.40	1.5	1	2	2
P-res (psi)	1409	1587	1789	1458	1195	1797
Depth of Top Perf (mBRT)	1168.6	1280.6	1391.5	1070.5	1073.5	1512
Avg Porosity (%)	24.1	25.6	32.3	26.8	26.9	25
Mobility (mD/cp)	273	5312.5	350	116	174	300
Screen Size	HESS Screen, 200 micron	Premium Screen, 175 micron	Premium Screen 250 micron	Premium Screen 175 micron	HESS Screen 300 micron	Premium Screen 175 micron
Perforation	12 spf, 60 deg	6 spf, 60 deg	6 spf, 60 deg	12 spf, 60 deg	12 spf, 60 deg	6 spf, 60 deg
Perforation Size	2.5" Deep Penetration	2.5" HSD	2.5" Deep Penetration	2.5" HSD	2.5" HSD	2.5" HSD

Additional perforation and continued with the installation of Straddle Screens have been carried out on 6 Gravel Pack wells at Handil Field in 2020 – 2022. Of the six wells, they have perforation density and varied screen types, ranging from High Erosion Sand Screen and Premium Screen.

Table 3. Result after Perforation and Straddle Screen Installed

Well	Res. Target	POP Date	Instantaneous Gain			Status	Np or Gp
			Qgas (MMSCFD)	Qoil (bopd)	Qwater (bwpd)		
H-QA-360	11-2aS0	21-Aug-22	0	166	93	Flowing	2.8 kbbo (at 10 Sept 2022)
H-HC-346.T1	12-02aS	7-May-21	1.55	0	0	Shut In at 15 Oct 2021 due to 100% water cut	0.113 BCF
H-Q-354	13-5aS2	1-Jul-21	0	283	195	Flowing	49 kbbo (at 10 Sept 2022)
H-Q-356	10-8aS0	9-Jul-22	0	108	83	Flowing	7.6 kbbo (at 10 Sept 2022)
H-X-357	9-5aS0	27-Jul-22	0	306	128	Flowing	8.8 kbbo (at 10 Sept 2022)
H-QA-351	13-5aS	12-Nov-20	0	21	173	Flowing	15.3 kbbo (at 10 Sept 2022)

Table 3 above is a table summary of the results after the work is done. From the six wells, it can be seen that the six wells received good results. For example, for well H-X-357, where perforation is carried out on Reservoir 9-5aS0, which is in the existing Zone 1 SSD, it has an oil rate of 306 bopd. And for the H-HC-346.T1 well, the gain was 1.5 MMSCFD, but after 5 months the well had to be closed due to a water rise of up to 100% water cut. The test results also show data that the screen is able to withstand the rate of sand and proppant in the shallow reservoir, with a result of 0 cc/hr for the sand rate.

Table 4 below is data regarding the total operation cost for each well. The cost includes costs for slickline, electricline, and testing when the screen has been installed. When compared with the previous method for producing reservoirs located in the existing gravel pack zone, namely squeeze cementing; perforations; and continued with the SCON job, which has a total cost of USD 451,000. The table below shows that by replacing the method with only perforation and the installation of a Straddle Screen, we managed to get an efficiency up to 95% for each well.

Table 4. Job Cost Analysis

Well	Job Cost Estimated (USD)	Actual Cost (USD)	Job Duration (days)	% Efisiensi
H-QA-360	$ 52,000.00	$ 21,074.00	5	95%
H-HC-346.T1	$ 58,000.00	$ 38,413.00	17	91%
H-Q-354	$ 47,000.00	$ 17,389.00	6	96%
H-Q-356	$ 50,000.00	$ 23,647.00	5	95%
H-X-357	$ 50,000.00	$ 16,800.00	5	96%

Table 5. Future Candidate

Well	Est. Stakes (kbbo)	Value (USD)
H-Q-358	22	1,804,000
H-L-168	25	2,050,000
H-L-174	50	4,100,000
H-LB-174	150	12,300,000
H-QA-347	75	6,150,000
H-QA-359	25	2,050,000
Total	**347**	**28,454,000**

Table 5 above is the list of the gravel pack wells that still have reservoir potential that have to be opened with existing gravel pack zone. From the 6 wells above, have the value up to USD 28 Million.

Installation of Straddle Screen, currently still has drawbacks, namely the allowable rate limitation to prevent erosion on the screen, which is 1 – 1.5 MMSCFD for gas rate; 500 blpd; and the allowable sand rate which is only limited to 21 cc/day. According to Setiadi, R. et al, 2022, in the application of SCON, it is expected that the gas velocity coming out of the perforation hole is not more than 4 m/s and for screen, it is expected not to be more than 0.6 ft/s for 100 ppmw sand. The selected screen is also expected to be suitable and strong enough to withstand sand jetting until a natural sand packing is formed, so it is strictly forbidden to suddenly increase the choke opening without stabilization first.

6 Conclusion

The conclusion about Straddle Screen installation to unlock other reservoirs in existing gravel pack zone, could be summarized as follows:

- This job has been 100% successfully implemented in 6 Gravel Pack Wells in Handil Field, East Kalimantan.
- The average cost saving is around 91-96 % compared to Squeeze Cementing plus SCON Job to unlock those reservoirs.
- There is potential for crossflow between the existing gravel pack zone and the newly opened reservoir. Therefore, further studies are needed regarding the potential for crossflow based on reservoir properties or further modeling before the work is carried out on a massive scale in the future.

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