Sustainable Sand Management Control and Solutions - Balancing Performance, Costs, and Environment

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Utilizing a Hybrid of Chemical and Mechanical Approach for Effective Sand Production Mitigation: Successful Field Trial in Malaysia

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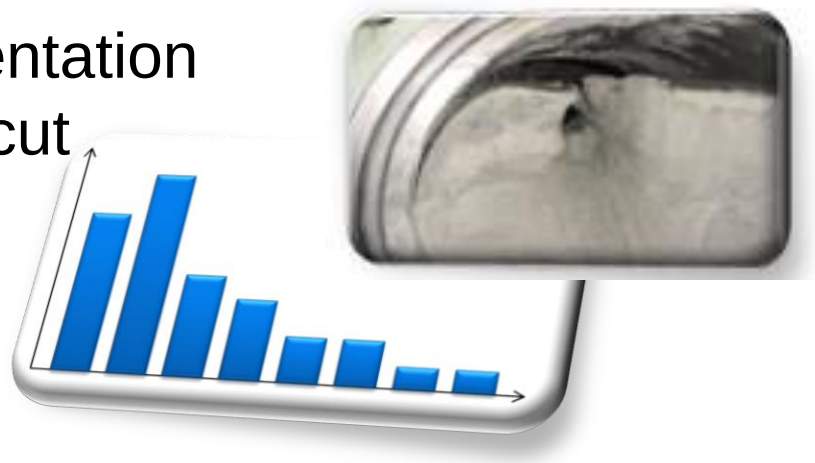
Outline

- ❑ Introduction
- ❑ Field Case
- ❑ Laboratory Evaluation
- ❑ Field Info and Sampling
- ❑ Laboratory Results
- ❑ Trial Execution
- ❑ Monitoring
- ❑ Conclusion
- ❑ Acknowledgement

Introduction

70% global oil and gas reserves in world are affected by sand production

Due to:
Inadequate cementation
Increased water cut



Production Deferment and Idle Wells

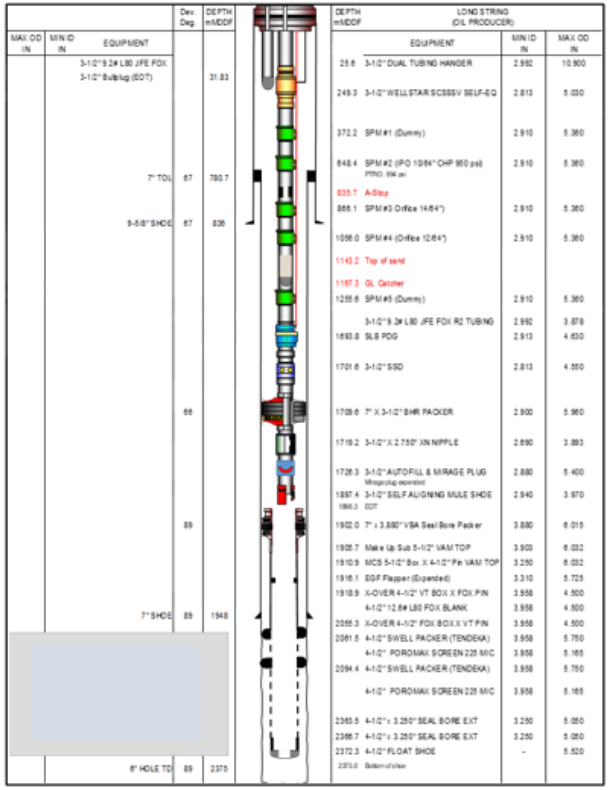
- Unplanned shutdown and downtime
- Limit production rate to control sand
- Shut-in of wells in severe cases

Equipment failure

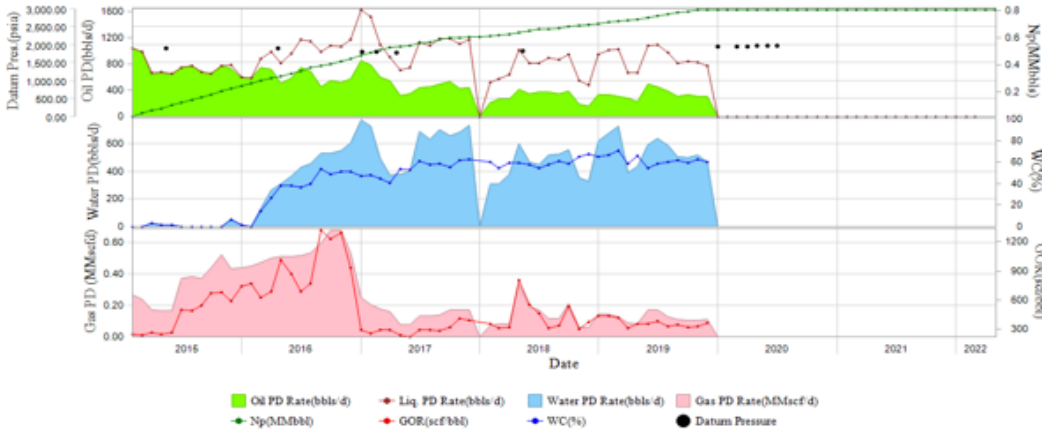
Field Case

- ❑ Single string, horizontal oil producer, first commence 2014
- ❑ 225-micron open hole stand alone sand screen (OHSAS)
- ❑ High sand production average 47 pptb
- ❑ Continuous sand build up and well idle in 2019
- ❑ D10 > 225-micron indicate OHSAS failure

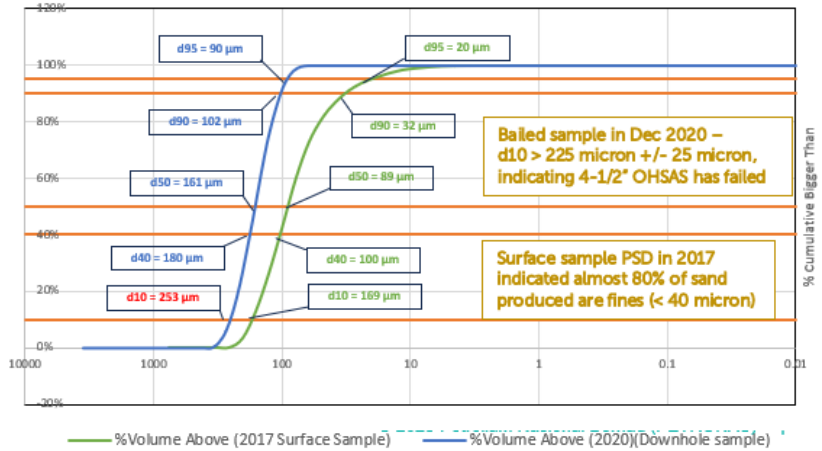
Well Completion Diagram



Well Production Profile



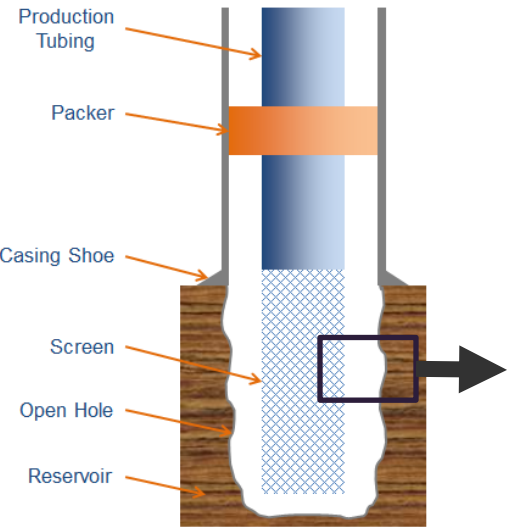
Particle Size Distribution



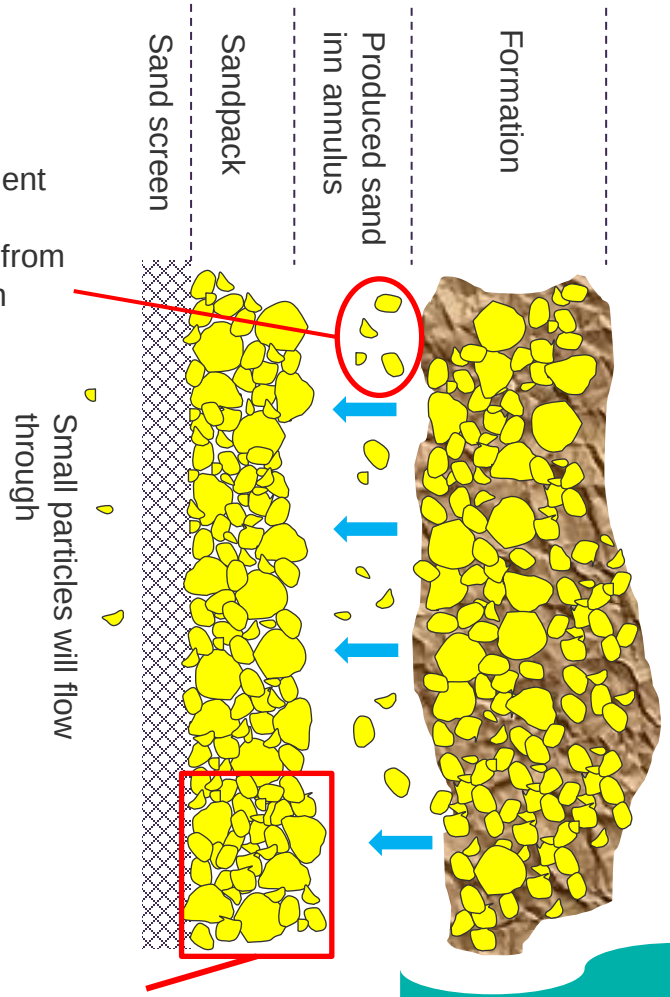
- ❑ Proposed solution:

  Screen change out to 200-micron ERTSS + Sand Agglomeration

Concept



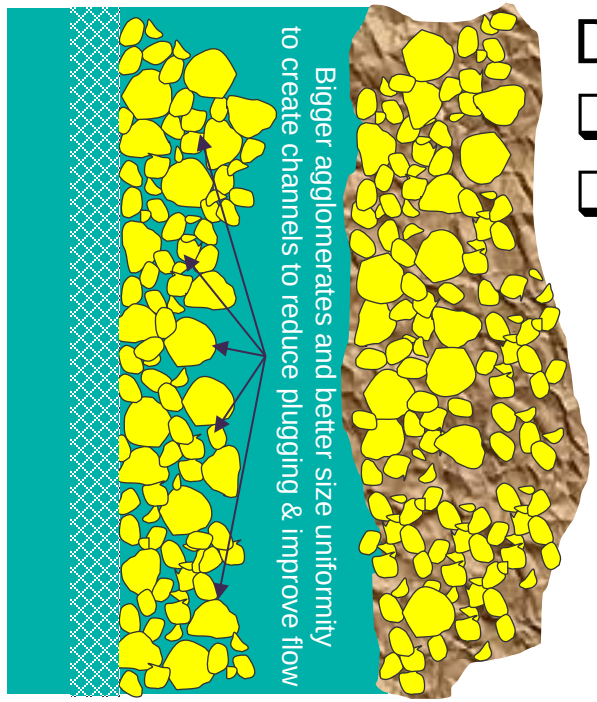
Open Hole Stand Alone Sand Screen (OHSAS) Completion

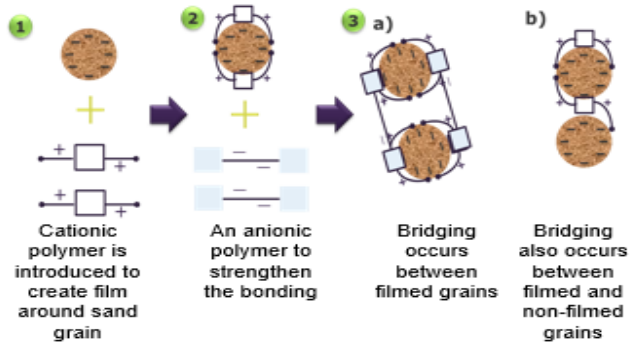


Due to various size and high uniformity coefficient, Uc, sand particles are packed at the surface of sand screen (sandpack) which will cause plugging.

Chemical injection

Uniformity coefficient, U_c is defined as the ratio of D60 by D10 of a particle size distribution (PSD)





Dual polymer

- ❑ Stronger aggregates
- ❑ Larger aggregate

Laboratory Evaluation

Sampling & Field Info → **Sample Characterization** → **Agglomeration Bottle Test** → **Compatibility Test**

- Core sample
- Produced water
- Crude oil
- Water cut
- Sand count
- Screen size

- Mineralogy
- Morphology
- Baseline PSD
- Water Analysis

- Agglomeration bottle test
- Physical Observation
- PSD Treated vs Untreated
- Calculate Uc & Sc

Compatibility with incumbent production chemicals

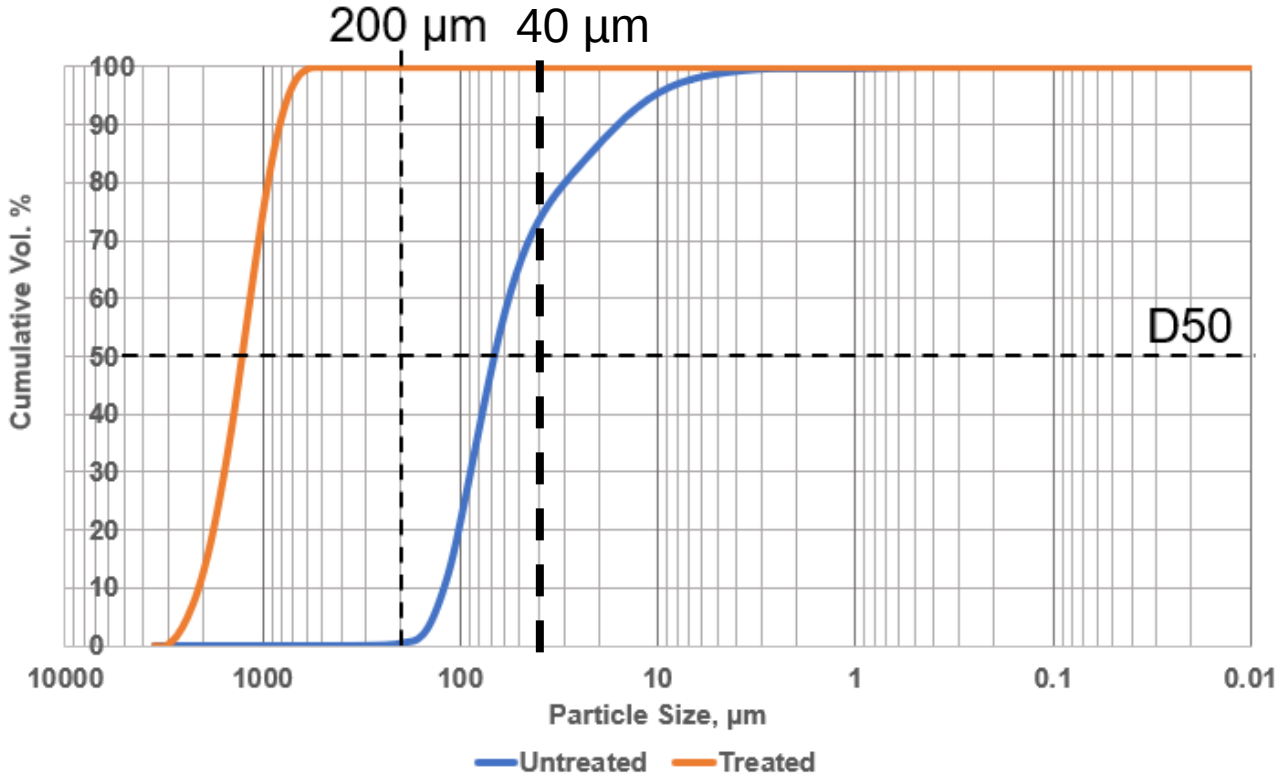
Note:
Uc : Uniformity Coefficient
Sc : Sorting Coefficient
PSD : Particle Size Distribution

Field Info and Sampling

Parameters	Information
Temperature	68^{O}C
Water Cut	60%
Average Sand Count	47 pptb
Sand Screen Size	200-micron ERTSS

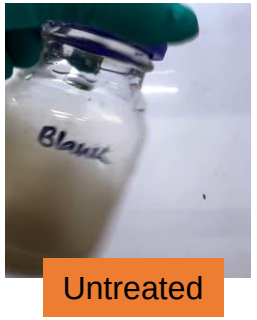
Sample	Remarks
Sand Sample	Unconsolidated core sample
Produced Water	Wellhead sample
Crude Oil	Wellhead sample
Incumbent Chemicals	Demulsifier

Laboratory Results – Agglomeration Test



With agglomeration chemical:

- ❑ Increased sand size
- ❑ Increased % of population > 200 µm
- ❑ Improved Uc
- ❑ Improved Sc



Sand	D50, µm	> 200 µm, Vol. %	Uc, (D40/D90)	Sc (D10/D95)
Untreated	76	0.3	4.9	11.6
Treated	1260	100	1.7	2.9

Sc < 10	well sorting
Sc > 10	poor sorting

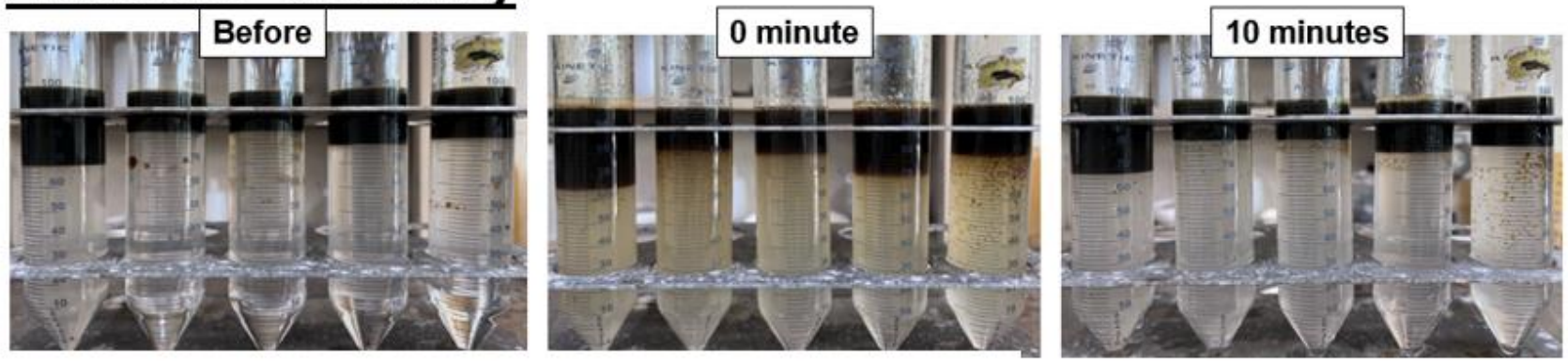
Uc < 3	uniform
3<Uc< 5	non-uniform
Uc > 5	highly non-uniform

Laboratory Results – Compatibility Test

Tube Sequence	Fluid	Composition by Volume %
1	Blank	60% Water + 40% Crude Oil + 5 ppm Demulsifier
2	* Backflow Liquid 1	50% Blank + 50% Component B
3	** Backflow Fluid 2	50% Blank + 25% Component A + 25% Component B
4	*** Flushing Liquid 1	Blank 75% + 25% Component A
5	Flushing Liquid 2	Blank 75% + 25% Component B

*To simulate the unreacted Polymer B going to flow into the system
**To simulate reacted polymer A & B going into the system.
***To simulate the unused chemicals from dead volume if plan to be injected into the system. Can be neglected if the plan to collect and send onshore as scheduled waste.

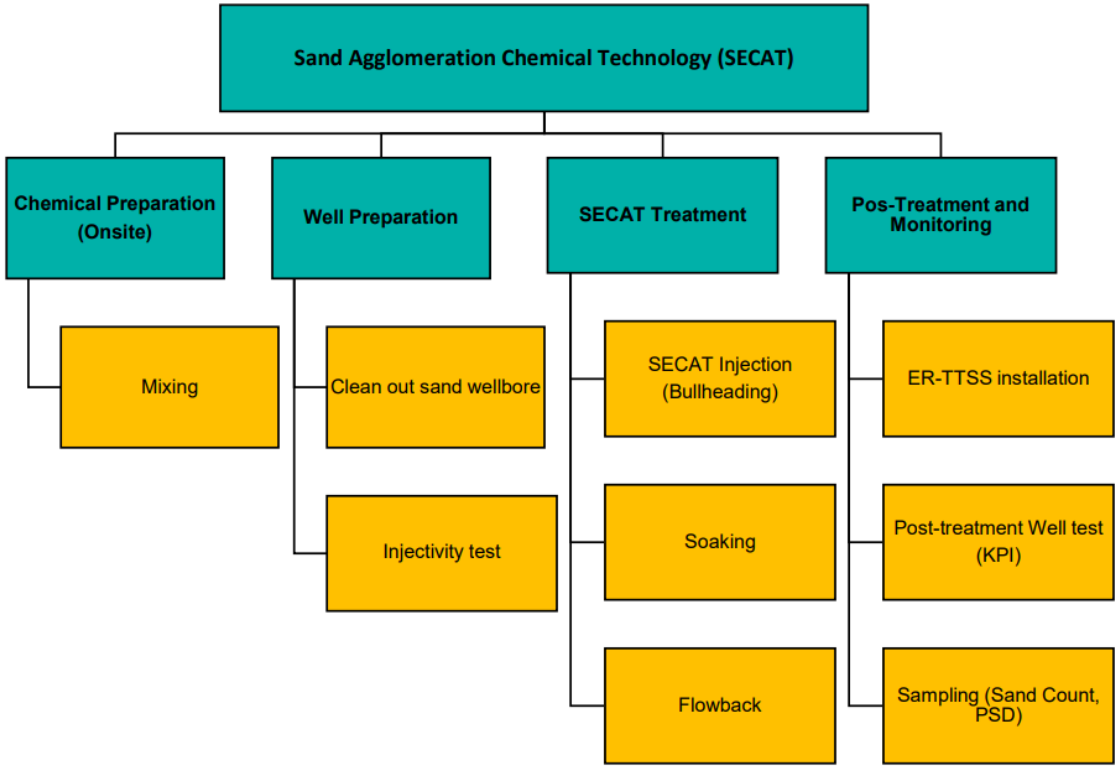
Emulsion Tendency

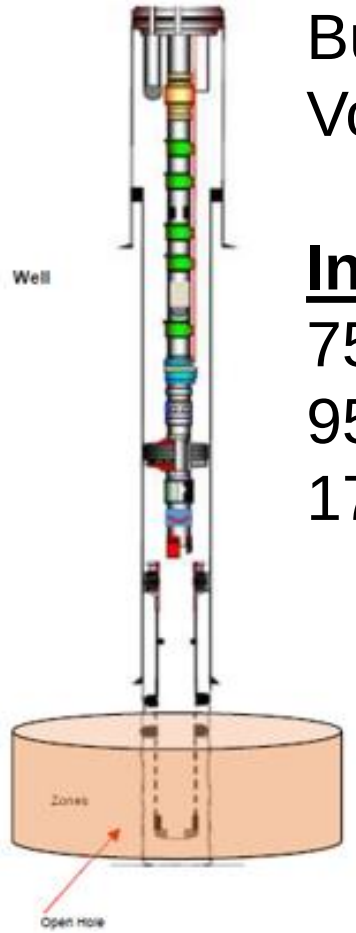


- ❑ No microemulsion and emulsion pad developed.
- ❑ Most separation (oil and water) occurred within 10 minutes.
- ❑ Water phase show good clarity after 10 minutes
- ❑ All samples show good flowability.

- ❑ No adverse effect on emulsion was observed

Trial Execution





Bullhead injection
Volumes for 1-ft from wellbore

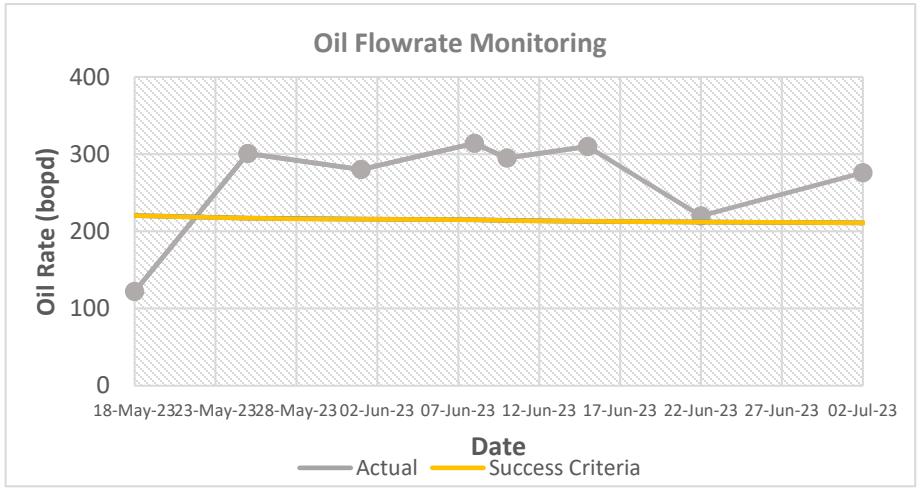
Injection Sequence

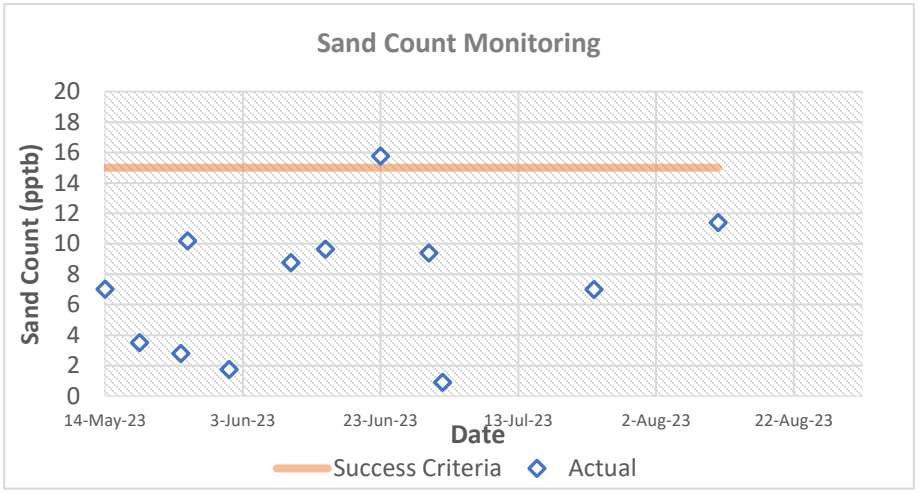
75 bbls Component A
95 bbls Component B
17 bbls postflush 3% KCl

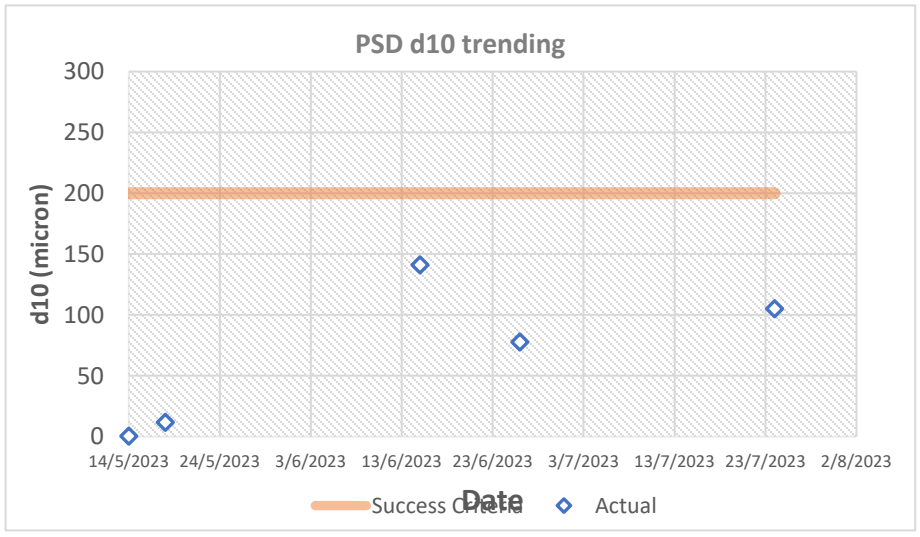
Polymer A & B was separately mixed (dissolved in treated seawater) at offshore using 50 bbls batch mixer

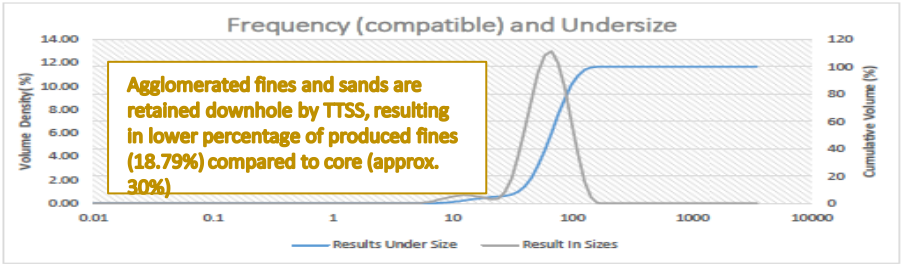
Monitoring

3-months well flow back, sampling and monitoring









Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.01	0.00	0.0679	0.00	0.46	0.00	3.12	0.00	21.2	4.67	144	99.44	976	100.00
0.0114	0.00	0.0771	0.00	0.523	0.00	3.55	0.00	24.1	5.03	163	99.96	1110	100.00
0.0129	0.00	0.0876	0.00	0.594	0.00	4.03	0.00	27.4	5.45	186	100.00	1260	100.00
0.0147	0.00	0.0995	0.00	0.675	0.00	4.58	0.00	31.1	6.40	211	100.00	1430	100.00
0.0167	0.00	0.113	0.00	0.767	0.00	5.21	0.00	35.3	8.51	240	100.00	1630	100.00
0.0189	0.00	0.128	0.00	0.872	0.00	5.92	0.00	40.1	12.47	272	100.00	1850	100.00
0.0215	0.00	0.146	0.00	0.991	0.00	6.72	0.08	45.6	18.79	310	100.00	2100	100.00
0.0244	0.00	0.166	0.00	1.13	0.00	7.64	0.24	51.8	27.65	352	100.00	2390	100.00
0.0278	0.00	0.188	0.00	1.28	0.00	8.68	0.55	58.9	38.79	400	100.00	2710	100.00
0.0315	0.00	0.214	0.00	1.45	0.00	9.86	0.99	66.9	51.42	454	100.00	3080	100.00
0.0358	0.00	0.243	0.00	1.65	0.00	11.2	1.56	76	64.40	516	100.00	3500	100.00
0.0407	0.00	0.276	0.00	1.88	0.00	12.7	2.22	86.4	76.40	586	100.00		
0.0463	0.00	0.314	0.00	2.13	0.00	14.5	2.94	98.1	86.29	666	100.00		
0.0526	0.00	0.357	0.00	2.42	0.00	16.4	3.62	111	93.39	756	100.00		
0.0597	0.00	0.405	0.00	2.75	0.00	18.7	4.21	127	97.63	859	100.00		

Conclusion / Summary

The trial has proven the success of sand agglomeration chemical at enhancing performance of downhole sand screen in managing sand production.

- ✓ 300 bopd idle well reactivation
- ✓ 81% reduction in sand count (from 47 pptb to 8.76 pptb)
- ✓ 37% reduction in fines
- ✓ Project delivered with positive NPV pay-out within 5 months.

Acknowledgement

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PETRONAS Carigali Sdn Bhd

Thank You

Q & A