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

20–21 AUGUST 2024 | KUALA LUMPUR, MALAYSIA

Performance Analysis of Through Tubing Sand Screen (TTSS) Application in Malaysia

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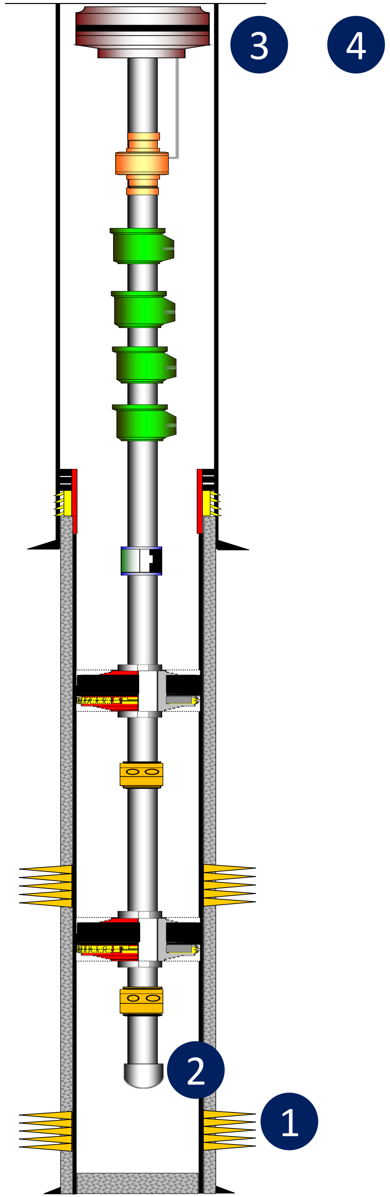
When primary sand control fails, what do we do?

1. Perform remedial sand control at the sandface e.g. **chemical treatment, critical drawdown control**
2. Perform remedial sand control via **through-tubing mechanical solutions** e.g. through-tubing sandscreens (TTSS), through-tubing gravel pack (TTGP)
3. Perform remedial sand control via **surface sand separation** e.g. desander, sand filter, in-vessel sand removal system
4. **Side-track or workover** with new primary sand control

Figure 1: *Well Schematic for Single String, Cased and Perf*



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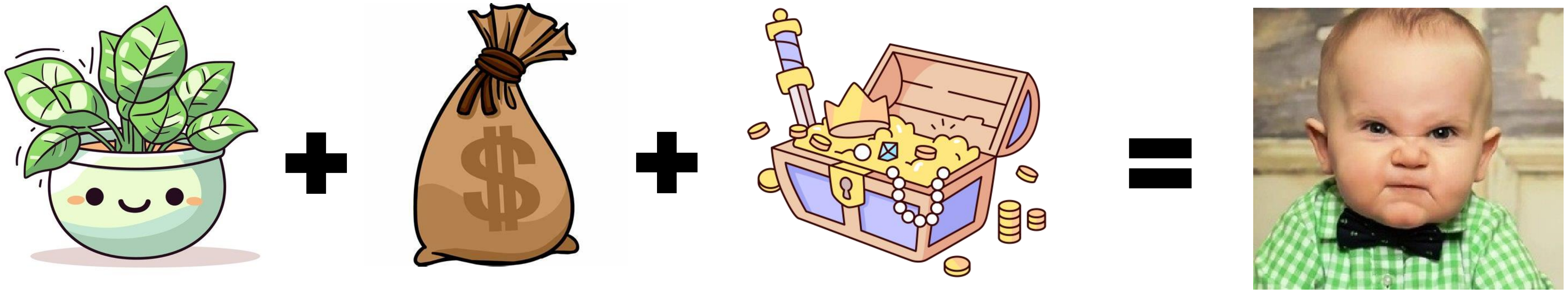
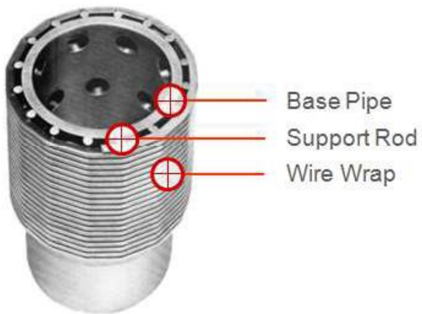
“The Uncertainty Principle”

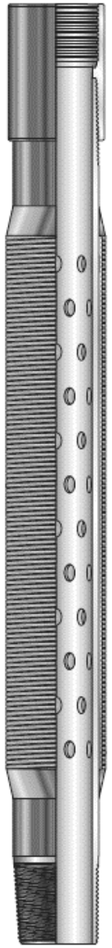


Overview Through-Tubing Sandscreen (TTSS)

Wire Wrap Screen

- Typically for low fines content <2%, uniform and well sorted sand.
- Consist of wire wrap and perforated base pipe
- Wire shape:
  - Keystone – self cleaning
  - House – more erosion resistant



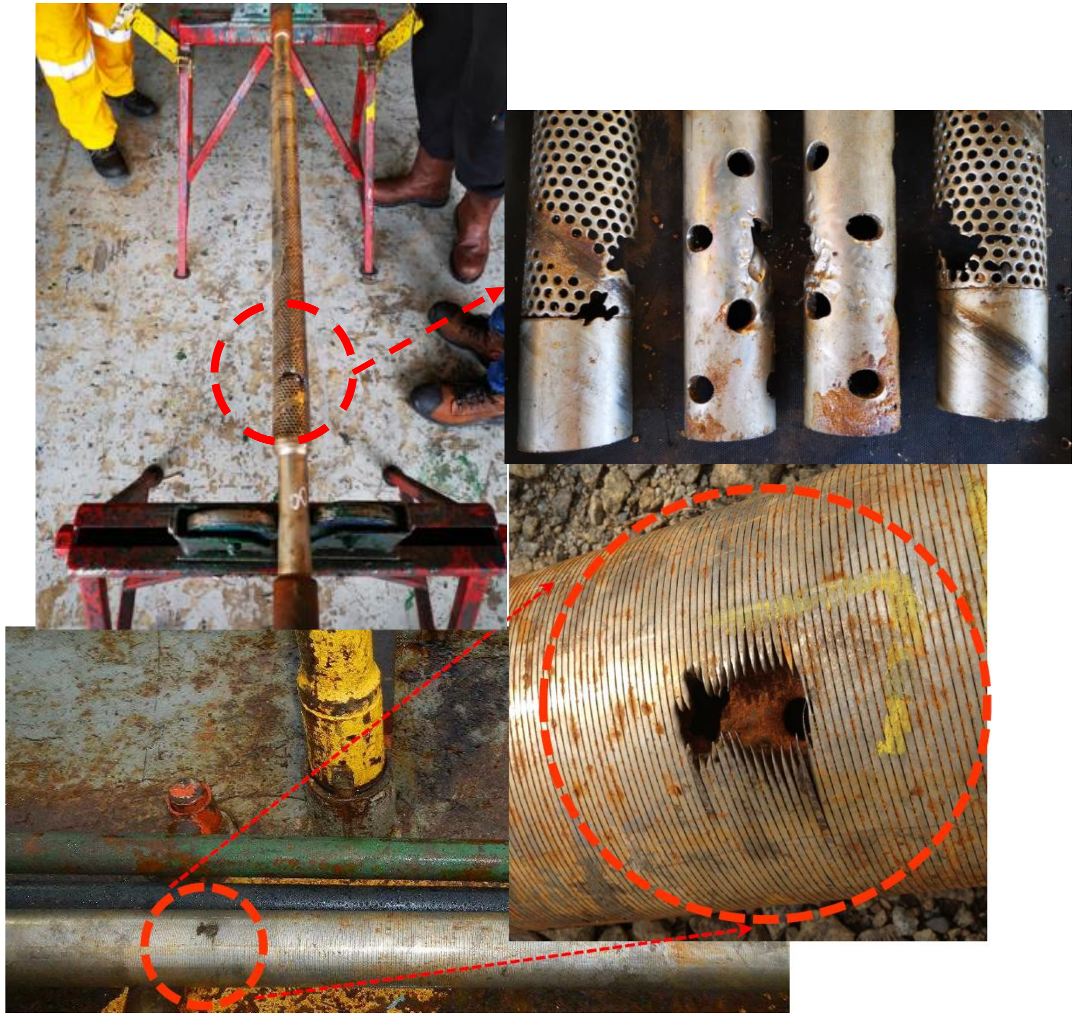


Premium Metal Mesh

- Typically for higher fines content <10%, slightly non-uniform and slightly poorly sorted sand
- Consist of shroud, mesh, drainage layer and perforated base pipe
- Many different weave patterns are available:
  - Plain
  - Dutch
  - Reverse Dutch etc.

What are current challenges with TTSS?

Erosion



Plugging

Study Workflow

Data Extraction → Data Analysis → Power BI Visualization

Data Extraction

- Extracted and populated data for **>200 remedial sand control installation** across PCSB's Malaysia Assets
- **> 7,300 data points**
- Info from **well intervention history** and wellbore diagram

Data Analysis

- Production **well test** and monthly allocation
- Well **interruption and downtime** classification
- Categorization of **failure cause**
- Correlating screen specifications to its **longevity**

Power BI Visualization

- **Charts, histograms, crossplots** to identify potential correlations btwn various parameters.

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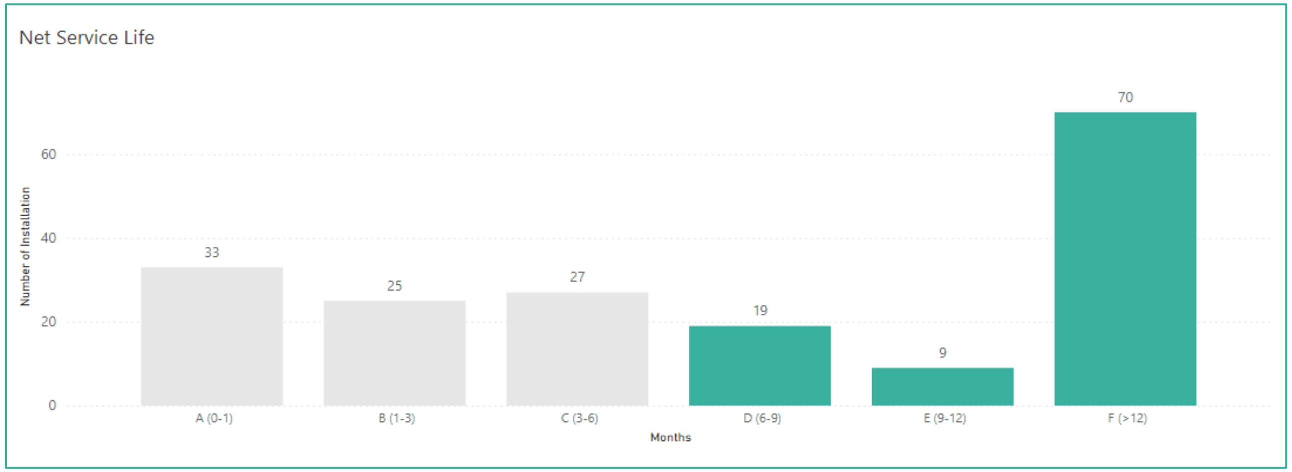
Average Net Service Life and Failure Cause

Figure 2: *Average Net Service Life for 183 TTSS installations.*



- Average Net Service Life for 183 TTSS installations is 13.68 months
- 54% of TTSS installed lasted more than 6 months
- Highest cause of TTSS failure is due to high sand count which indicates screen erosion or oversized screen opening

Figure 3: *Average Net Service Life for 183 TTSS installations.*

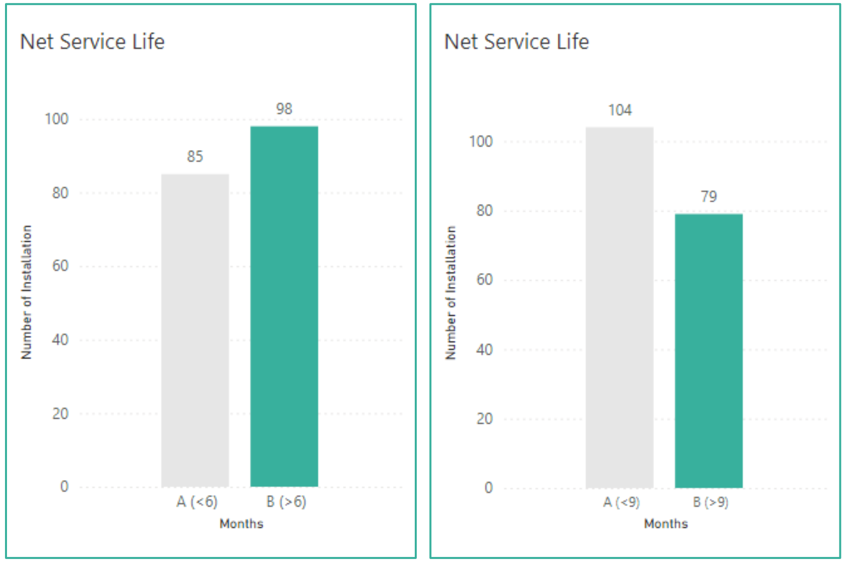
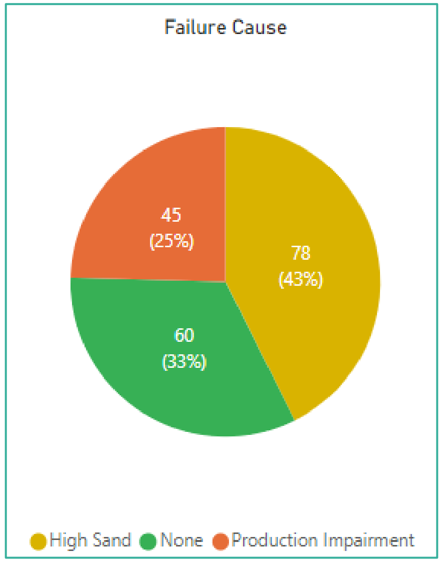


Figure 4: *Identified Failure Cause*



Definition:

- **Net Service Life:** Total production days from TTSS installation until retrieval
- **Production Impairment:** >50% against production before TTSS installation, possible indication of screen plugging
- **High Sand:** high sand count above normal average, possible indication of screen erosion or improper sizing
- **None:** Well is still flowing or no sand related failure

Net Service Life by Field

Figure 5: *Net Service Life Histogram for 183 TTSS installations.*

Figure 6: *Net Service Life Histogram for Field A.*

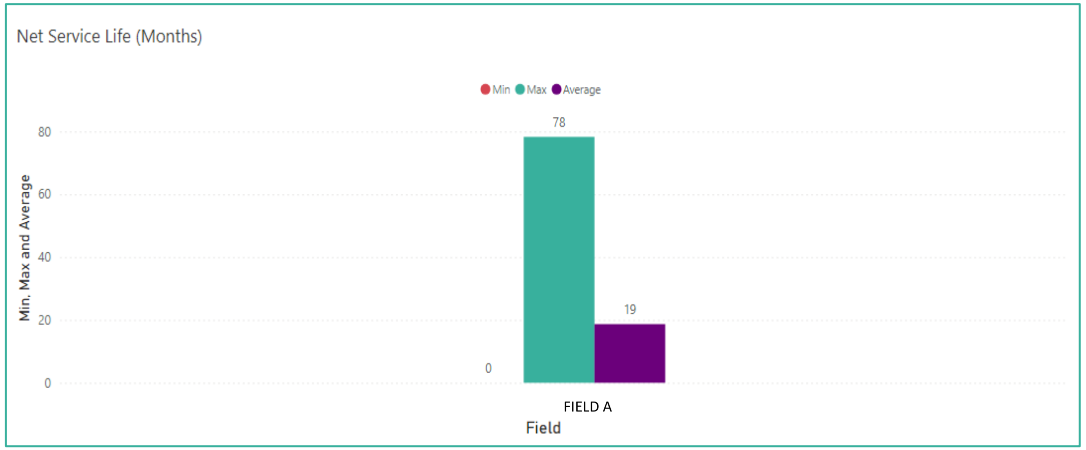
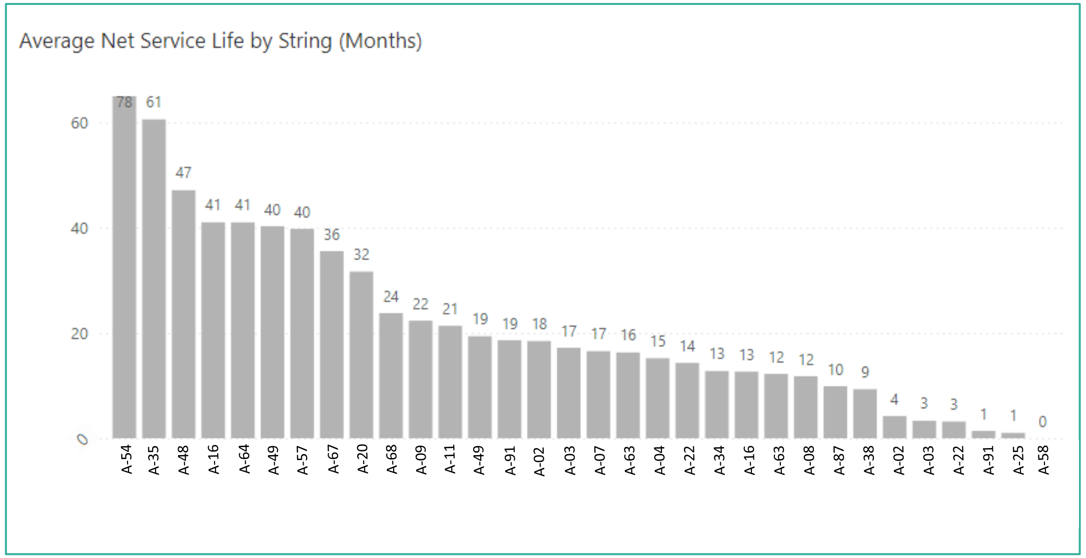


Figure 7: *Net Service Life Distribution by Strings for Field A.*



- Population of minimum, average and maximum net service life of TTSS by field provides a clear comparison of the durability of TTSS across different fields.
- Most fields shows a big gap between maximum and average net service life which indicates screen specifications for most wells can be optimized.
- Identifying the wells with higher screen longevity in a particular field and understanding their success factor will assist in optimizing the screen selection for lower performing wells in the field.

Parametric Evaluation

Figure 8: *Average of Net Service Life vs Screen Opening Sizes for Field A,B,C,D,E.*

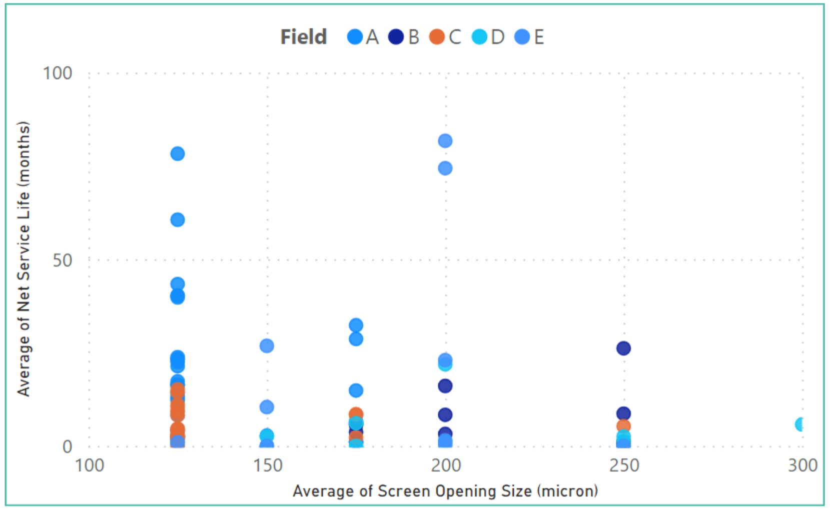


Figure 9: *Average of Net Service Life vs Screen Length for Field A,B,C,D,E.*

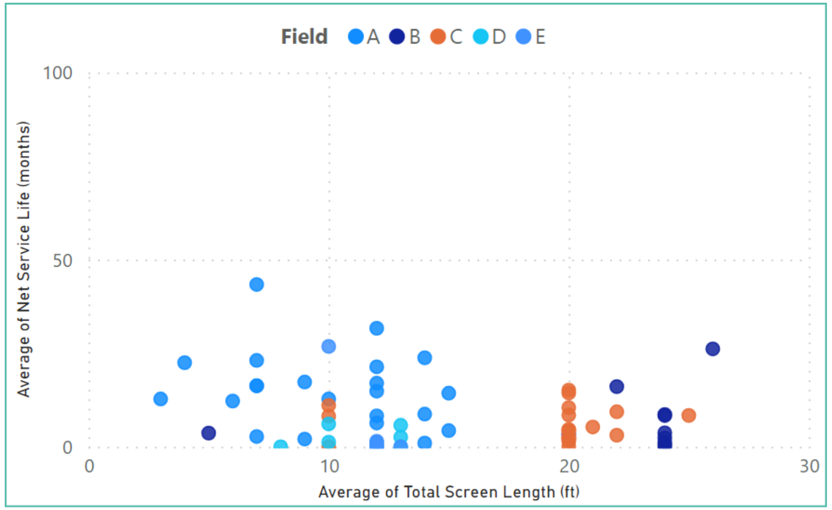
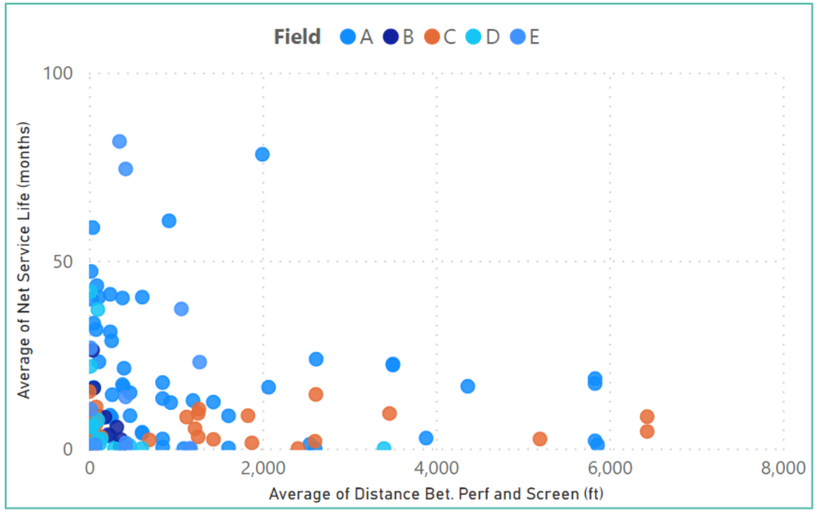


Figure 10: *Average of Net Service Life vs Distance to Perforation for Field A,B,C,D,E.*



- Understanding the relationship between screen size opening and average net service life in a particular field / string / reservoir increases the likelihood of better screen sizing.

- Shorter screen lengths reduces effective flow area which increases erosive forces through flow convergence, potentially leading to erosive failure.
- Though no apparent correlation, longer screen length is advocated, but slickline/wireline operational constraints may limit screen length.

- Notable decline observed in screen longevity when the distance between perforation and TTSS exceeds 850 ft.
- Higher fluid velocities at shallower depth (greater distances from perforations) can lead to erosive failure.
- Reduced net service life attributed to higher pressure drop from sand deposition within tubing with greater distance.

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Pre vs. Post Production Evaluation

Figure 11: *Pre vs Post Job Liquid Rate for TTSS Installations in Field A.*

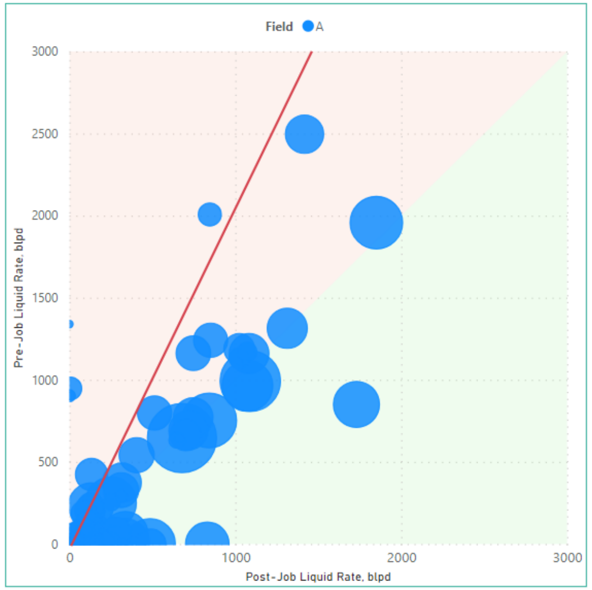


Figure 12: *Pre vs Post Job Liquid Rate for TTSS Installations in Field B.*

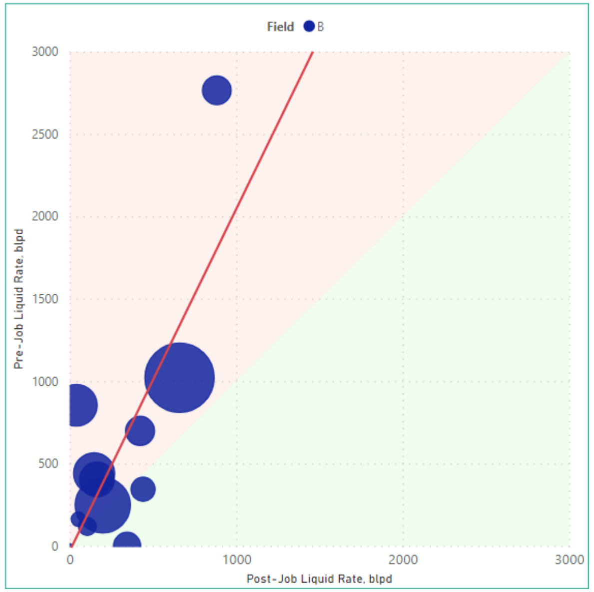
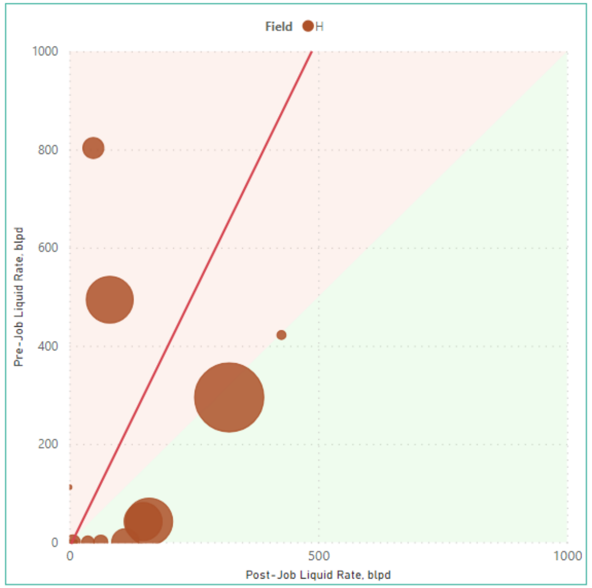


Figure 13: *Pre vs Post Job Liquid Rate for TTSS Installations in Field H.*



- The linear graph plots post-oil production (x-axis) against pre-oil production (y-axis), with bubble size representing the net service life of each installation.
- The unity line signifies that TTSS installation is effective, maintaining production levels without impairment.
- Data points below the unity line indicate increased oil production post TTSS installation, suggesting effective sand control and ability to bean-up well while maintain an acceptable sand production rate.
- Data points above the unity line suggest decreased oil production post TTSS installation, potentially due to plugging or excessive pressure drop.

Execution Efficiency

Figure 14: *Comparison btwn Total Service Life, Net Service Life and Net Effective Life.*

Total Service Life – Total calendar days from TTSS installation until retrieval

Net Service Life – Total production days from TTSS installation until retrieval

Net Effective Life – Total production days from TTSS installation until retrieval or failure, whichever comes first

- The comparison between Total Service Life, Net Service Life and Net Effective Life gives an indication of the reaction time and proactiveness to TTSS changeout once failure is observed.

Conclusion and Wayforward

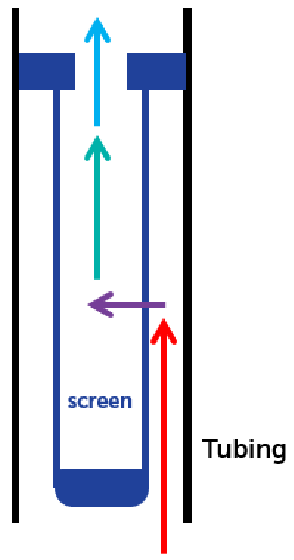
A. Adherence to regular change-out frequency and improved governance

1 ***Changeout Frequency***	• Revised from **6 monthly to 9 monthly** • Prioritize utilization of existing TTSS inventory
2 ***PE Proposal Category***	Revised from **Non-Routine to Routine**, subject to full compliance of below criteria: i. Minimum historical net service life of 6 months for previous screens ii. Same screen type (WWS/premium mesh) iii. Similar slot sizing (+/- 50 micron) iv. Same dimensions (OD and length) v. Obtained concurrence from respective discipline and ISM TP
3 ***Sampling Frequency***	• More **frequent sampling within the first 3 months** • Bi-weekly sampling or as per well open-up program, whichever higher
4 ***Data Hygiene***	Following information to be recorded in the Well Intervention DOR: i. Screen type ii. Same provider & product name iii. Screen opening size iv. Screen OD and length v. Serial number

Conclusion and Wayforward

B. In-house downhole screen erosional velocity to define and benchmark operating envelope btwn regular metallic TTSS and erosion-resistant TTSS

Coupling OD (max)	Qg (MMscfd)	FTHP (psi)	Annular Velocity (ft/s)	Tangential Velocity (ft/s)	Internal Velocity (ft/s)	Internal C Factor
3.5"	4.3	870	29	2.8	48	53
3.5"	7.7	800	55	5.2	90	97
3.5"	8.7	800	62	5.9	101	109



Components	Size (in)
Tubing OD	4-1/2"
Tubing ID	3.958"
No Go size	3.725"
Height	18 -24 ft (3 or 4 joints - 6ft/ea)
Screen Open Area	10%
Effective Open Area	40%
Coupling OD (max)	3.5"
Screen OD	2.875"
Screen ID	2.125"

C. Surface flowline erosion-risked based approach to establish acceptable sand rate for wells that exhibit severe production impairment using industry latest SPPS 6.2 erosion correlation.

***Figure 15:** Erosion Severity Matrix.*

Conclusion and Wayforward

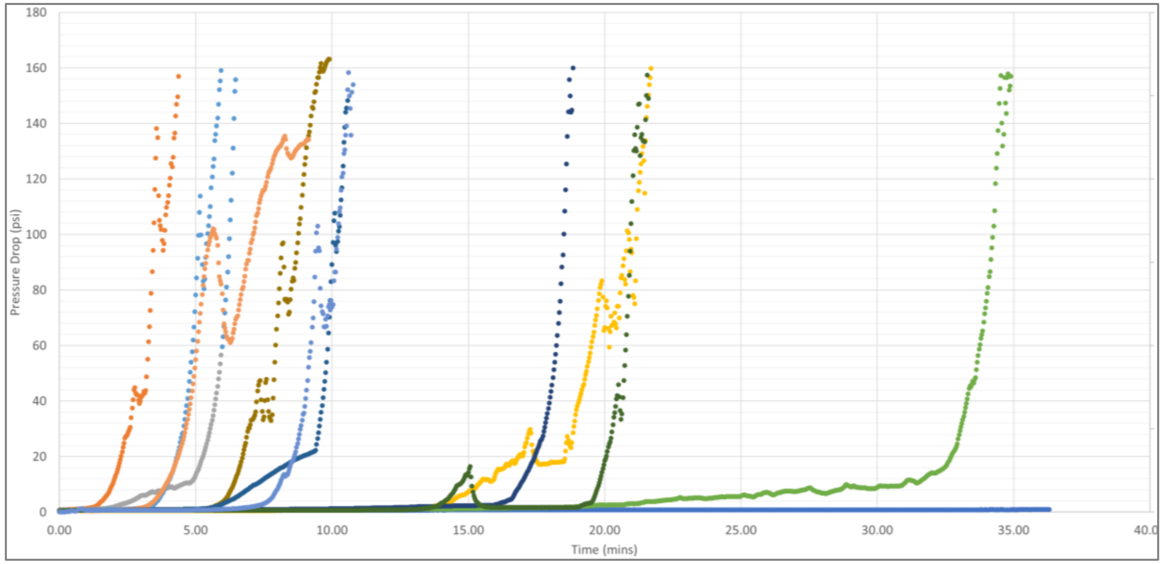
D. Adopt a standardized tolerance and QAQC method for all types of screens, example shown below is for WWS.

Figure 16: *Wirewrap screen slot tolerance.*

Company	Tolerance
A	+0.003 in (75 micron) -0.005 in (150 micron)
B	+0.002 in (50 micron) -0.002 in (50 micron)
C	+0.001 in (25 micron) -0.002 in (50 micron)
D	+0.002 in (50 micron) -0.003 in (75 micron)
E	+/- 0.003 in (75 micron)
F	+0.003 in (75 micron) -0.002 in (50 micron)
G	+/- 0.001 in (25 micron)

E. Continuous improvement in sand retention testing (SRT) procedure and analysis for better screen sizing and selection, with ongoing development of screen mastercurves. Partnership and collaboration with academic institution.

Figure 17: *Pressure vs Time Graph for Sand Retention Testing.*



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Thank you!

Our gratitude and appreciation to the management of PETRONAS Carigali Sdn. Bhd. for their permission to share the findings. Special thanks to all the Asset surveillance and well intervention team for providing the dataset for the analysis and fellow colleagues that was involved in the data analysis and visualization.