Sand Management at MOC Malaysia

(Sand Management TRT CORAL 2.0)

KLCC Convention Center

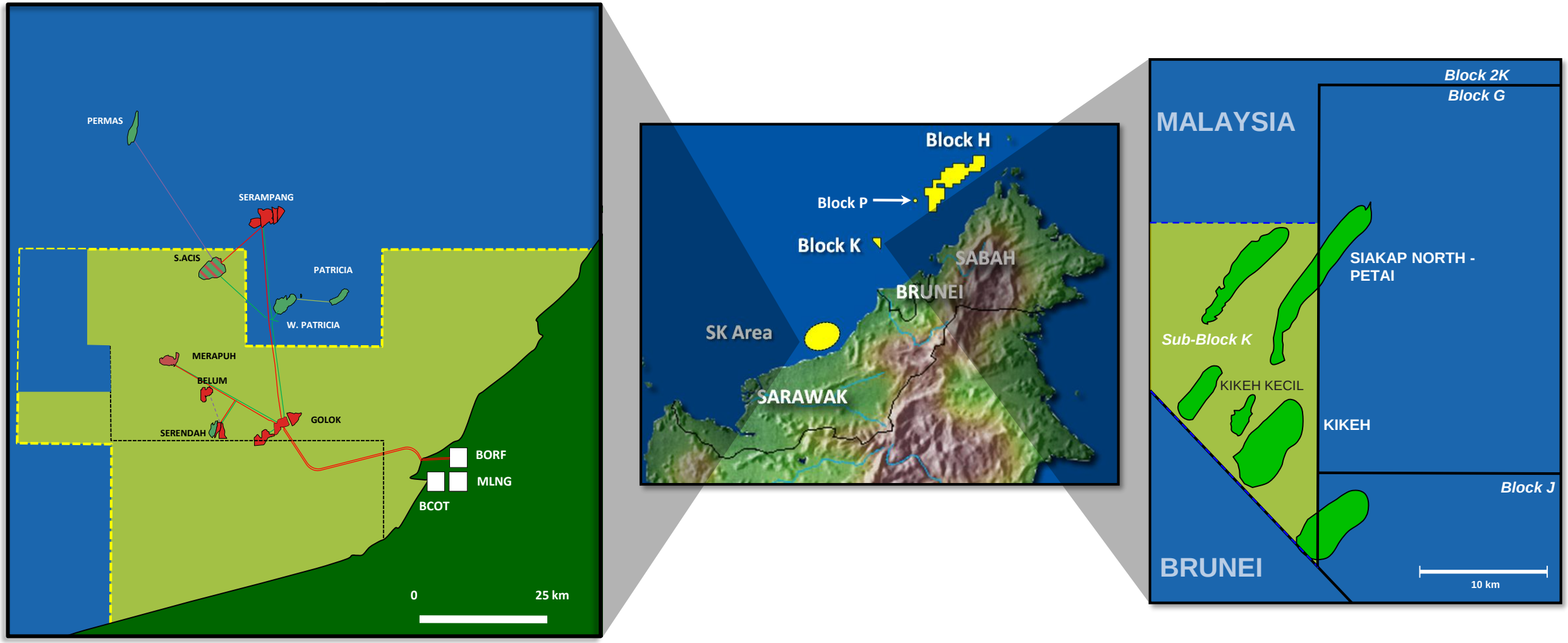
30 November 2018

MURPHY OIL CORPORATION

Presentation Outline

- Location of Sanding Issues in Murphy Malaysia
- Sabah Sanding Problems & Resolution
- Sarawak Sanding Problems
  - Events to date
  - Sand Management
    - Current System
    - Future System
- Conclusions

Location of Sanding Issues



- Operations in Sabah (deepwater oil bearing turbidite sands) and Sarawak (shallow water oil and gas bearing channel systems). Sand production observed in Kikeh and Sarawak Gas fields.
- Approach to problem resolution is the same, but solution(s) selection is different. No “one solution” to the problem.

Sabah - Kikeh Sanding Problems

- Jan 2010, failure of sand screen completion (ESS) at one of the oil production wells resulting in **1-2 tonnes of sand production per day**.
- Well choked back. Major production impact.
- Damaged choke valve, diverter valves, FTL and FPSO swivel.
- Frequent clean out at HP Separators on FPSO.

Kikeh Sanding Problem Resolution

Short Term - Implement Topsides Sand Management System

- Remove at surface, to the highest possible degree, the produced sand as soon as practicable in the process flow.
- Wellhead desanders selected. Sufficient space to allow installation.
- Wells producing from 3,000-20,000 blpd.
- Challenges: dedicated manpower; solids management; equipment erosion; carry through of fines to FPSO tanks.

Long Term – Completion re-design and Topsides Mods

- Changed from ESS to OHGP. Design applied to Siakap North Petai field.
- Solved the problem (with occasional OHGP failures).

- Merpro Tore system installed in Kikeh FPSO separators.

Overall Equipment Height: 7.5 m

Overall Equipment Wt: 6 T

Sarawak - Outline of Problem

- SK Gas wells completed bottoms up in 3.1/2” monobore (downhole sand control limited):
  - Intervals become weaker at depths less than ca. 800m TVDSS.
  - SK Oil Wells all completed with ESS, although some recompletions are C&P (limited sand observed to date).

- To date GOPA, GOPB & SEPA only completed in shallower intervals but eventually all facilities will experience the same.

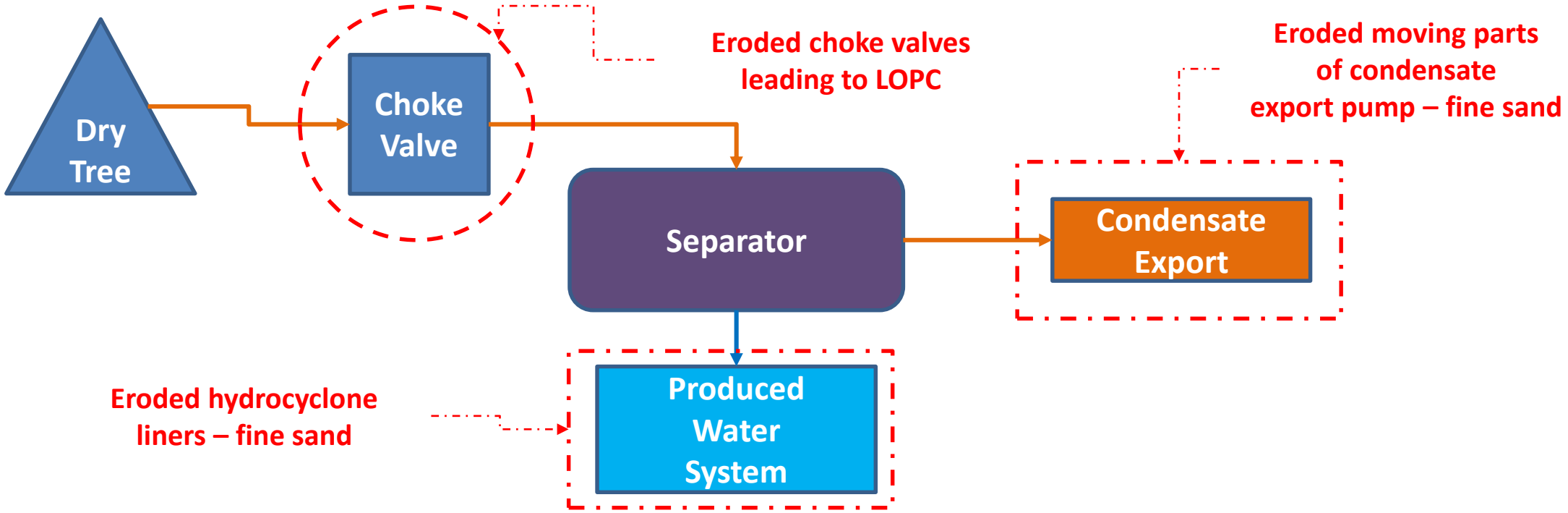
- Sand production has been ‘controlled’ by MSFR (Maximum Sand Free Rate) testing, i.e. stepping up rate to initiate sand production, then cutting back. Sand monitored using ultrasonic sand detectors (1 ea. at Test and Prod Headers).

- Despite this sand has been produced in small quantities (up to 100kg/week) but sufficient enough to give problems topsides. The main issue is fines carry through (sand detectors unable to see sand <15microns).

- **Costly in terms of downtime, equipment repair/replacement and decreased well potential.**

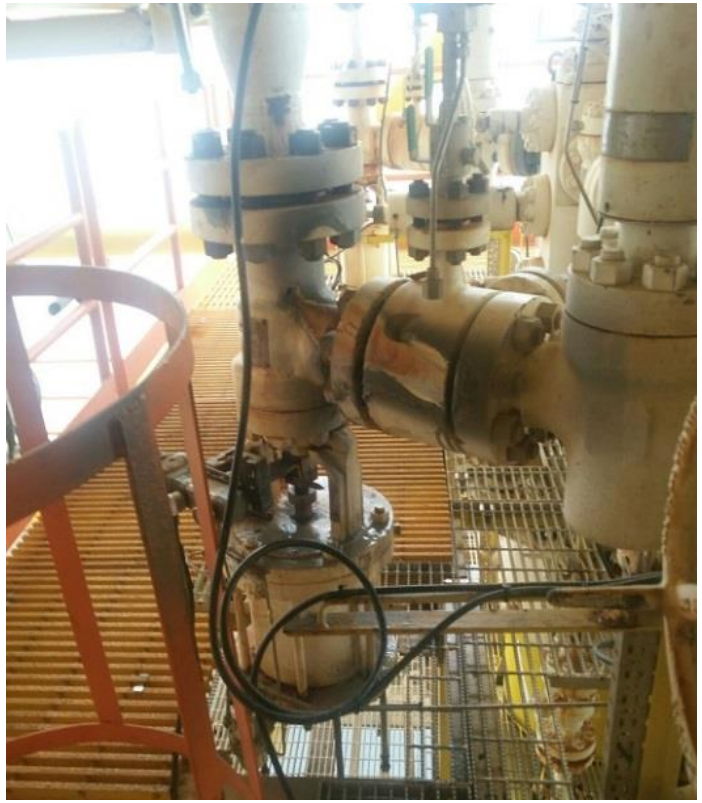
Events to Date

- Facilities Equipment Damage:
  - Pin Hole Leaks, Valve and Condy Pumps (Mech Seals) Damage, Pump Impellors, Hydrocyclone Liners, Plugging Equipment and Filling Vessels, amounting to $MM's in repairs.
  - Began experiencing in July 2012 after GOPA recompletions to shallower intervals in June 2012. Detection improved in June 2013, and MSFR testing began (to reduce sand production).
  - 2014: GOPA offline for ca. 3.5 months due to equipment failures caused by sand.



Events to Date

- LOPC: 12-13th Dec 2015 – GOPA-04 LOPC due to Sand Production.
  - New ‘sand service’ choke installed (external sleeve).



Sand Management – Previous Methodology

1. Monitor/Minimise: To date monitoring sand production vs rate (MSFR testing) has been the primary method of management.
   - Sand detectors located at Test and Production Headers. Unable to take BS&W in gas wells so physical solids detection is impossible.
   - Wells tested through TS and put back on production at 'sand free' rate.
   - No well monitoring real time – reliant on single production header detector.

- Not 100% successful as sand <15micron cannot be seen (but we can assume that fines travel with coarser sand), and we do not have 100% sand detector coverage.
  - Being addressed through better calibration of sand detectors inc. link back to KL office to allow online (zero) calibration based on changing well conditions.
  - Installation of detectors on each well.
  - Does not allow wells to be produced at a higher rate (loss of well potential).

2. Remove/Repair: Sand is removed from the system when required, with repairs as necessary.
   - Costly with potential for high downtime.

Management – Current Methodology

System needs to be a multi-pronged approach with the realisation that sand production cannot be stopped 100%

1. Prevent: Focus on downhole treatment
   - Solutions being assessed with field trials performed and planned.
     - Downhole sand consolidation chemical treatments in three wells in 2017 were unsuccessful – issue with post pumping crossflow (most likely). Does not rule it out as an option in specific circumstances.
     - Downhole sand screens and/or thru-tubing CHGP to be trialed in 2018/2019.
   - Difficult to perform as multiple horizons have been perforated in 3.1/2" monobore C&P completions.
   - May not entirely eliminate sand production (esp. fines)…

2. Monitor/Minimise: Sand detectors at each well & Downhole Sand Detection
   - Live monitoring with alarm notification is key to avoiding issues. Understanding sanding behavior is crucial.
   - Ongoing MSFR testing is required.
   - How much sand can be tolerated?
   - Downhole sand detection to plan for sand control.

3. Protect: Equipment to protect surface facilities
   - Sand Service chokes.
   - Sand Removal at Topsides – conventional approach vs fit for purpose approach.
     - Increase time to equipment failure, reduce OPEX.

Prevent - Downhole Sand Control

- Downhole Sand Consolidation.
  - 2 type of chemicals were used in three wells:
    - **Sand Trap ABC** is an aqueous based Resin Consolidation System – HES
    - **SandAid** is a chemical system that alters the “zeta potential” of solid surfaces, causing agglomeration – SLB.
  - Results were not positive likely due to post pumping crossflow as all the wells were completed in multiple horizons – a known risk to success.
  - It is believed that the techniques could be effective in single zone applications.

- Thru Tubing Gravel Pack in 3.1/2” Completion
  - Trial will be performed at GOPA-01ST1 end of 2018 or early 2019.
  - Rigless operation, combination of slickline deployment and pumping.

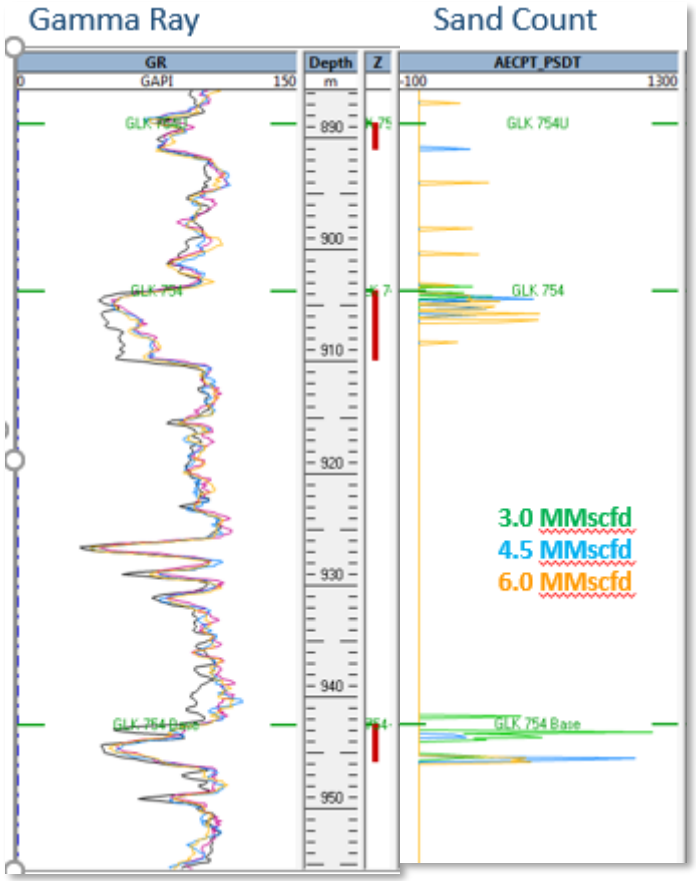
Monitor – Ultrasonic Surface Sand Detectors

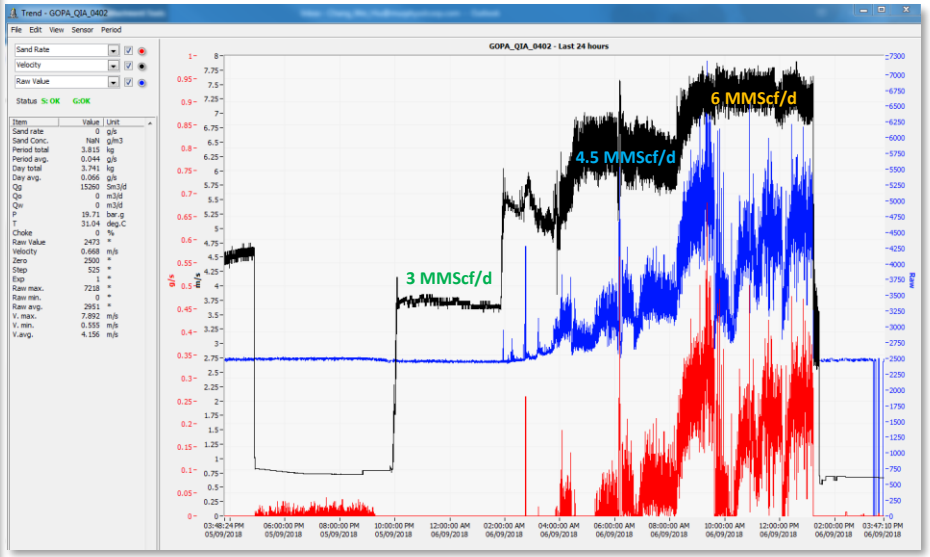
- Can detect sand larger than 15-20um.
- Average sand rate calculation is dependent on the raw, zero and step value.
- Sand Rate = (Raw-Zero)/Step
- Raw = Reading from Detector
- Zero = Background/Flow noise – noise increases as velocity increases.
- Step = accounts for the velocity dependency. For a given amount of sand, the signal response will increase as velocity increases.
- Detectors can give accurate data if they are used correctly and sand production events are understood.
  - Live velocity calculation – gas wells with rate transmitters.
  - Pressure and Temp compensated – more accurate velocity calculation.
  - Sand moving around on surface vs sand produced from the well.
- Wells tested regularly for MSFR to minimize sand production.

Monitor – Downhole Sand Detection Tool

SLB Sand View Tool

- Quantifies sand production by detecting and counting sand grain impacts.
- Impacts are counted and quantified based on their energy levels.
- Tool can only detect sand larger than 100um.
- Purpose was to identify sanding zones for downhole sand control.
- It wasn't possible to directly compare downhole to surface detection sand rates, but they were in the same order of magnitude.



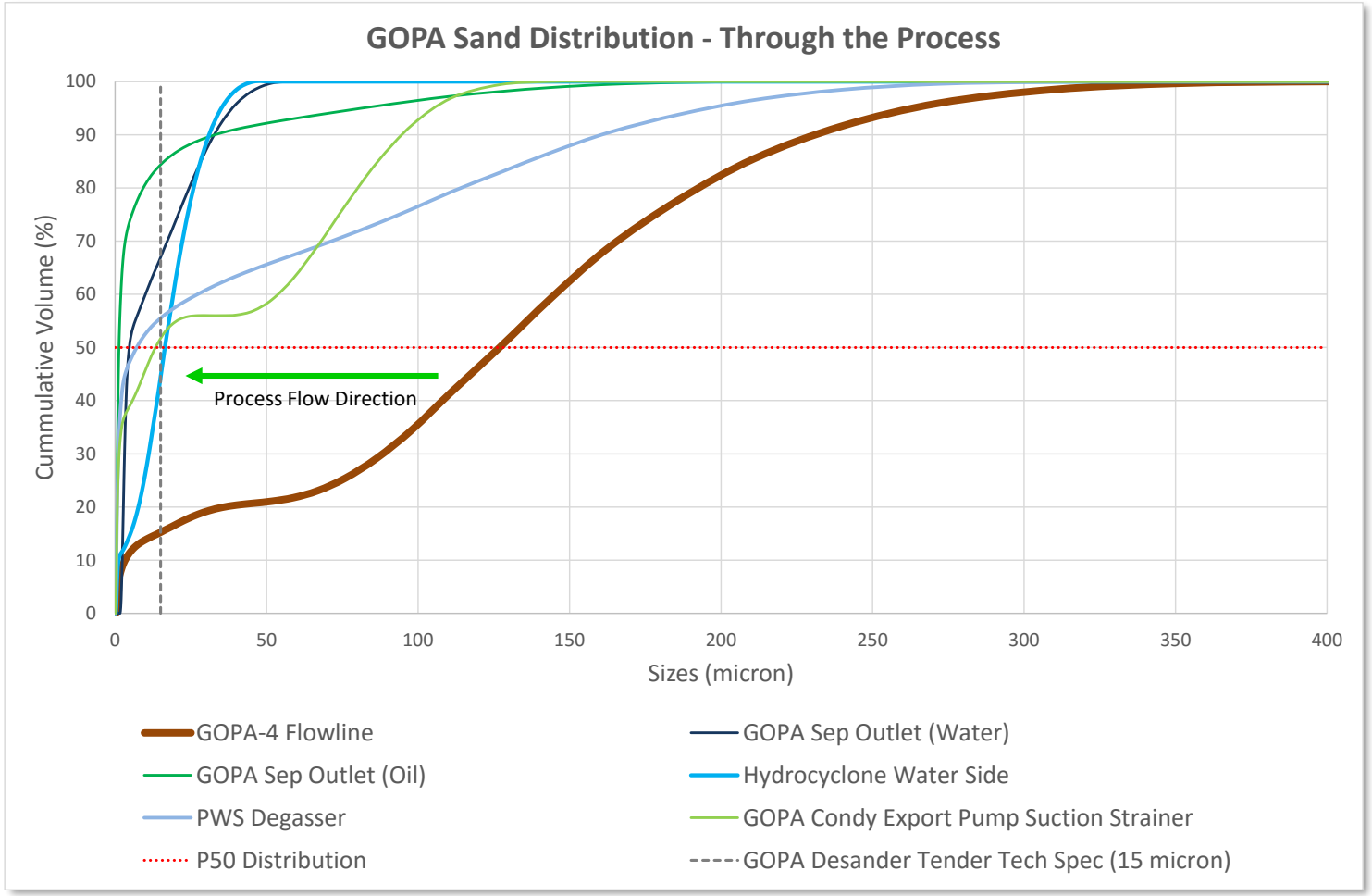


Protect: Desanders – The Conventional Solution…

- Cyclonic desanders limited to removal of >20micron sand (but only with liquid presence).
- Other concerns are space availability (deck extension required), cost, and ability to operate in unmanned platforms.
- Pressure drop (3 bar) across desander ultimately reducing reserves.

What is our actual problem?

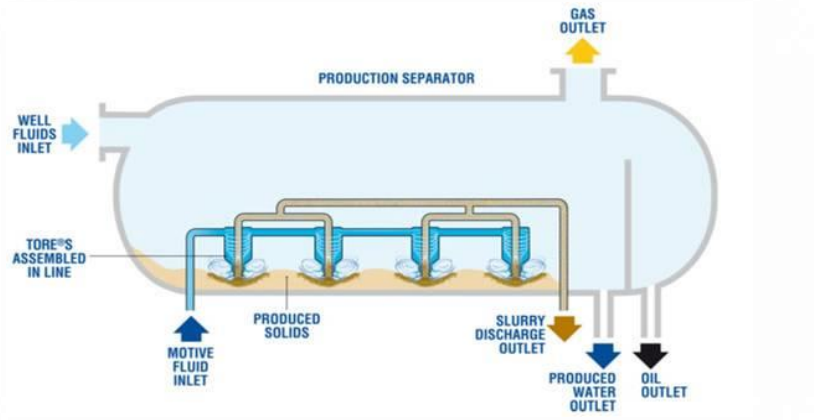
- Fine sand being carried through the system.
  - Well sand: P50 ~ 125micron.
  - Sand carried through the system: P50 <15micron.
- **Conclusion**: cyclones not suitable for these assets.
- **Key**: Accurate problem definition.



Protect: Topsides Management – Fit For Purpose Solution

Approach taken: online sand removal from major vessels with system designed to improve sand drop out and capture, and minimize fines carry through.

- Installation of sand jetting system in Production Separator.
  - PW outlet nozzle raised by 2-3 inches to act as improved sand dam.
  - Cyclonic type internal desander, creates simultaneous suction and evacuation (no pressure loss).
  - Removal of deflector plate and installation of inlet device (Schoepentoeter) to improve sand separation and settling, reducing fines entrained in the gas stream.
  - Installed at two locations in 2018 (Nov) and two in 2019.
- Water source – tote tank from nearby oil platforms with treated SW (injection water).



Conclusions

- No single solution to resolve every situation. Don’t just apply what you used in the past, be flexible.
  - Different solutions applied to Sabah and Sarawak fields, both topsides and downhole.
- A fully integrated approach has to be taken, from well through to export. The key is understanding what the problem really is.
- Downhole solutions have to be applied to a suitable candidate. Learn from failures, and do not necessarily eliminate a “failed” technique.
- Ultrasonic sand detection is not comparable to a normal transmitter function (e.g. P/T/q) and has to be worked to achieve good results. Accurate results are achievable when the correct approach is taken.