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Separating Solids First – Design and Operation of the Multiphase Desander

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eProcess TECHNOLOGIES

Society of Petroleum Engineers

SPE and STTS

Separations Technology Technical Section

- Purpose:
  - Share knowledge, experience, and best practices
  - Identify major issues and technology areas
  - Promote awareness of separation-related issues and technologies
  - Enhance members technical competencies
- Webinars
  - Three per year
- ATCE Special Sessions
  - 2014 “Unlocking Hidden Production Potential in Existing Facilities & Mature Fields”
  - 2015 “Gas Scrubber Design and Validation for Robust Separation Duty”
  - 2016 “Three-Phase Separation”

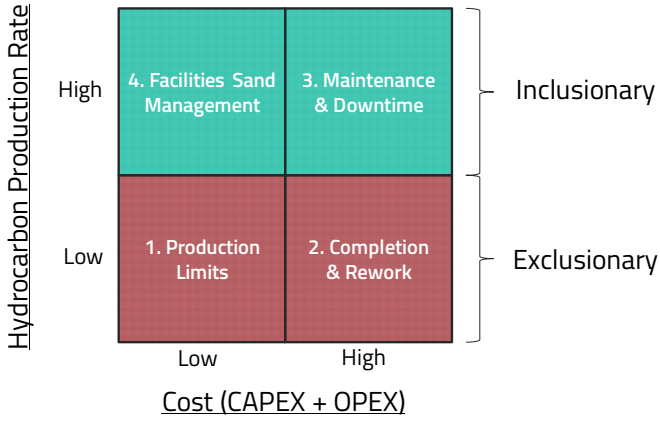
Slide 4

Sand Management Options

All oil & gas wells produce sand

Exclusion Methodology
- Production Limits
- Downhole equipment

Inclusion Methodology
- Maintenance
- Facilities Sand Management



Slide 5

Facilities Sand Management (FSM)

Facilities: surface/subsea equipment for separation, cleaning, and energy addition (e.g. wellhead to LACT)
Sand: tiny loose pieces of rock*
Management: to handle or direct with a degree of skill*
*definitions from Merriam-Webster.com

- Not a waste stream treatment exercise…it is a critical Flow Assurance issue
- Increase/maximize production…while reducing / minimizing operating costs

Slide 6

What are Produced Solids?

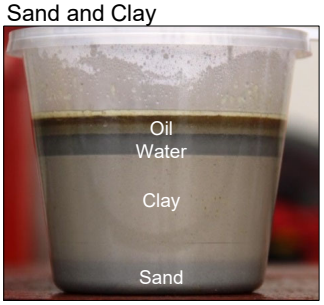
Inorganic, Insoluble, Particulate Material

Primarily “sand” by ISO/ASTM definition

- Not asphaltene, paraffin, wax, hydrate, or resin (organic)
- Not precipitates (soluble) or scale (non-particulate)
- Additionally scale debris, corrosion products, junk, proppant, etc.

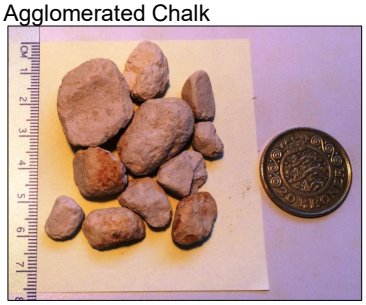
Solid particles that are separable in facilities equipment

Sand and Clay



Deepwater South China Sea

Agglomerated Chalk



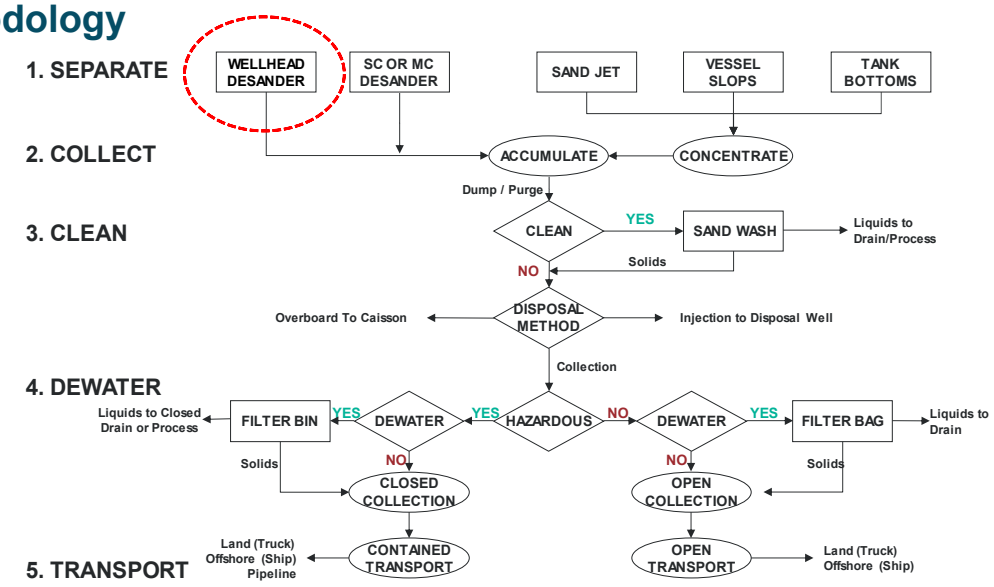
North Sea Danish Sector

Chicken feathers, seeds, and newspaper

Onshore Egypt

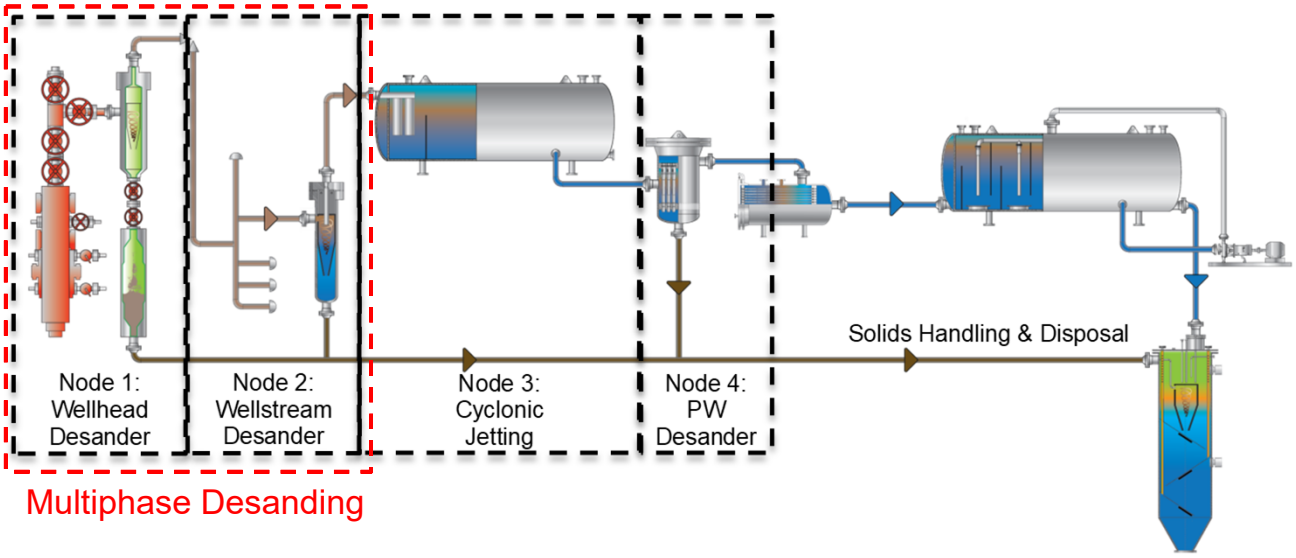
Slide 7

Methodology



Slide 8

Four Nodes of Sand Separation



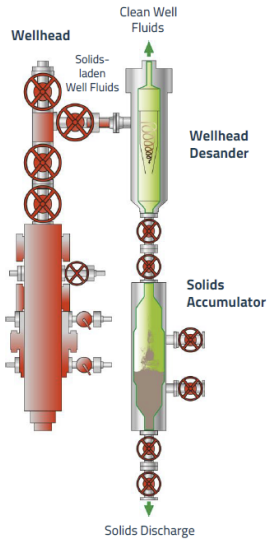
Slide 9

Multiphase Desander (@ Wellhead)

Pressure Retaining Vessel
- ASME: 150# to 2500#
- API-6A: 5/10/15 K rating
- API at full shut-in pressure, no PSV
- Small hold-up volume

Cyclonic Insert
- Performs separation duty
- Contains erosion
- Duplex SS/WC or SiC
- 4"-10" replaceable inserts
- Interchangeable size and materials

Installation/Operation
- Upstream/downstream of choke
- Service tool or production
- 5-75 psi ΔP
- Operate 0-100% GVF
- 10-25 micron separation
- On-line batch sand discharge

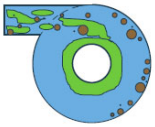


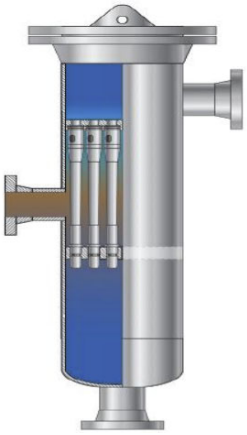
Slide 10

Packaging Comparison

Insert Style (Single Cone)

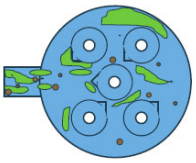
- Multiphase applications
- One insert per vessel
- Smaller/lighter vessel
- Change insert diameter for high turndown (>3:1)
- No fluid partitioning
- Particles to 1″-2″
- Concentration to 5 wt.%





Liner Style (Multi-Cone)

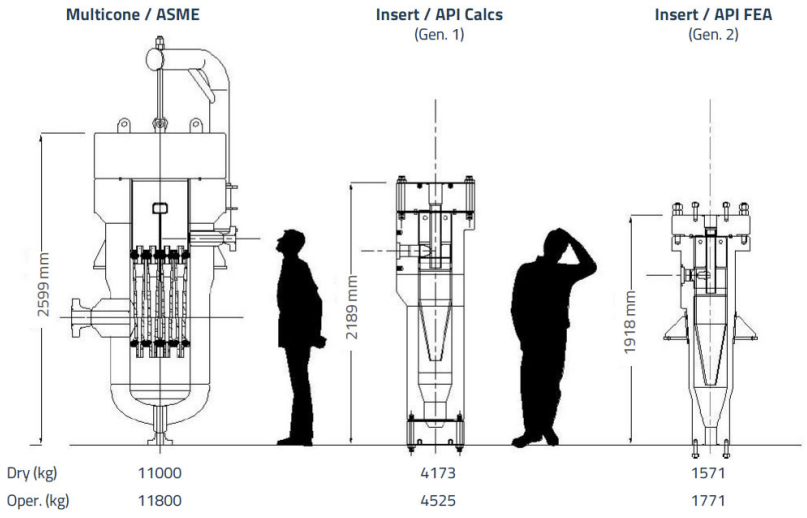
- Liquid applications
- Many liners per vessel
- Larger vessel
- Change quantity of liners for high turndown (>3:1)
- Unequal fluid partitioning
- Particles to 0.1″-0.2″
- Concentration to 0.25 wt.%



Slide 11

Wellhead Desander Vessel

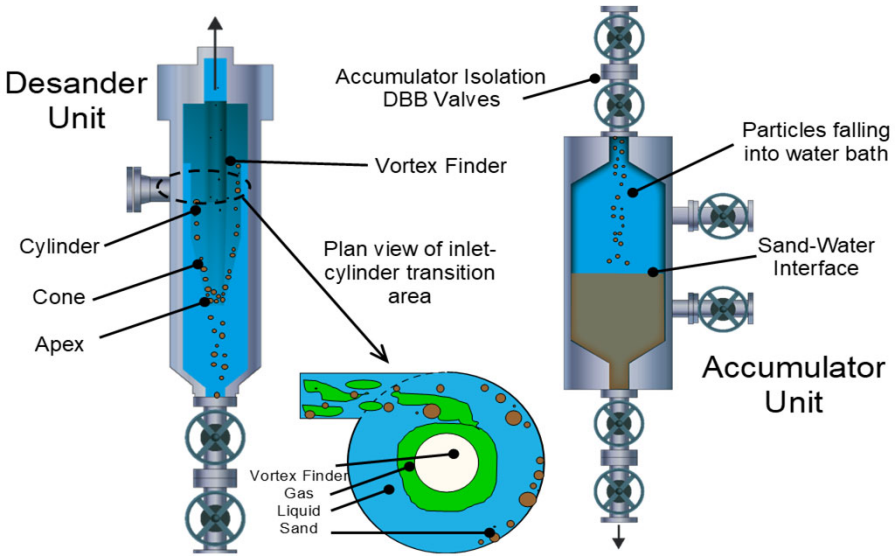
Duty: 10,000 psi MAWP / 100 MMSCFD + 7,500 BLPD



Dry (kg)	11000	4173	1571
Oper. (kg)	11800	4525	1771

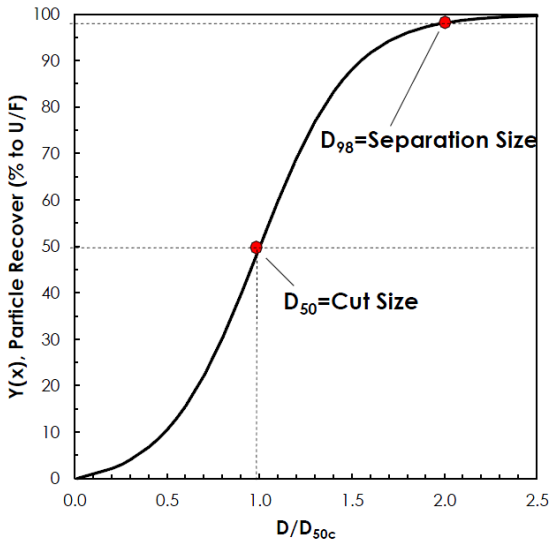
Slide 12

Particle Travel



Slide 13

Multiphase Model



- Flow regime determines model
  - Hydraulic model for liquid dominant
  - Pneumatic model for gas dominant
  - Model convergence/overlap
- Use mixing rules for fluid properties
- Calculate multiphase pressure drop
- Ensure critical velocity regions stay within limits
- Calculate separation size and collection efficiency

Rule-of-thumb: Wellhead desander will remove solids that settle within a production separator

- Particles collecting at oil-water interface or passing into oil phase not captured

Slide 14

Development History

Jan.1994	• Concept initiated as internal development project
Mar-Apr 1994	• Laboratory testing using air-water-sand with 10" mining cyclone
Late 1994	• JIP initiated for pilot-plant testing and mechanical design
Mid-1995	• JIP pilot-plant test at (BP) Wytch Farm onshore gathering stations • ANSI 300# unit, 10" diameter desander • Sand injected into clean stream • Also tested with five sand monitoring devices
Late-1995	• Detailed mechanical design for industrial unit • 5K ASME design with single insert
1996	• First commercial unit • Unit still in service

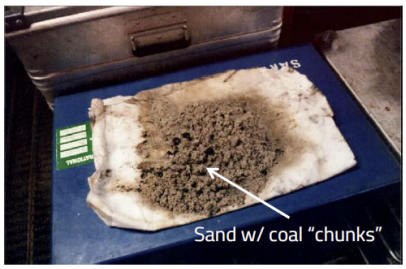
Slide 15

First Commercial Wellhead Desander (1996)

Deployed in 1996
- Shell/Expro – Brent D
- ASME 5K WHD Skid
- Coiled-tubing well cleanout

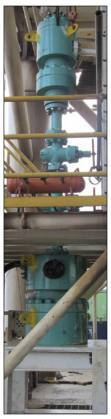
Process Flow
- Gas: 6.4-19.2 MMSCFD
- Liquid: 16,000 BPD

Performance
- <75 psid pressure drop
- D_{98} = 20 micron



Slide 16

Operating Units



Date: 2012
Location: Malaysia
Operator: Petronas Carigali
Field: Duyong Fixed Platform
Unit: API 5K Wellhead Desander
Flow: 6 MMSCFD gas (trace liquids)
Operation: D_{98}>20 microns

Date: 2014
Location: Saudi Arabia
Operator: Halliburton
Field: Well Testing
Unit: API 15K Wellhead Desander
Flow: 15000 BLPD + 200 MMSCFD
Operation: D_{98}>20 microns

Date: 2011
Location: Turkmenistan
Operator: Dragon Oil
Field: LAM B
Unit: API 900# Wellstream Desander
Flow: 4000 BLPD + 5 MMSCFD
Operation: D_{98}>23 microns

Date: 2014
Location: Argentina
Operator: YPF
Field: Unidad de Negocios Neuquen
Unit: API 5K Wellhead Desander
Flow: 600 BLPD + 10 MMSCFD
Operation: D_{98}>10 microns

Slide 17

Component Design

Cyclone Inserts
Replaceable and interchangeable
4”-10” (100 – 250 mm)
Designed for multiphase flow
Standard UNS 31803 (duplex SS) with tungsten carbide internal spray
Alternate cast SiC

Valves
FC type slab gate valve (manual or actuated)
Material class DD/EE-NL
Temperature class P+U/X
Certification: PSL3/PR1 or 2
Forged 4130 CS body
Internals 410 SS with hard face

Slide 18

Application & Operations

Installation Location	• Pre choke (API) • Post choke (ASME) • Subsea – in development
Applications	• Well testing, well cleanout, underbalanced drilling, produced solids, proppant flow back
Utilities	• Flush/fill accumulator (clean water any source at 50 psi)
Consumables	• Insert replacement and o-rings
Process Connections	• Five standard: inlet, clean fluid outlet, solids discharge, accumulator-vent and accumulator-flush/fill

Slide 19

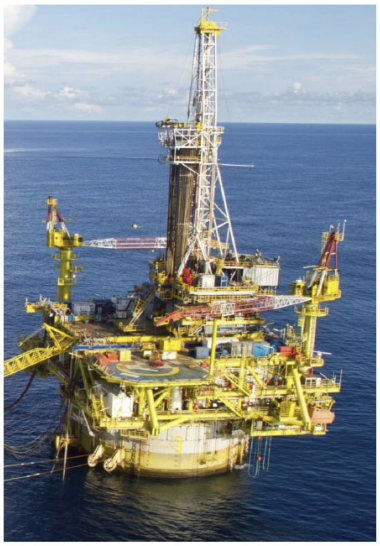
Operating Boundaries: Process Fluids & Pressure

Pressure Drop	• Minimum 3-5 psi based on GVF • Maximum set at 25-75 psi for wear life • Will impose back pressure on artificial lift wells
Flow Conditions	• Operation from 0-100% GVF • Turndown: – Per insert 3:1 liquid only, 5:1 multiphase – Per vessel 20:1 by changing inserts
Slugging	• Must stay within pressure drop range
Fluid Viscosity	• Difficult to process heavy oil with high liquid viscosity (>~100 cP), low watercut and low GVF

Slide 20

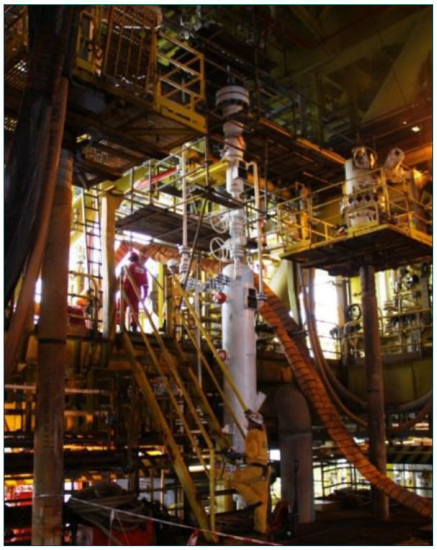
Malaysia: Murphy Oil

Operator	• Murphy Sarawak Oil Co. Ltd.
Location	• Kikeh Spar DTU – 1300 m water
Technology	• 10-1500# Wellhead Desanders • Integrated into wellbay • Solids transport, dewatering, bagging and cleaning system • Interim fix for failed completions
Operation	• 3300-6700 BPD • 1.5-12 MMSCFD, • WHFP 1200 psig at 40°C • ΔP = 30-50 psi, D_{98}=16-25 micron • >1000 BOPD increase per well • 1-2 tons/day sand treated



Slide 21

Malaysia: Murphy Oil



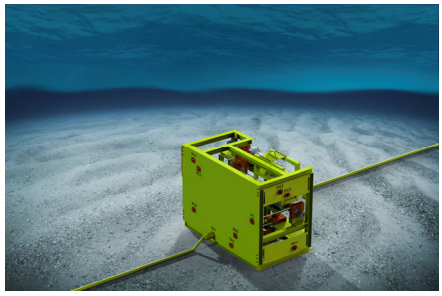
Slide 22

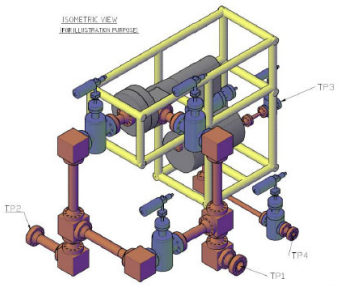
Subsea Wellhead Desander

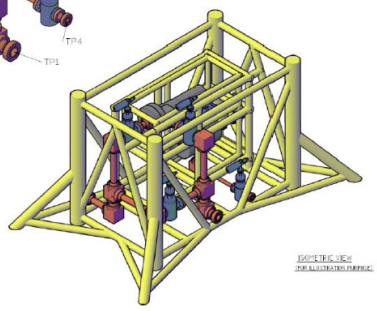
Process:
- Gas-condensate well
- 120 MMSCFD, 2000 BPD
- 25 psid, 12 micron D98

Vessels:
- FEA with DNV Certification
- API 6A/17D
- 5K, PSL 3, P+X, F22

System:
- Four tie-in points (TP)
- 8" inlet/outlet, 2" flush, 4" sand
- Bypass piping
- Automated operation
- Sand discharge or container







Slide 23

Multiphase Desander Key Items

- All oil & gas wells produced sand
- Facilities Sand Management part of flow assurance
- Separation of sand at the wellhead can restore or increase hydrocarbon production
- Sand removed at the wellhead is easy to transport and handle
- Multiphase desander operates at 0-100% GVF
- Single insert design most appropriate for multiphase flow
- Mechanical design to API 15K

Slide 24

Technical Paper References

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4. Rawlins, C.H., "Sand Management Methodologies for Sustained Facilities Operations", Oil & Gas Facilities, Vol. 2, No. 5, October 2013, pp. 27-34.
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Slide 25

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