

Primary funding is provided by

**The SPE Foundation through member donations
and a contribution from Offshore Europe**

The Society is grateful to those companies that allow their
professionals to serve as lecturers

Additional support provided by AIME



Society of Petroleum Engineers
Distinguished Lecturer Program
www.spe.org/dl



Enhanced Production Through Surface Facilities Sand Management

Dr. Hank Rawlins
Technical Director



Society of Petroleum Engineers
Distinguished Lecturer Program
www.spe.org/dl

Road Map

Sand Management Options Facilities Sand Management Five-Steps of Sand Management

1. Separation
2. Collection
3. Cleaning
4. Dewatering
5. Transport

The One Slide to Stay Awake For
Tech Paper References...



**The Latest in
Facility Technology**
An SPE GCS Technology Workshop

FACILITIES SAND MANAGEMENT:
**"Getting the Beach
Out of Production"**

Can you afford to shut down a deepwater well due to solids? Learn about the latest technology, equipment and design options for facilities sand management.

Wednesday, April 10th, 2002
Wyndham Greenspoint Hotel
Houston, TX

**What are your options? Hear
about the latest approaches.**

Society of Petroleum Engineers

For more information visit the SPE Gulf Coast Section website
www.spegcs.org

Training Module Outline

Two-Day SPE Course



Module	Title
FSM-M1	Introduction to Facilities Sand Management
FSM-M2	The Nature of Solids
FSM-M3	Solids Handling
FSM-M4	Liquid Desander
FSM-M5	Multiphase Desander
FSM-M6	Wellhead Screen-Filters
FSM-M7	Separator Solids Removal and Cyclonic Jetting
FSM-M8	Sand Cleaning
FSM-M9	Solids Dewatering, Transport, and Disposal
FSM-M10	Subsea Sand Management
FSM-M11	Heavy Oil Sand Management

Solids Production

All oil & gas wells produce sand.

- Now or at some point in future
- Especially with water breakthrough
- Small or large amounts and sizes



Deepwater South China Sea



North Sea Danish Sector



Onshore Egypt

Know what comes out of your well.

What are Produced Solids?



Inorganic, Insoluble Particulate Material

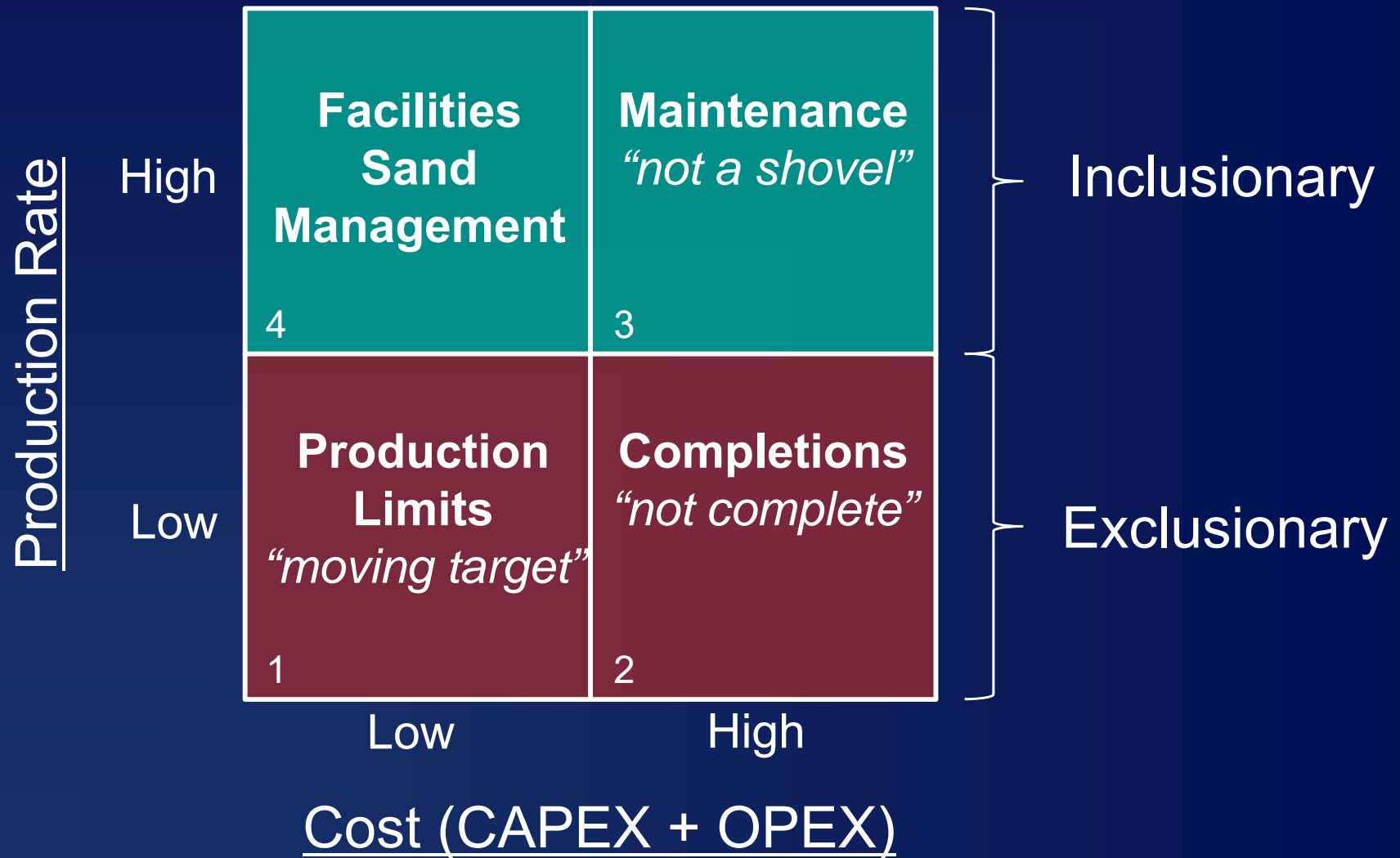
- Not asphaltene, paraffin, wax, hydrate, or resin (organic)
- Not precipitates (soluble) or scale (non-particulate)
- Natural solids: from reservoir material
- Artificial solids: corrosion debris, proppant, junk, etc.

Primarily “sand” by classification

- ISO/Wentworth “sand” from 63-2000 microns
- Practical separation limit is 10 microns

Solid particles separable in facilities equipment

Sand Management Options



Don't minimize production.

Facilities Sand Management



<u>Facilities:</u>	Surface/subsea equipment for separation and energy addition
<u>Sand:</u>	Tiny loose pieces of rock
<u>Management:</u>	Handle with a <i>degree of skill</i>

Not a waste stream exercise...
... but a critical Flow Assurance issue

Effects on Facilities

Erosion

- High velocity zones
- Chokes, pipe, valves, deoilers, etc.

Collection/Filling

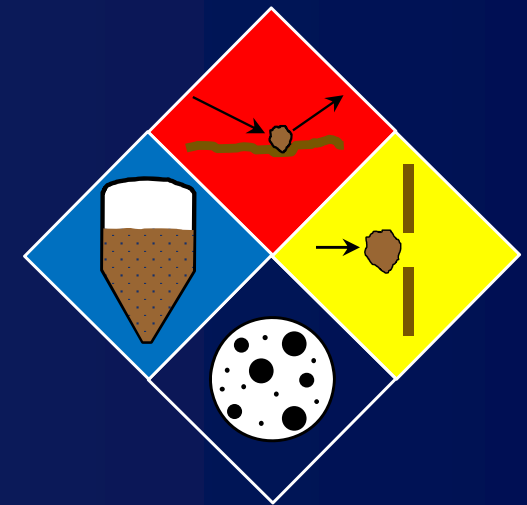
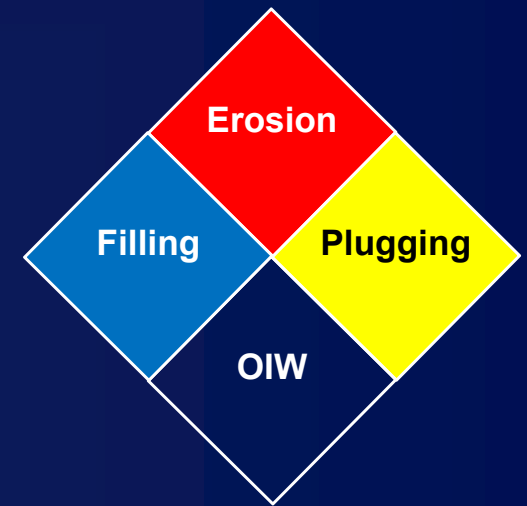
- Low velocity zones
- Vessels, tanks, separators, float cells, etc.
- Creates corrosion zones where solids collect

Interference

- Instruments plugged, valve range of motion, seals, swivels, any small orifices or gaps

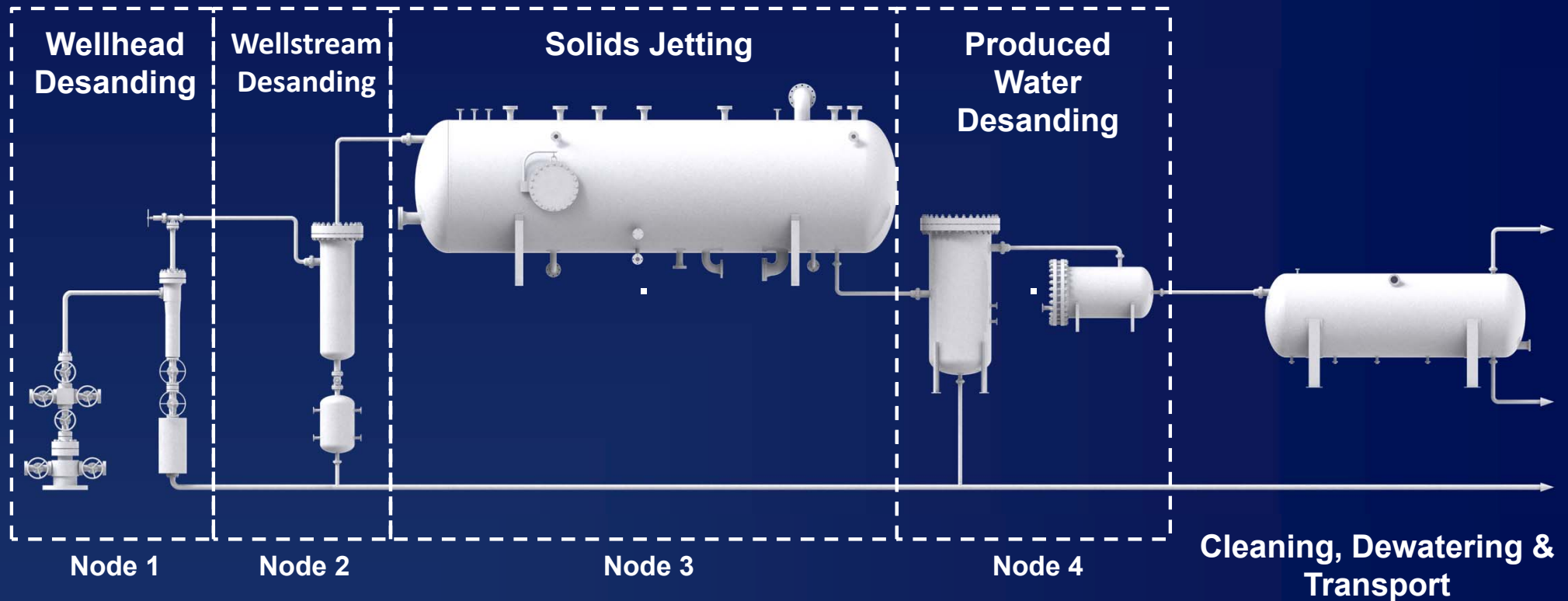
Oil-in-Water (OIW) Content

- Increases OIW concentration
- Stabilizes emulsions



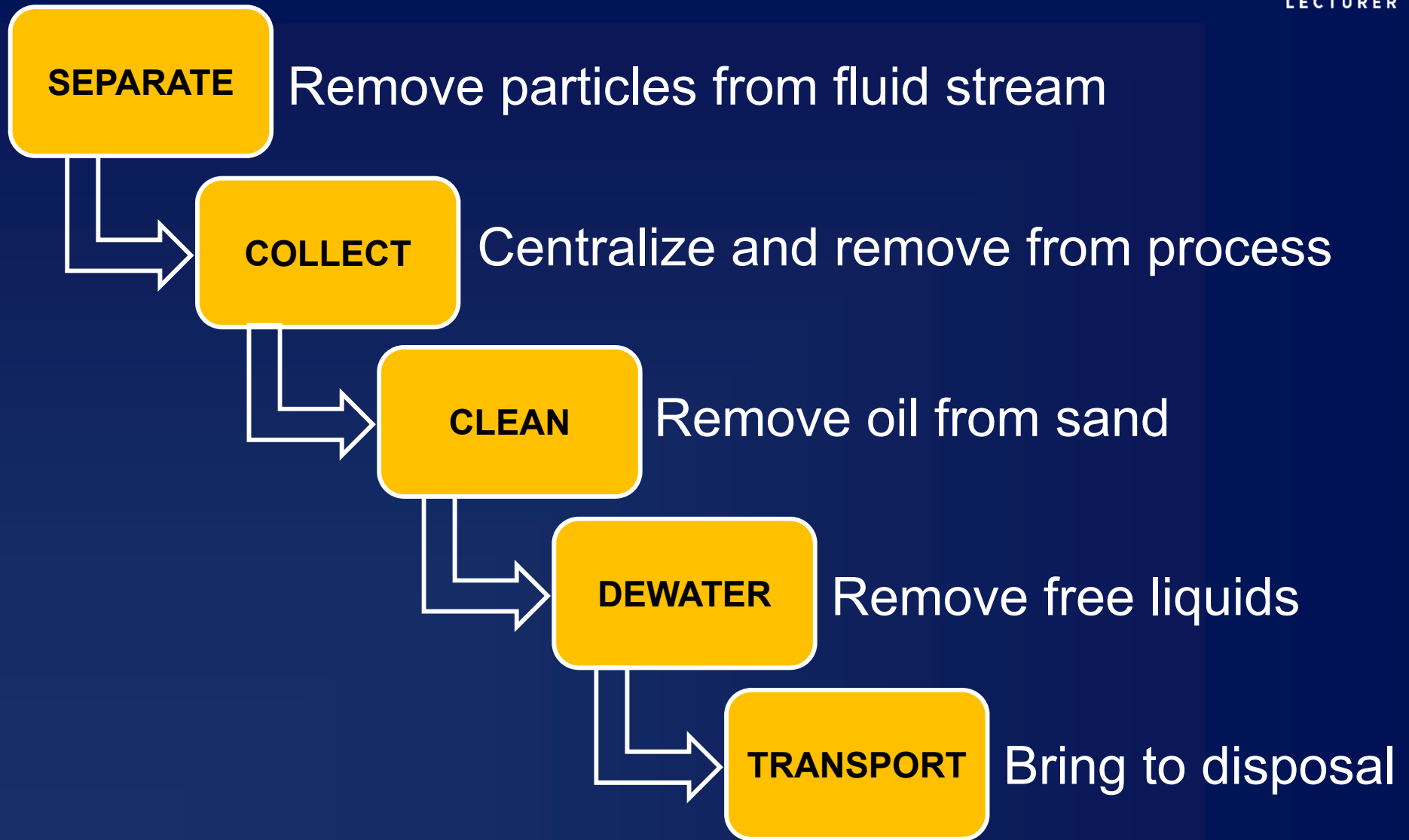
Define what problem sand causes.

Where to Remove Sand?



Solve the right problem.

Five-Steps of Sand Management



Follow all the steps.

Step 1: Separate



Remove particles from fluid stream

- Dilute, dispersed particles in fluid (oil + water + gas)
- Solids must be separable
- Continuous flow process

Enhanced Separation

- Cyclonic: Multiphase (Wellhead) or Produced Water Desander
- Impact w/ Retention: Filters or Screens
- Flotation: Attached to oil droplets

Low Velocity Zones

- Bottom of production separator

Sand separation equipment is the smallest...

- ...compared to oil-water-gas separation

Focus on the methodology – not a piece of equipment.

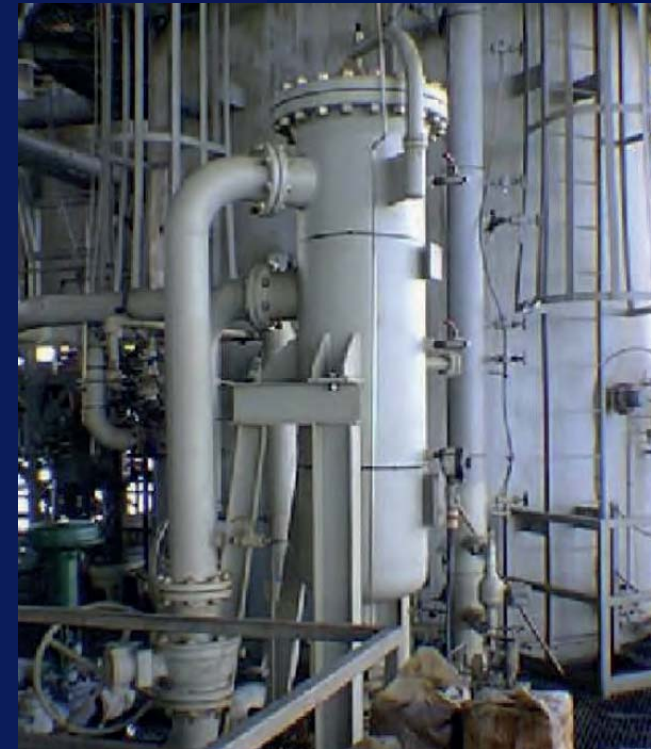
Unit Process: Separation



Sand Filter
API 10K
Australia 2013



Wellhead Desander
API 5K
Malaysia 2012



PW Desander
ASME 150#
US GoM 1999

Step 2: Collect



Gather separated solids to central location

- Isolate from pressure and flow
- Minimize letdown points
- Remove from process without interrupting production

Minimize volume of fluids with solids

- Desander accumulator minimizes hydrocarbon ingress
- Jetting systems: large amounts of process fluids

Any vessel/tank - isolated, vented, and flushed

- Batch process
- Fill with clean water to aid cleaning and prevent packing/plugging

Unit Process: Collection



Wellhead Desander Acc.
ASME 1500#, 600 liter
Malaysia 2011



Wellstream Desander Acc.
ASME 900#, 108 liter
Turkmenistan 2011



PW Desander Acc. (integral)
ASME 150#, 65 liter
(Graphic)

Step 3: Clean



Remove adsorbed oil from surface of particle

- Not H₂S, pyrophoric material, heavy metals, or NORM

Clean to meet offshore discharge

- <1 weight% oil-on-dry solids (OSPAR spec)
- Offshore cleaning systems use batch cyclone-recirculation loop
- Specialized systems use chemicals, heat, and/or biological agents

Integrate cleaning action in all areas

- Separation, collection, and transport
- May eliminate need for specific cleaning station

Cleaned sand is easier to dewater and transport

Unit Process: Cleaning



Attrition Scrubbing System
Floating Barge
Venezuela 1997



Attrition Scrubbing System
Deepwater Spar
Malaysia 2014



Attrition Scrubbing System
Fixed Platform
Malaysia 2015

Step 4: Dewater



Removing free liquids associated with sand

- Minimizes disposal volume
- Up to 90% reduction in volume

Open (non-hazardous) dewatering

- Liquids to open drain, sand/vapors open to atmosphere
- Hanging dewatering bag

Closed (hazardous) dewatering

- Liquids captured to closed drain, vapors captured to vent system, and solids not exposed to atmosphere or personnel
- Screen-lined bin

Dewatering bag/bin also transport device

- Combined step with transport

Unit Process: Dewatering



Two-Stage System (Open)
Desilter & Dewatering Bag
Malaysia 2011



Enclosure System (Open)
Dewatering Bin
Austria 2006



DNV Transport (Closed)
Dewatering Bin
Saudi Arabia 2013

Step 5: Transport

Disposal site determines route & method

Overboard discharge:

- Transported by pipe as a slurry to caisson

Landfill disposal:

- Transported in dewatering bag or bin to landfill

Slurry injection:

- Transported by pipe as a slurry to injection pump

Unique methods:

- Add sand to road surface mix
- Add sand to existing drill cuttings disposal
- Grind smaller size prior to injection disposal
- Bioremediation

Know where to put the sand.

Unit Process: Transport



Slurry Injection Disposal
Sand from PW System
Australia 2007



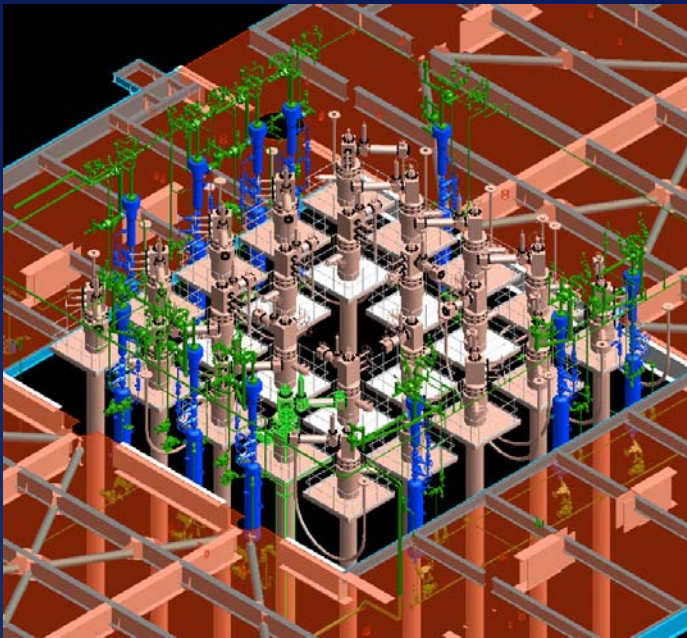
Dewatering Bag to Skip Transport
Wellhead Desander System
Malaysia 2011



Dewatering Bin Transport
Sand Jetting System
Malaysia 2015

Putting it all Together (OTC-24705)

Collapsed Expandable Screens Completion and FSM Approach



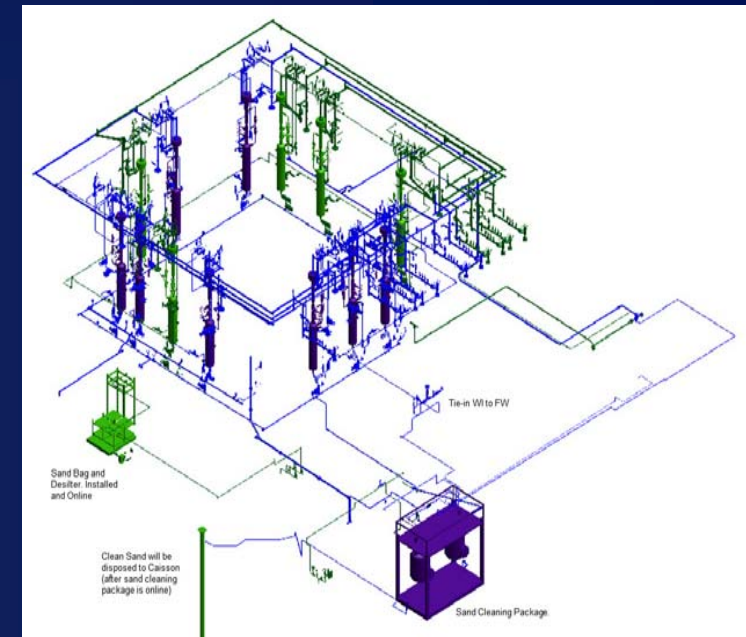
10 Wellhead Desanders
Retrofit into Well bay of Spar
Three-year Re-completion Work

Separation



Wellhead Desander, 1500#
Solids D98 = 16 micron
600 liter Accumulator

Collection



Piping header from Accumulators
Transport Slurry to Dewatering
Or to Cleaning Station

Continued (OTC-24705)

Cleaning



Recirculation Scrubbing
Design: 32 tons/day
<1 wt. % oil on sand

Dewatering



Four-Place Layout
Desilter – Bulk Removal
Dewater Bag – Final Removal

Transport



Piping header from Accumulators
Transport Slurry to Dewatering
Or to Cleaning Station

START HERE

Do You
Know Sand
Production?

NO

- Sample Flow Stream
- Physical Analysis

YES

Remove
Sand
upstream of
choke?

NO

Remove
Sand before
separator?

NO

Remove
Sand in
separator?

NO

Remove
Sand from
Produced
Water?

NO

Use
Other
Means

YES

Wellhead
Desander

YES

Wellstream
Desander

YES

Cyclonic
Jetting

YES

Produced
Water
Desander

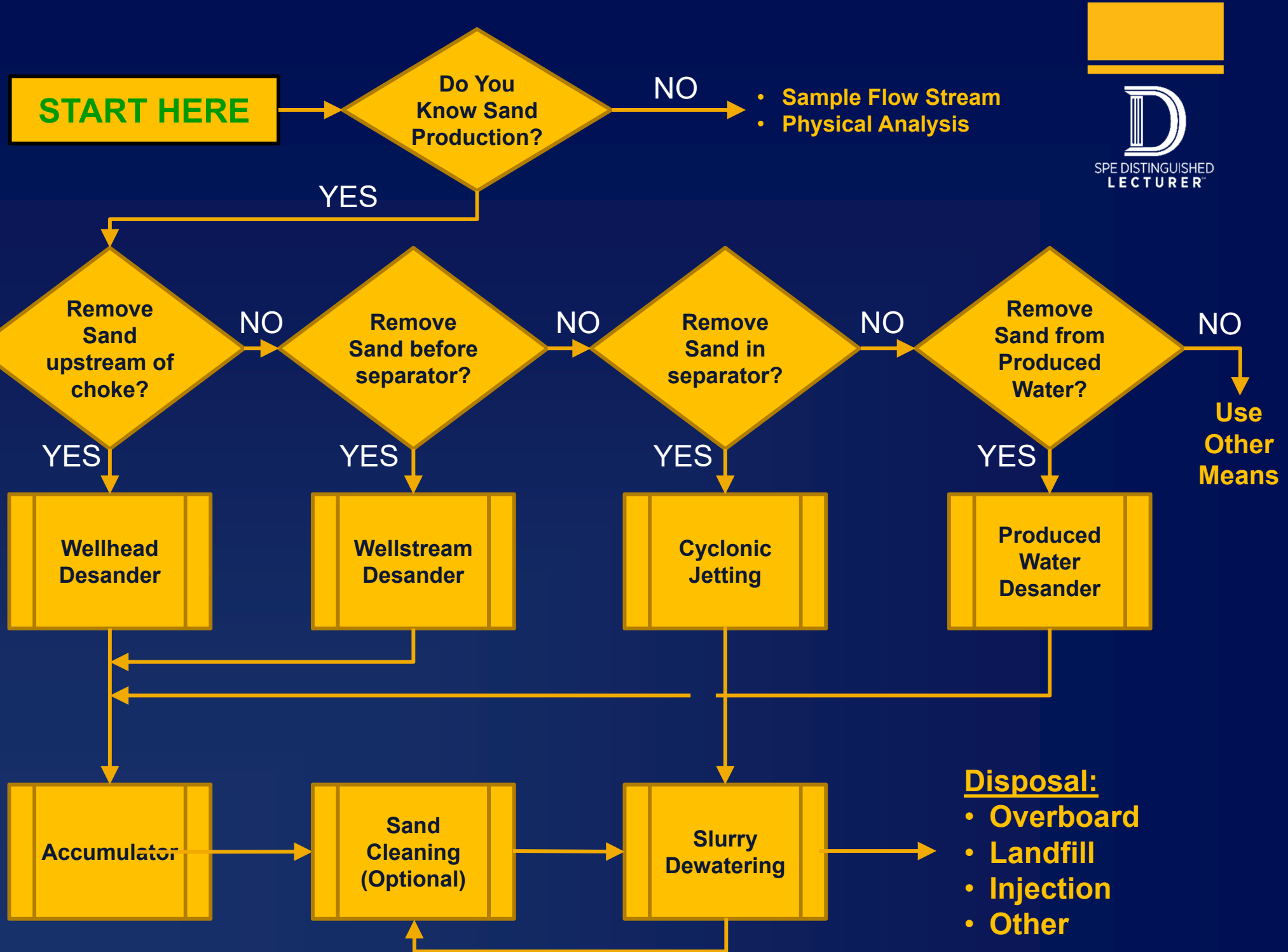
Accumulator

Sand
Cleaning
(Optional)

Slurry
Dewatering

Disposal:

- Overboard
- Landfill
- Injection
- Other



The One Slide to Stay Awake For

All oil and gas wells produce sand.

1. Know what comes out of your well.
2. Don't minimize production.
3. Define what problem sand causes.
4. Solve the right problem.
5. Follow all the steps.
6. Focus on the methodology – not a piece of equipment.
7. Know where to put the sand!

Facilities Sand Management into initial system

- Add taps and blinds (and space) for future equipment
- Add place for sand to go – don't choke system
- Ensure parts can have material upgrade in future
- Spares management can be a philosophy but not the best

Technical Paper References...

(OnePetro papers in yellow)



1. SPE-27797: "Fluid Production Enhancement by Exploiting Sand Production"
2. SPE-63235: "How Can Sand Production Yield a Several-Fold Increase in Productivity: Experimental and Field Data"
3. SPE-28815: "The Separation of Solids and Liquids With Hydrocyclone-Based Technology for Water Treatment and Crude Processing"
4. SPE-185658: "Separating Solids First – Design and Operation of the Multiphase Desander"
5. Priestman et al., Trans IChemE: "The Design and Operation of Oil-Gas Production Separator Desanding Systems"
6. Lohne, Trans IChemE: "Separation of Solids From Produced Water Using Hydrocyclone Technology"
7. SPE-166118: "Design of a Cyclonic Solids Jetting Device and Slurry Transport System for Production Systems"
8. SPE-72999: "Design and Installation of a Sand Separation and Handling System for a Gulf of Mexico Oil Production Facility"
9. OTC-24705: "Upgrade of Spar Topsides with Comprehensive Facilities Sand Management System"
10. SPE-56812: "Generalization of API RP 14E for Erosive Service in Multiphase Production"
11. SPE-66577: "E&P Waste Management in the Orinoco Delta"
12. Jones et al., IPEC: "Discharge Practices and Standards for Offshore Operations around the World"

Where to get more info?

Connect on LinkedIn 

- Publish a FSM article each week on Tuesday (60+ so far)
- Material taken directly from FSM training course

Check out company website (www.eprocess-tech.com)

Get articles from OnePetro (www.onepetro.org)

Email me (hrawlins@eprocess-tech.com)

Take Facilities Sand Management two-day training course

Your Feedback is Important

Enter your section in the DL Evaluation Contest by
completing the evaluation form for this presentation

Visit [SPE.org/dl](https://www.spe.org/dl)

#SPEDL



Society of Petroleum Engineers
Distinguished Lecturer Program
www.spe.org/dl

