



Enhanced Production Through Surface Facilities Sand Management

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



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From the 2018-2019 DL Year

Hank Rawlins

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Metallurgical Engineer (PhD, P.E.)

27 years experience

- Facilities Sand Management
- Produced Water Treatment
- Compact Separation Systems

Former Chair of SPE Separations Technical Section (STTS)

Fifty-Seven Published Articles

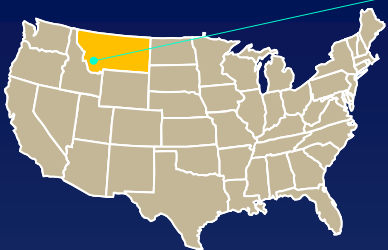
Adjunct at Montana Tech University (Butte, MT)

Luxuriant Facial Hair Club for Scientists (2016)



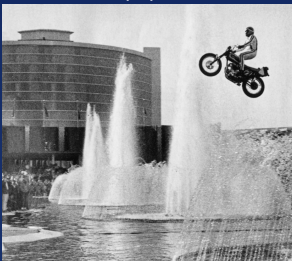
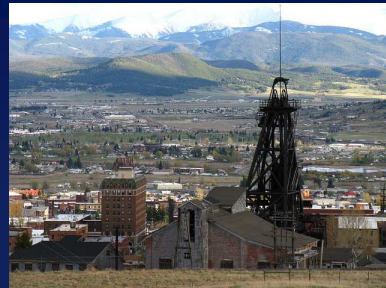
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Greetings from Butte, MT, USA



Pop: 33,503
Elev.: 1688 m
Weather:
• Jan: -40°C
• Jul: +30°C

Montana: 380,800 km² (147,164 mi²)
1.03 million pop.



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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...



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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

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Solids Production



All oil & gas wells produce sand.

- Now or at some point in future
- Especially with water breakthrough or completion failure
- Wide range of concentration and particle size



Deepwater South China Sea



North Sea Danish Sector



Onshore Egypt

Know what comes out of your well.

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What are Produced Solids?



Inorganic, Insoluble Particulate Material

- Not asphaltene, paraffin, wax, hydrate, or resin
- Not precipitates (soluble) or scale (non-particulate)
- Natural solids: 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

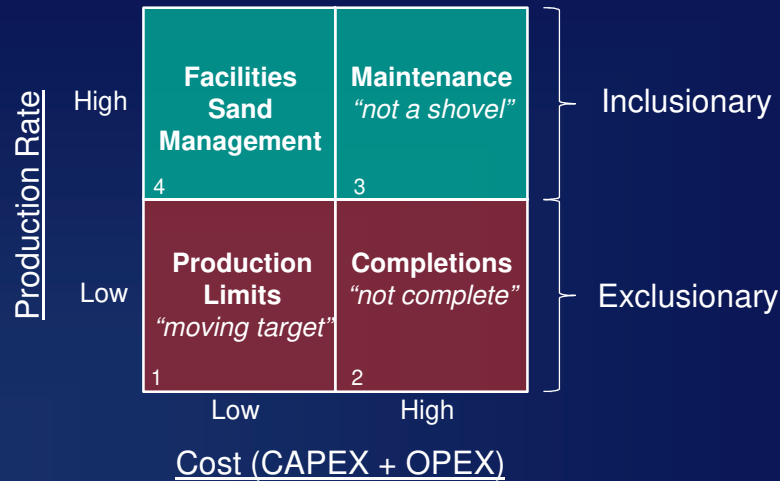
ISO/Wentworth Handout

MICRONS	U.S. MESH	TYLER MESH	3/8	9.525		
8000		2 1/2	5/16	8.000	GRAVEL	Coarse
6730		3	0.265	6.730		
2613		3 1/2	0.221	5.613		
4800	4	4	0.185	4.800		
4000	5	5	0.157	4.000		
3400	6	6	0.131	3.400	Fine	SAND
2840	7	7	0.110	2.840		
2400	8	8	0.093	2.400		
2000	10	9	0.075	2.000		
1700	12	10	0.065	1.700		
1420	14	12	0.055	1.420	Coarse	SAND
1200	16	14	0.046	1.200		
1000	18	16	0.039	1.000		
850	20	20	0.033	0.850		
710	25	24	0.0278	0.710		
600	30	28	0.0236	0.600	Medium	SAND
500	35	32	0.0197	0.500		
425	40	35	0.0165	0.425		
355	45	42	0.0139	0.355		
300	50	48	0.0117	0.300		
250	60	60	0.0098	0.250	Fine	SAND
212	70	65	0.0083	0.212		
180	80	80	0.0069	0.180		
150	100	100	0.0058	0.150		
125	120	115	0.0049	0.125		
106	140	150	0.0041	0.106	Coarse	SILT
90	170	170	0.0035	0.090		
75	200	200	0.0029	0.075		
63	230	250	0.0025	0.063		
53	270	270	0.0021	0.053		
45	325	325	0.0017	0.045	Fine	SILT
37	400	400	0.0014	0.037		
32	450	450	0.00126	0.032		
25	500	500	0.00098	0.025		
20	635	635	0.000729	0.020		

“Solid particles that are separable in facilities equipment”

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Sand Management Options



Don't minimize production.

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Facilities Sand Management



Facilities: Surface/subsea equipment for separation and energy addition (wellhead to custody transfer)

Sand: Tiny loose pieces of rock

Management: Handle with a *degree of skill*

Not a waste stream exercise...

... but a critical facilities Flow Assurance issue

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Effects on Facilities

Erosion

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

Collection/Filling

- Low velocity zones
- Vessels, tanks, separators, float cells, etc.

Interference

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

Oil-in-Water (OIW) Content

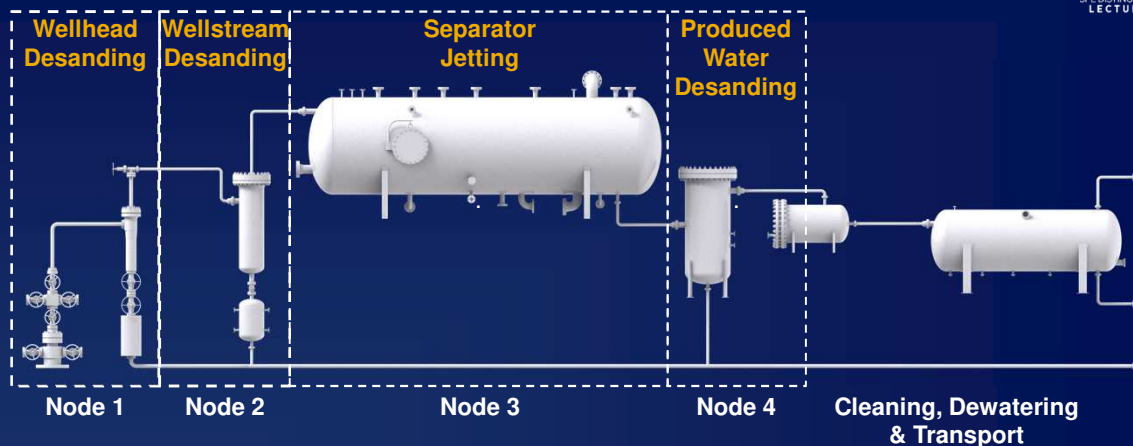
- Increases OIW concentration
- Stabilizes emulsions



Define what problem sand causes.

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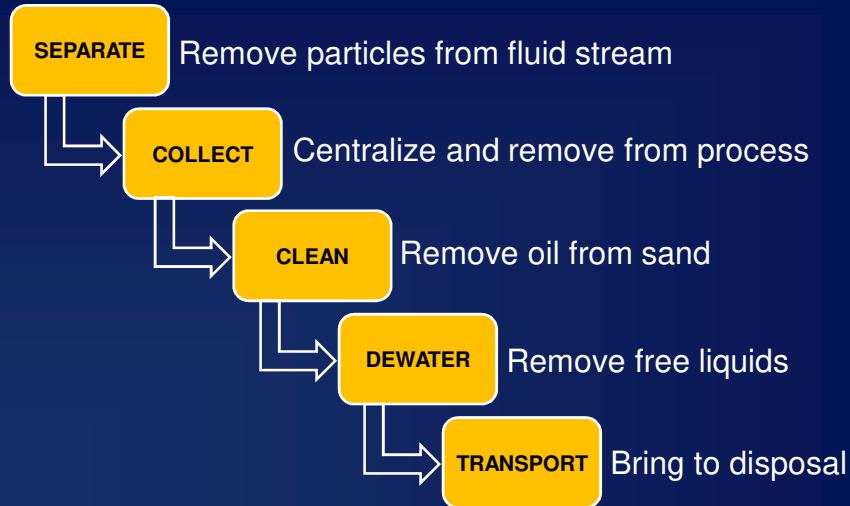
Where to Remove Solids?



Solve the right problem.

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Five-Steps of Sand Management



Follow all the steps.

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Step 1: Separate



Remove particles from fluid stream

- Dilute, dispersed particles
- Solids must be separable
- Continuous flow process

Enhanced Separation

- Cyclonic: Multiphase or Liquid 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.

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Unit Process: Separation



Sand Filter
API 10K
Australia 2013



Wellhead Desander
API 5K
Malaysia 2012



PW Desander
ASME 150#
US GoM 1999

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Step 2: Collect



Gather separated solids to central location

- Isolate from pressure and flow
- Minimize letdown points
- Remove 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

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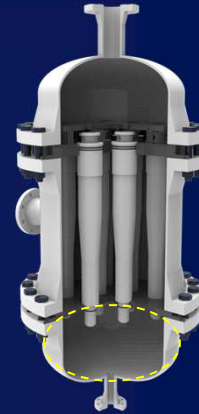
Unit Process: Collection



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)

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Step 3: Clean



Remove adsorbed oil from surface of particle

- Not H₂S, heavy metals, or NORM

Clean to meet offshore discharge

- <1 weight% oil-on-dry solids
- Batch cyclone-recirculation loop
- Other: chemicals or heat

Integrate cleaning action in all areas

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

Cleaned sand is easier to dewater and transport

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Unit Process: Cleaning



Attrition Scrubbing System
Floating Barge
Venezuela 1997



Attrition Scrubbing System
Deepwater Spar
Malaysia 2014



Attrition Scrubbing System
Fixed Platform
Malaysia 2015

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Step 4: Dewater



Removing free liquids associated with sand

- Minimize disposal volume
- Up to 90% volume reduction

Open (non-hazardous) dewatering

- Liquids to open drain, open to atmosphere
- Hanging dewatering bag

Closed (hazardous) dewatering

- Liquids to closed drain, vapors to vent, and solids not exposed
- Screen-lined bin

Dewatering bag/bin also transport device

- Combined step with transport

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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

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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.

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Unit Process: Transport



Slurry Injection Disposal
Sand from PW System
Australia 2007



Dewatering Bag to Skip Transport
Wellhead Desander System
Malaysia 2011



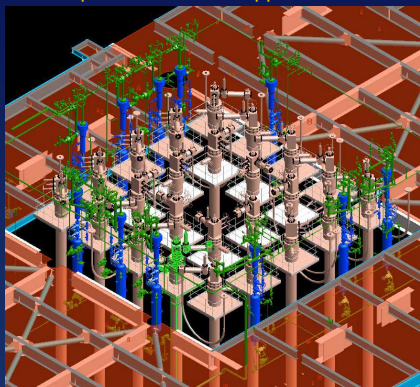
Dewatering Bin Transport
Sand Jetting System
Malaysia 2015

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OTC-24705: PUTTING IT ALL TOGETHER



Failed Expandable Screens
Re-completion and FSM Approach



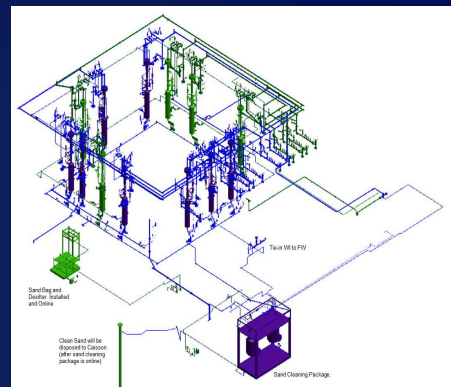
10 Wellhead Desanders
Retrofit into Well bay of Spar
Three-year Re-completion Work

Separation



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

Collection



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

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Continued (OTC-24705)



Cleaning



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

Dewatering



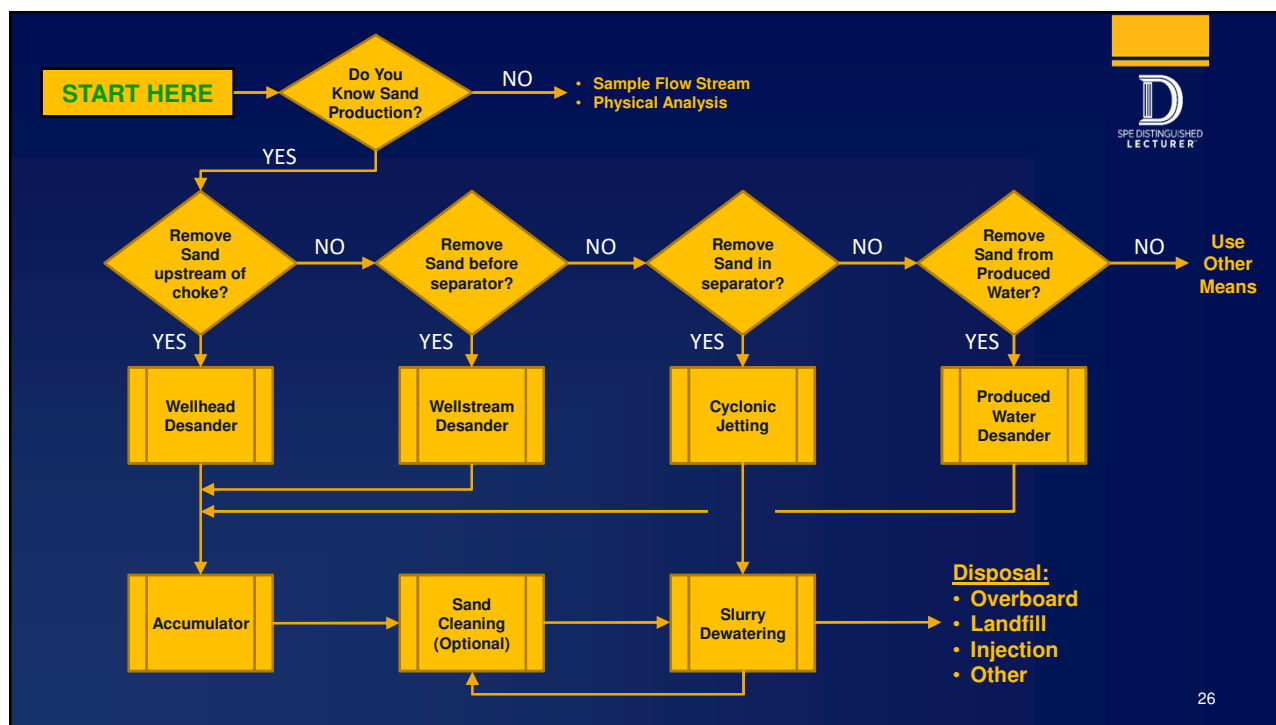
Four-Place Layout
Desilter – Bulk Removal
Dewater Bag – Final Removal

Transport



Piping Header from Accumulators
Transport Slurry to Dewatering
or to Cleaning Station

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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

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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"

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Where to get more info?

Connect on LinkedIn 

- Publish weekly FSM article (97 so far)
- Material taken from FSM training course

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

Get articles from OnePetro (www.onepetro.org)

Take Facilities Sand Management two-day training course

- Working to put on-line in 2020



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Questions?



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