ProSep

Field Data From Oil in Water Polishing of Produced Water for Discharge and Reinjection with Osorb® Media

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2014

- Osorb® Media Introduction
  - How Osorb ® media works
  - What Osorb ® media can capture
- Regeneration
  - Methods for reuse of Osorb ® media
- Case Studies
- Summary

Osorb® Media Introduction

Osorb® Media Properties

OSORB® MEDIA

- Organically-modified silica
- Porous, flexible matrix
- Hydrophobic
- Adsorption & absorption
- Regenerable & reusable

Removal of free, dispersed, emulsified, and soluble hydrocarbons and some oilfield chemicals from water

Osorb® Media Usage

TREATMENT OF:

- Produced water (PW)
- Flowback & completion returns
- Pipeline fluids
- Chemical EOR fluids

OTHER APPLICATIONS:

- Membrane fouling protection
- Hydrocarbon Dew Point Reduction (HDPR)
- Gas emissions control

Final polishing for overboard discharge and reinjection

SMALL SCALE TRIAL TESTING:

- Low flow feasibility testing & performance evaluations
- In situ regeneration evaluations

3” Diameter Column

6” Diameter Column

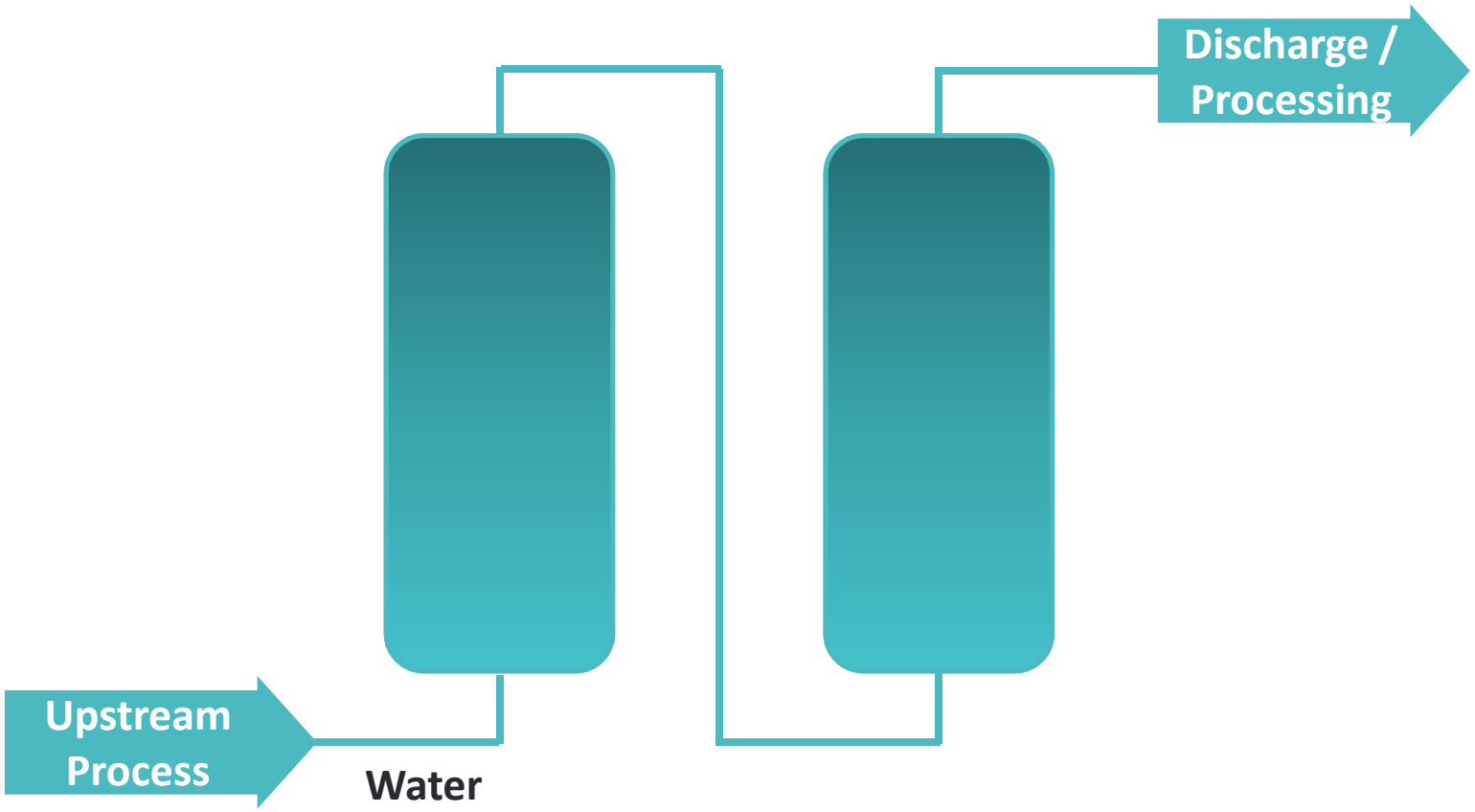
6” Acrylic Column

Designed to: DNV 2.7-1, ASME Section VIII Div. 1 / PD 5500, CE Mark

Installed & Commissioned Offshore Netherlands – 11th April 2014

1.9 m x 1.6 m x 2.8 m

Lead-Lag Treatment



Regeneration

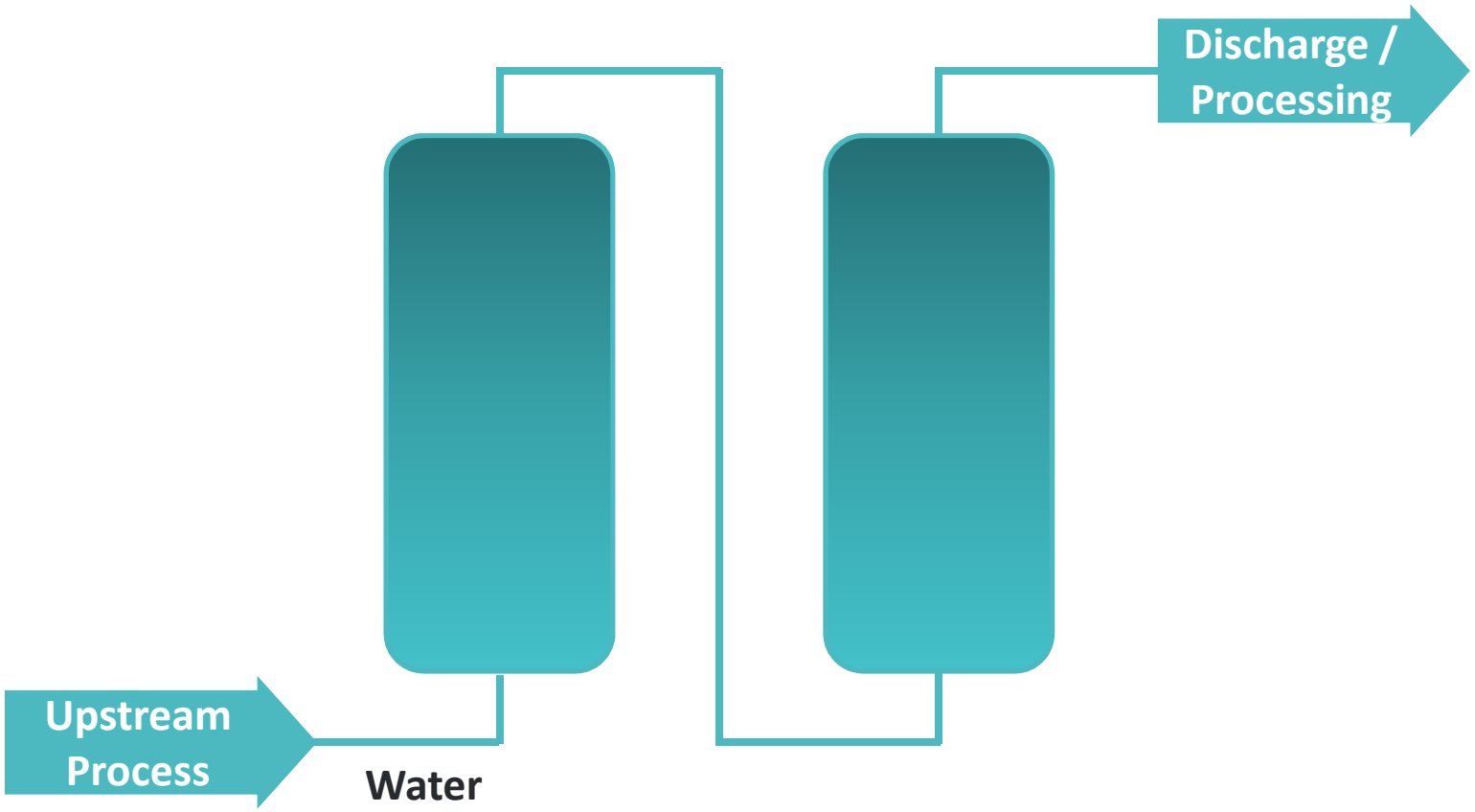
Lower Molecular Weight Sorbates

- Temperature swing adsorption process to volatilize sorbates from Osorb® media

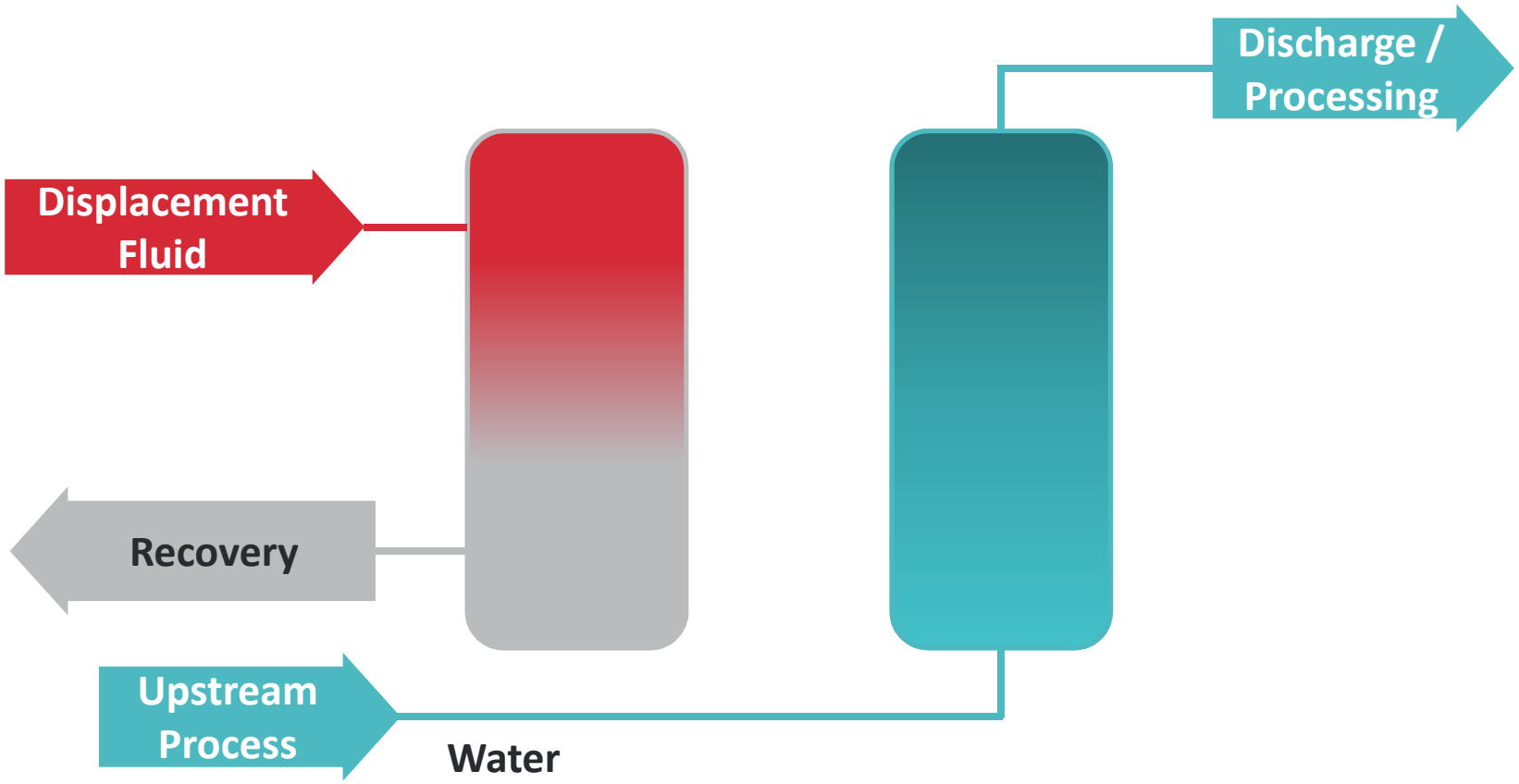
Higher Molecular Weight Sorbates

- Tailored displacement fluid purge to displace sorbates
- Temperature swing adsorption process to volatilize displacement fluid from Osorb® media

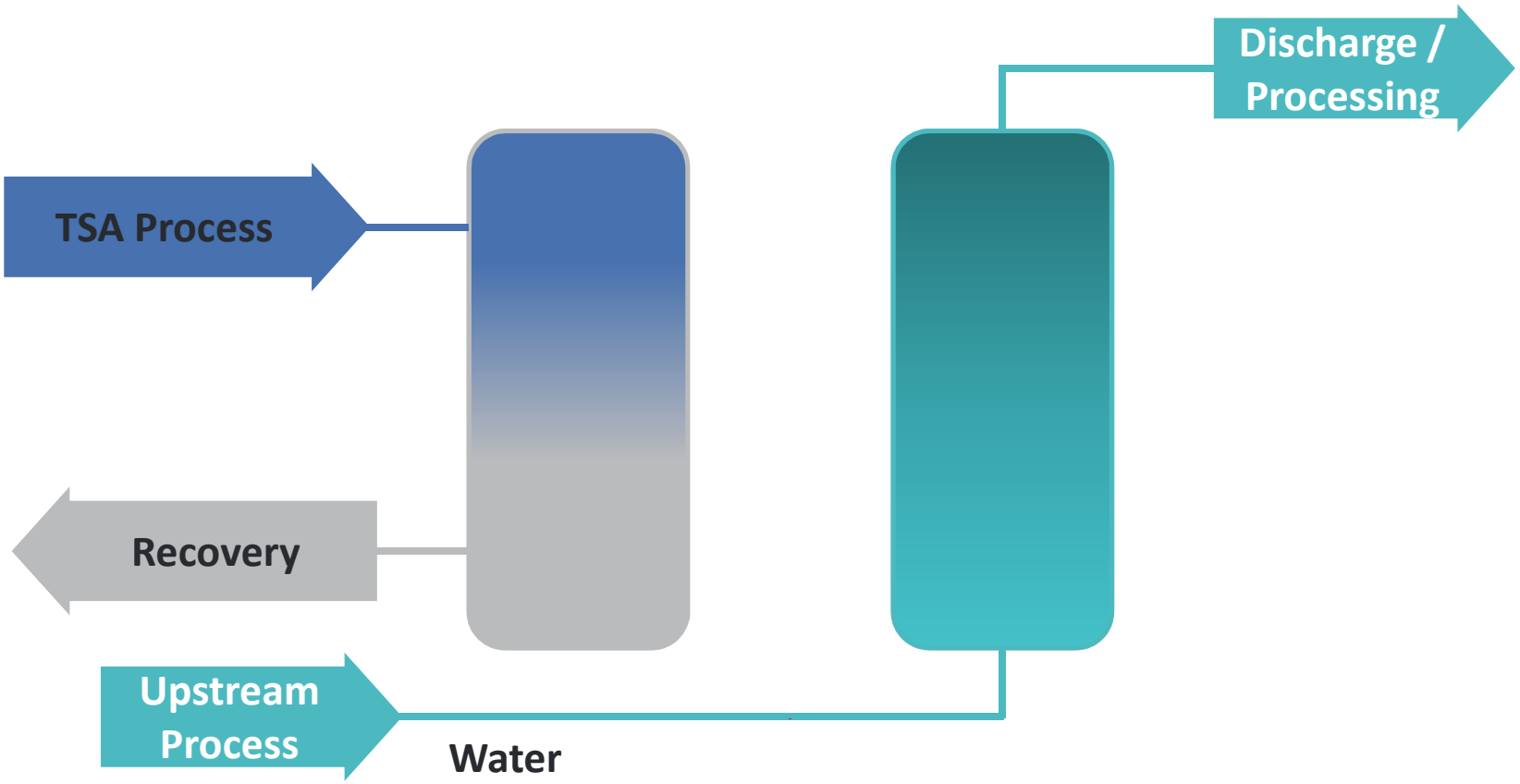
Lead-Lag Treatment & Regeneration



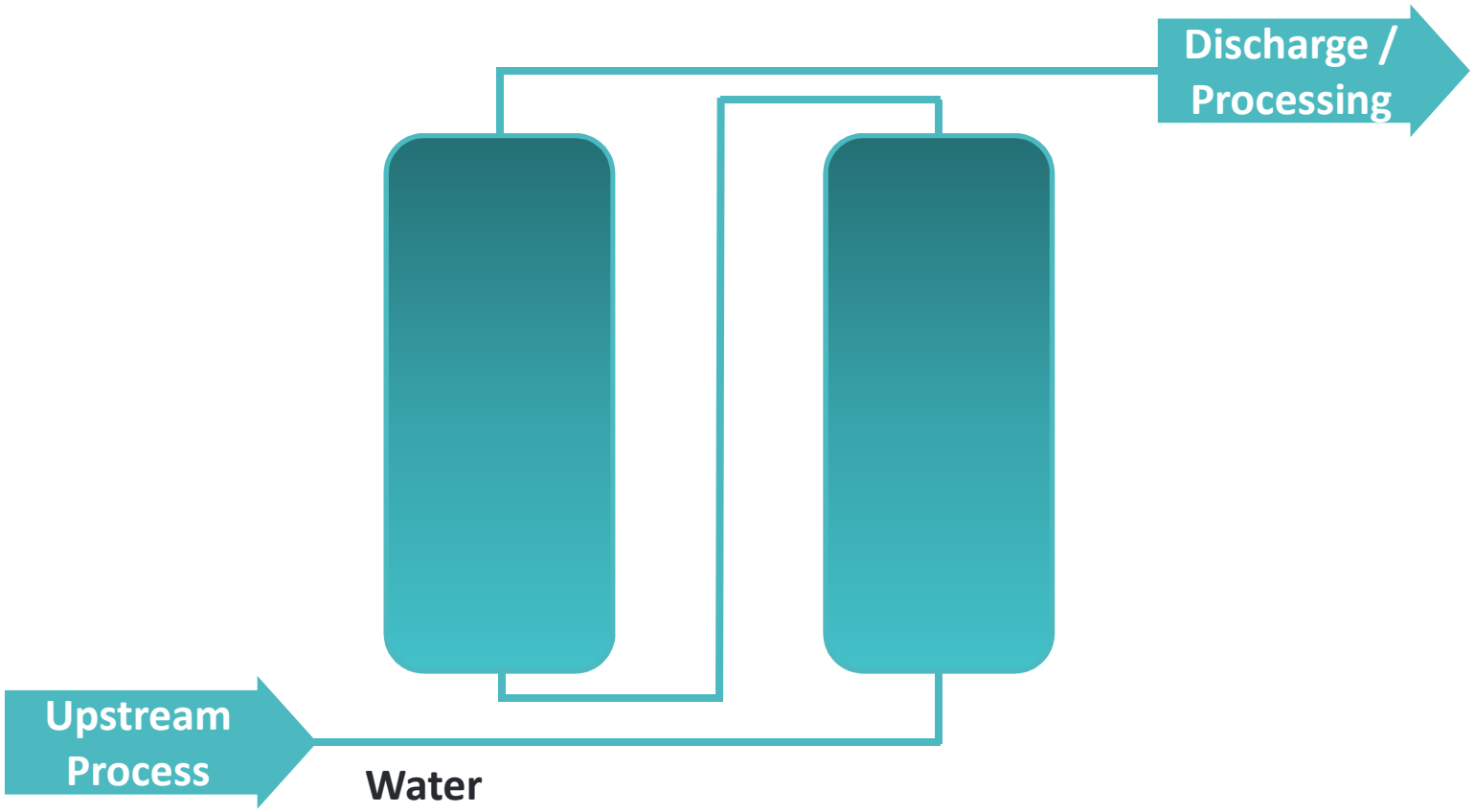
Lead-Lag Treatment & Regeneration



Lead-Lag Treatment & Regeneration



Lead-Lag Treatment & Regeneration



Field Regeneration – HDPR

Sorbate in Osorb® Media	RT (min)	BP (°C)	ppm in DCM		% Regenerated
			Before Regeneration	After Regeneration	
benzene	2.63	80	26	0	100
heptane	2.98	98	429	0	100
methylcyclohexane	3.35	101	734	0	100
toluene	4.17	111	338	0	100
octane	4.96	126	730	0	100
ethylcyclohexane	5.95	131	325	0	100
p-xylene	6.92	138	510	0	100
m-xylene	7.49	139	171	0	100
nonane	7.65	151	706	0	100
propylcyclohexane	8.31	155	274	0	100

Regeneration of Osorb® media with TSA process results in **pure condensate value stream.**

Kuwait – Osorb® Media Regeneration

1. Tailored displacement fluid
2. TSA Process
   - Thermal Input

Case Studies

Kuwait
6” Test Column

- Onshore treatment for reinjection
- 18-20 API Oil
- 43-52°C
- > 120% w/w oil Osorb® Media loading

Sample Time	Total Treatment Time	Inlet Oil & Grease (mg/L)	Outlet Oil & Grease (mg/L)	Flow Rate (GPM)	Inlet Pressure (PSI)	Outlet Pressure (PSI)
10-Oct						
8:05	0	--	--	0.5	128	127
8:25	20	63,020	--	0.5	129	128
8:55	50	927	<1	0.5	129	128
9:25	80	1,855	--	0.5	129	128
9:55	110	1,565	31	0.6	129	128
10:25	140	5,927	13	0.5	129	127
10:55	170	1,740	--	0.5	129	127
10:55	170	94	--	0.65	129	127
11:25	200	533	--	0.5	128	126
11:55	230	32,746	11	0.5	129	126
24-Oct						
8:15	230	--	--	0.5	129	128
8:45	260	72	3	0.5	128.5	127
9:45	320	110	<1	0.7	133	131
10:45	380	127	<1	0.7	132	130
10:46	381	--	--	1.5	130	127.5
11:45	440	78	2	1.4	131	129
12:45	500	69	<1	1.4	131	128
13:45	560	72	<1	1.4	129	124
14:15	590	--	--	1.6	132	128

Kuwait – Post Regeneration Treatment Performance

Osorb® Media regeneration

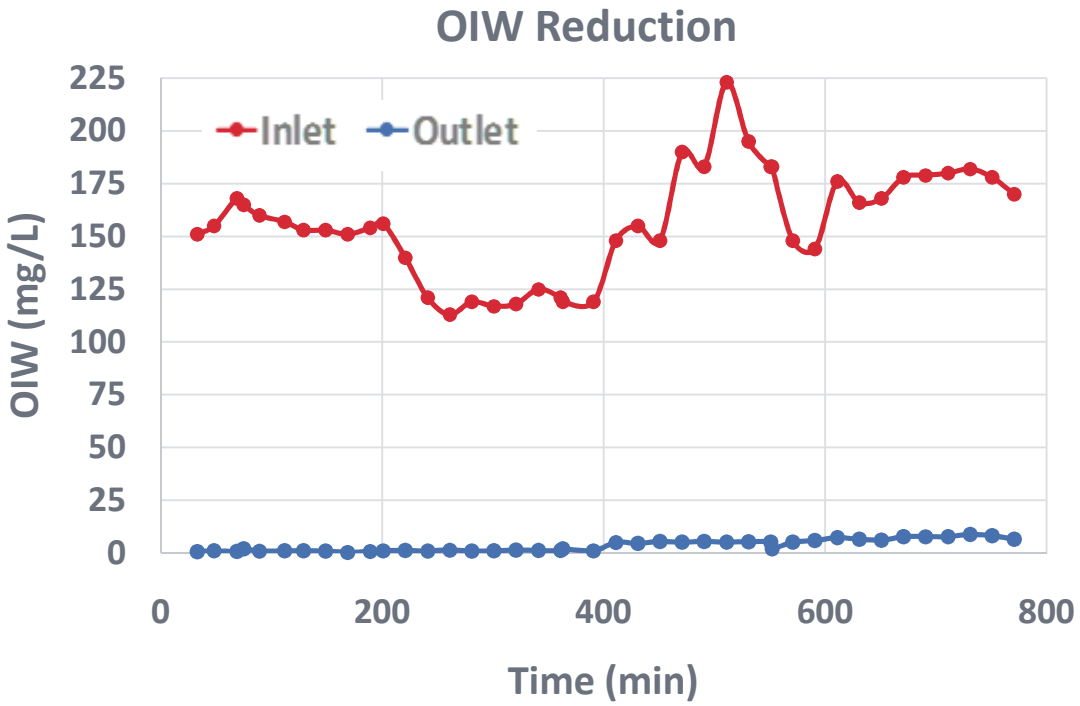
1. Tailored displacement fluid
2. TSA Process
   - Thermal input

18-20 API oil

Sample Time	Total Treatment Time	Inlet Oil & Grease (mg/L)	Outlet Oil & Grease (mg/L)	Flow Rate (GPM)	Inlet Pressure (PSI)	Outlet Pressure (PSI)
29-Oct						
09:00	0			0.5	129.5	128.5
09:15	15	--	--	0.5	128.5	128.5
09:30	30	7	<1	0.5	126.5	125.5
09:45	45	10	--	0.5	129	127.5
10:00	60	4	<1	0.5	129	127.7

North America
6” Test Column

- Offshore treatment for discharge
- Management of offshore excursions
- 10-18 API Oil
- High asphaletene concentrations
- 79°C



Treatment of PW from Gas Deliquification

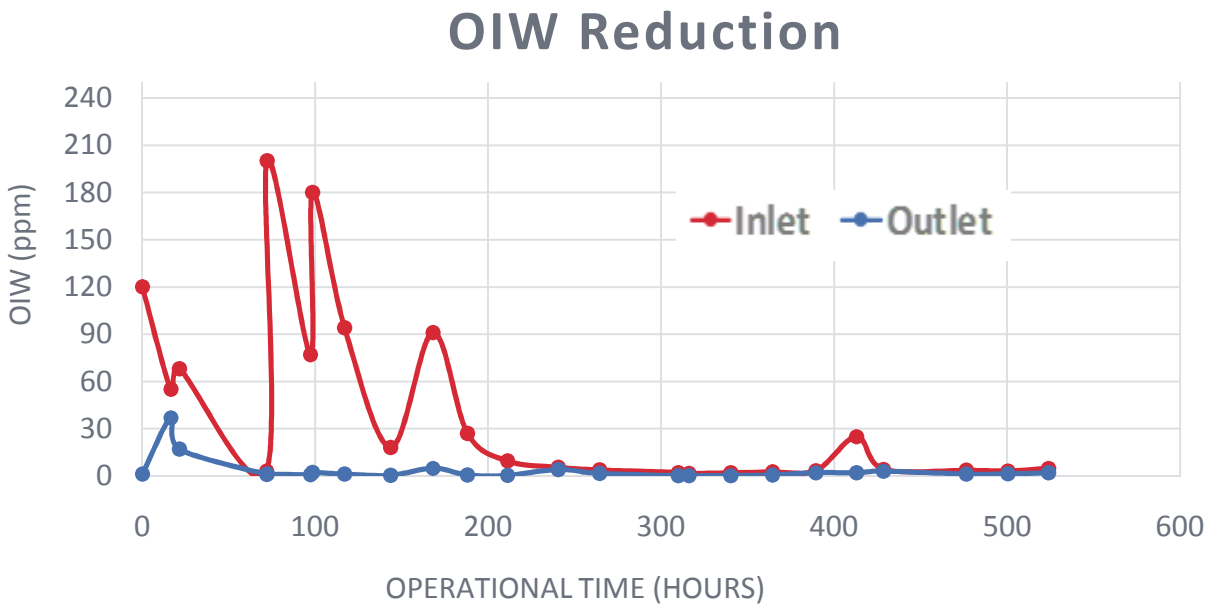
Offshore North Sea Jar Testing

- Q3 2013

Company	Platform #	Untreated (OIW ppm)	Treated (OIW ppm)	Foamer Added – Treated (OIW ppm)
Operator 1	1	210	5.1	-
	2	14000	1	21
Operator 2	4	2000	17	-
	5	42	0.34	3.6
Operator 3	6	1900	1.3	-

Offshore North Sea 6” Test Column

- Q4 2013
- Offshore treatment for overboard discharge



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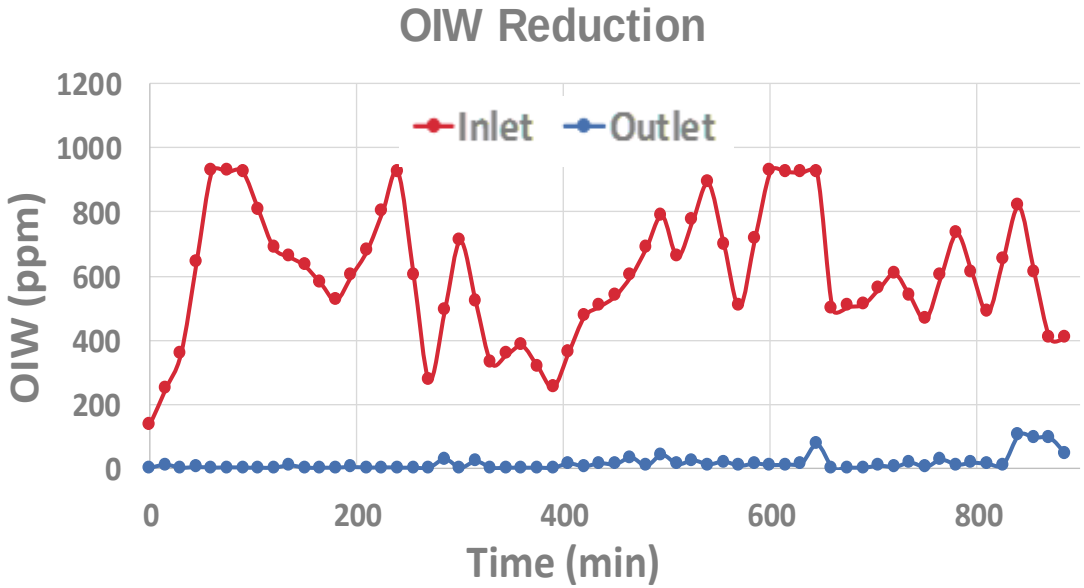
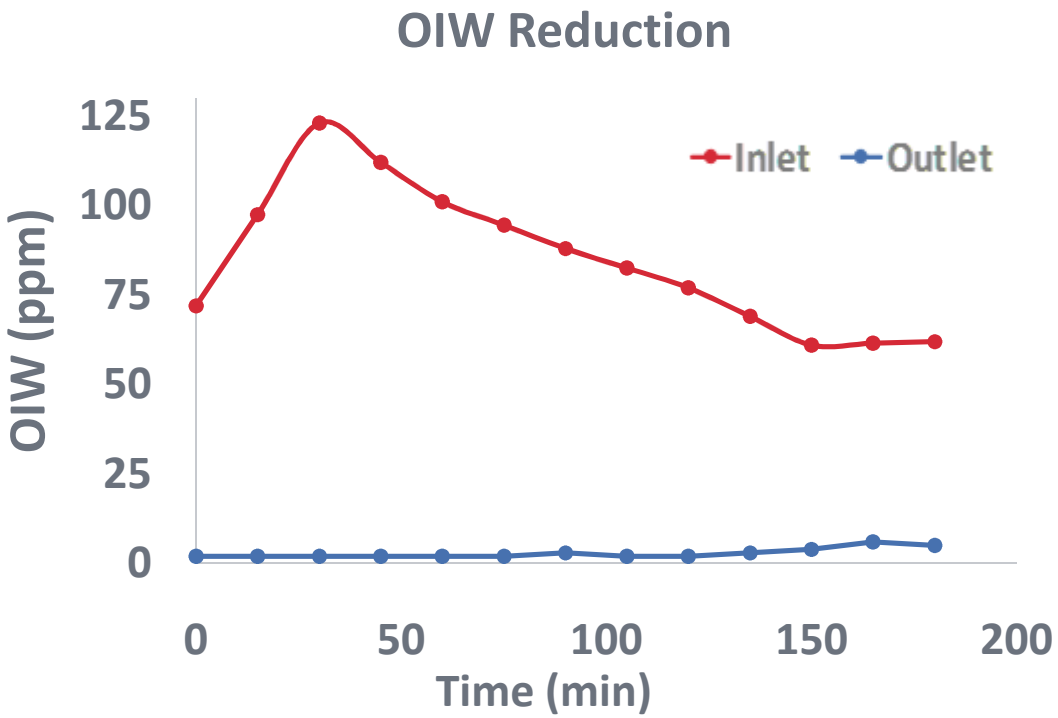
Far East
6” Test Column

- Q2 2013
- Offshore treatment for overboard discharge
- Avg. **98.7%** OIW Removal
  - Avg. Influent = **604 ppm**
  - Avg. Effluent = **7.4 ppm**
- API 44 Oil



Far East
6” Test Column

- Q1 2013
- Onshore treatment for discharge of offshore produced water
- Avg. **96.6%** OIW Removal
  - Avg. Influent = **85 ppm**
  - Avg. Effluent = **2.9 ppm**
- API 39.4 Oil, 1% TDS, pH 7



Middle East
6" Test Column

- Removal of BTEX from downstream process water
- TSA process performed on Osorb® Media

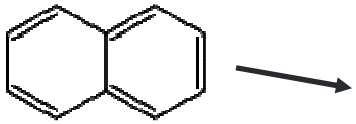
Time (hr)	Total BTEX (ppb)	
	Inlet	Outlet
0	241	<1
2	1104	71
5	1121	7
9	1626	94
21	(visual free oil)	6
Post Regeneration	(visual free oil)	13

Parameter (ppb)	Treatment Duration (hours)									
	0		2		5		9		21	
	In	Out	In	Out	In	Out	In	Out	In	Out
Benzene	120	<1	873	47	773	<1	1,316	78	<1	<1
Toluene	7	<1	89	11	267	7	154	14	12	6
Ethyl-Benzene	56	<1	74	3	26	<1	66	<1	<1	<1
Xylene	58	<1	68	10	55	<1	90	2	1	<1

Treatment of Downstream Process Water – Case 2

Middle East
6” Test Column

- Polyaromatic Hydrocarbons (PAH)
- 97°C
- Regenerated media
- **4681.3 ppb to 275.3 ppb Total PAH**



Naphthalene

Constituent	Inlet (ppb)	Outlet (ppb)
Acenapthene	42.7	< 1.0
Acenapthylene	725	5.3
Anthracene	19.5	< 1.0
Benzo(a)anthracene	3.1	< 1.0
Benzo(a)pyrene	0.9	< 1.0
Benzo(b)fluoranthene	< 1.0	< 1.0
Benzo(b)perylene	< 1.0	< 1.0
Benzo(k)fluoranthene	< 1.0	< 1.0
Chrysene	1.8	< 1.0
Dibenzo(a,h)anthracene	< 1.0	< 1.0
Fluoranthene	7.1	< 1.0
Fluorene	133	< 1.0
Indeno(1,2,3-dc)pyrene	<1.0	< 1.0
Napthalene	3630	270.0
Phenanthrene	106	< 1.0
Pyrene	12.2	< 1.0

- Osorb® media is a polishing technology
  - Free & dispersed
  - Emulsified
  - Soluble hydrocarbons
  - Oilfield chemicals
- Osorb ® media has demonstrated the ability
  - Remove low API oils to high API oils
  - Soluble organic
  - Oilfield chemicals
  - Large upset conditions to fine polishing
- The media can be regenerated for reuse

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Thank You!