

# PRODUCED WATER PORTFOLIO

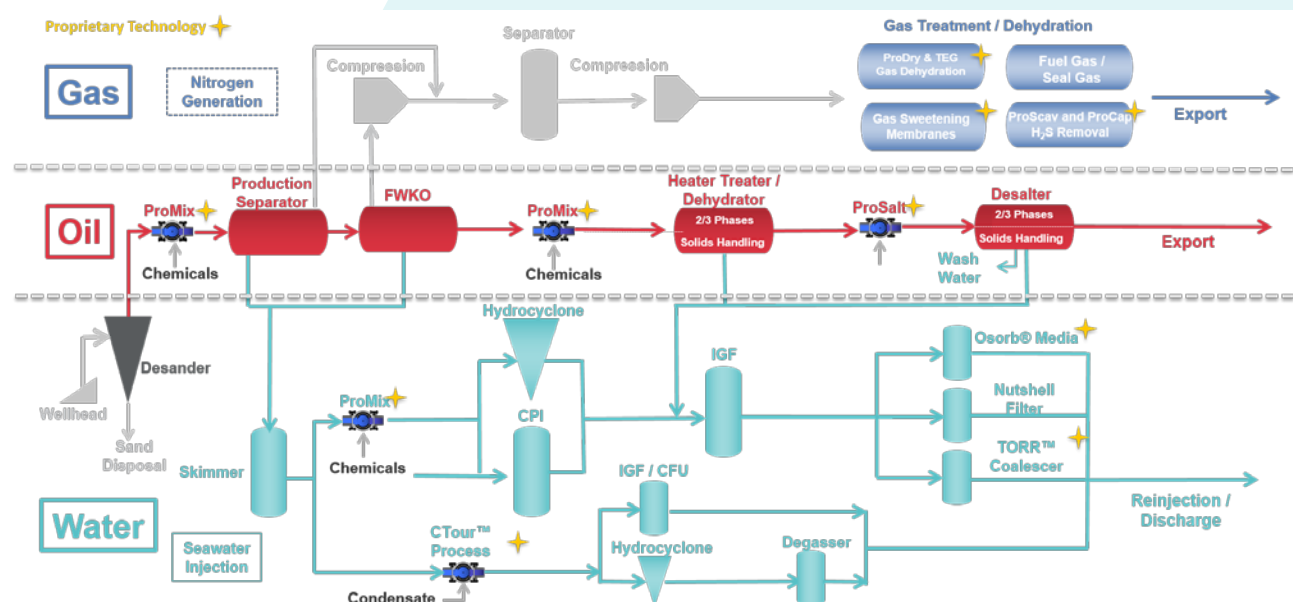
The most comprehensive full lifecycle produced water treatment technologies available including proprietary tertiary and 'polishing' technologies

Hydrocyclone & IGF  
Produced Water  
Package



# WHO WE ARE

Integrated process separation technology solutions provider for oil, gas and produced water streams to the global oil and gas industry



ProSep has a wide range of capabilities including crude dehydration and desalting, gas treatment and dehydration as well as a full lifecycle produced water treatment offering. ProSep Energy Services provides a diverse range of rental skids designed for the temporary treatment of a wide variety produced water streams.

ProSep is headquartered in Houston, TX, USA which is also the location of our state of the art laboratory and manufacturing/fabrication facility. ProSep has regional offices in Aberdeen, UK, Abu Dhabi, UAE and Kuala Lumpur, Malaysia.

## WHY PROSEP

- Global presence with over 200 projects delivered worldwide. On average we have delivered a new project every 15 days since 2005.
- Well-documented global reputation, and track record for performance, value and safety.
- Flexible & dynamic team, offering custom solutions to customers.
- Comprehensive solutions across oil, gas and produced water streams.
- Innovative proprietary technologies proven to reduce OPEX & CAPEX.

## WHAT WE DO

Our patented portfolio of onshore and offshore solutions for the treatment of oil, gas, and produced water offer innovative technologies packaged with global project management and execution expertise.

ProSep provides technologies & solutions for:

- PRIMARY SEPARATION
- CHEMICAL INJECTION
- THIRD PARTY MANUFACTURING
- RENTAL/LEASE OPTIONS
- GAS DEHYDRATION
- CO<sub>2</sub> SWEETENING
- H<sub>2</sub>S SCAVENGING
- FUEL GAS CONDITIONING
- HCDP REDUCTION
- DEMULSIFIER OPTIMIZATION
- DECREASED WASH WATER CONSUMPTION
- DEHYDRATION & DESALTING
- CRUDE BLENDING
- PRODUCED WATER TREATMENT
- OIL IN WATER POLISHING
- OIL COALESCENCE
- SEAWATER TREATMENT

# PRIMARY & SECONDARY TREATMENT

## CPI & VERTICAL SKIMMERS

Available for onshore and offshore applications, these ProSep units are designed for normal operating conditions, as well as handle production surges and upsets, while still delivering results as low as 50-150 mg/l OIW concentration.



### AVAILABLE DESIGNS

- + Pressurized or atmospheric design
- + Liquid packed pressure vessel
- + Code or non code vessels
- + Poly or SS plate packs
- + Stand-alone vessel or turnkey package

#### CPI

ProSep's CPI provide the same removal efficiency as a traditional gravity separator, but in a much smaller footprint. This makes it ideal for offshore platforms and FPSO's as well as land based installations.

ProSep's CPI is designed to enhance oil coalescence, and separation, by decreasing the distance the oil droplets must

travel to be removed from the continuous water phase.

ProSep's CPI units are available in different plate pack spacing arrangements and effective areas to accommodate different applications and flow rates, they are often utilized in offshore applications for rainwater runoff and open drain fluids treatment.

For floating applications with low pressure profiles, ProSep can design a CPI as a liquid packed pressure vessel, mitigating the problems that traditional atmospheric CPI units have with wave motion.

#### VERTICAL SKIMMER

ProSep's Vertical Skimmer can serve as a substitute for a CPI when footprint size is critical, particularly for offshore

applications.

#### DIFFERENCES

While the vertical skimmer is typically larger than a CPI, its upright design allows for the smaller footprint area and space saving.

ProSep's vertical skimmer units can be fitted with coalescing packs to enhance OIW removal.

HIGH OIW  
& SOLIDS  
REMOVAL  
EFFICIENCY

LOW CAPEX &  
OPEX

DESIGNS  
REDUCE IMPACT  
OF OFFSHORE  
MOTION

ADAPTABLE  
DESIGN



# IGF

Offering vertical and horizontal, mechanical and hydraulic, single and multiple cell designs, ProSep's induced gas flotation units can meet nearly any process requirement, onshore or offshore, upstream or downstream.



## AVAILABLE DESIGNS

- + Pressurized or atmospheric design
- + Liquid packed pressure vessel
- + Code or non-code vessels
- + Poly or SS plate packs
- + Stand-alone vessel or turnkey package

### IGF

IGF units are ideal for secondary treatment of produced water in upstream oilfield locations, as well as waste waters in refineries and petrochemical plants.

### VARIATIONS

ProSep's IGF units are available as either a vertical single cell or horizontal multi cell, and as hydraulic and mechanical units. The horizontal multi-

cell systems typically have increased separation efficiency when handling large upsets, and high flow rates, while the vertical single cell systems provide efficient removal with minimal footprint impact.

### HOW IT WORKS

The hydraulic IGF process uses a venturi-type eductor utilizing pressurized effluent water as the motive fluid passing through the eductor, creating a vacuum on the gas suction

port, and inducing gas into the recycle water stream.

The mechanical IGF process utilizes a rotor/stator/disperser mechanism to create a vortex which draws fluids up from the bottom and gas down from the free board of the cell.

HIGH OIW  
& SOLIDS  
REMOVAL  
EFFICIENCY

LOW CAPEX &  
OPEX

LOW  
INSTALLATION  
COSTS

DESIGNS  
REDUCE IMPACT  
OF OFFSHORE  
MOTION

# HYDROCYCLONES

ProSep designs and engineers liquid/liquid hydrocyclone separation systems, whether for primary free oil separation, secondary produced water treatment, or in conjunction with our patented CTour™ process. ProSep's experts can provide cost effective solutions to meet your produced water specifications.



## APPLICATION METHODS

### Upstream:

- + Primary bulk oil removal
- + Secondary produced water treatment for re-injection, discharge, or disposal
- + Mechanical separation upstream of flotation units

### Downstream:

- + Wash water processing from de-salting units
- + Reduced footprint replacement for API separators
- + Ethylene quench water treatment

## HYDROCYCLONE

Due to its small footprint and high OIW removal efficiency, this primary and secondary separation solution is used in offshore applications where sufficient process pressure is available.

## HOW IT WORKS

Using the existing process pressure or booster pumps to supply the motive force, hydrocyclones mechanically

separate oil from water via enhanced gravity separation. The tangential inlets create a swirling motion that gradually moves through a reducing section toward the water outlet, or underflow. The fluid travels through this narrowing cone, developing the centrifugal forces needed to effectively separate oil from water.

The denser water moves to the outer walls of the

hydrocyclone and out the underflow discharge. The less dense oil is displaced to the low-pressure core and, by controlling back pressure at the oil outlet, flows towards the overflow oil outlet.

## TREATMENT LEVELS

ProSep's hydrocyclone systems deliver removal efficiencies of 85-95% of oil droplets >12-15 micron, with an effluent quality of between 25-100 mg/l OIW.

REDUCED  
FOOTPRINT

NO MOVING  
PARTS

MINIMAL  
MAINTENANCE

NO ADDITIONAL  
CHEMICALS

# TERTIARY & POLISHING TREATMENT

## DEEP BED NUTSHELL FILTER

ProSep provides high performance Deep Bed Nutshell Filters that remove up to 98% of free & dispersed hydrocarbons, and solid particles greater than 5 microns.



### BENEFITS

- + Reduced backwash frequency due to deep bed design
- + Influent stream used as backwash water stream, thus eliminating storage and pumping
- + Nutshell media is less susceptible to fouling or plugging when compared to other sand or multimedia filters
- + Low maintenance
- + Minimal annual media attrition
- + Efficient backwashing design

### NUTSHELL FILTER

ProSep's Deep Bed Nutshell Filter provides superior filtration performance with a backwash system design that provides optimized media cleaning. The backwash system significantly reduces the need for large quantities of backwash water, air scouring and surfactants.

The Deep Bed Nutshell Filter utilizes the nutshell media particles to form a tortuous path for oil droplets and solid particles to be "strained" from the process stream. Oil droplets and solid particles become trapped in the small crevices between adjacent media particles and are effectively removed from the process stream. If the contaminants are solid

particles, as they become trapped, the filter becomes more efficient until resistance to flow builds creating a pressure drop which initiates the backwash cycle.

### THE MEDIA

The unique blend of both crushed pecan and walnut shells make for an efficient yet particularly hard and durable filtration media.

REDUCED  
BACKWASH  
FREQUENCY  
DUE TO DEEP  
BED DESIGN

ELIMINATION  
OF PUMPING &  
STORAGE DUE  
TO DESIGN

MEDIA IS LESS  
SUSCEPTIBLE  
TO FOULING OR  
PLUGGING

MINIMAL  
ANNUAL MEDIA  
ATTRITION



# CTOUR™ PROCESS

The patented CTour™ process removes both dispersed oil, and water soluble organics through condensate injection into produced water streams.



## CTOUR™ PROCESS

The CTour™ process utilizes the principles of solvent extraction to remove residual hydrocarbons from produced water by injecting condensate into the process stream.

## HOW IT WORKS

During the injection of condensate through ProSep's proprietary inline injection and mixing technology, the residual hydrocarbons coalesce with the condensate

to form larger and less dense droplets. These oil droplets are hydraulically or mechanically separated from the produced water stream by downstream separation equipment, and the hydrocarbons are recovered back into the applicable process stream.

## TREATMENT LEVELS

The CTour process routinely yields residual oil discharges of < 5 ppm total petroleum hydrocarbons (TPH), while at

the same time removing 80-95% of harmful water soluble organics, such as polycyclic aromatic hydrocarbons (PAH) and BTEX (benzene, toluene, ethyl-benzene and xylene) components.

The CTour process is used extensively in Norway, having treated as much as 70% of all Norwegian offshore produced water. This equates to more than 2 million barrels of water per day.

## BENEFITS

- + Simple retrofit for existing systems
- + Low OPEX
- + Robust process, low maintenance
- + Removal of < 5 micron oil droplets
- + Applicable for a wide range of API crudes

## PROCESS PRINCIPLES

- + Solvent extraction process for dissolved and dispersed hydrocarbons
- + Homogenous mixing is achieved with ProSep's proprietary mixer technology
- + Oil & condensate are removed by a standard separator:
  - Hydrocyclone
  - Flotation
  - Axial cyclone
  - Gravity vessel
  - Coalescing filter

REMOVES OIW  
TO BELOW 5  
PPM TPH

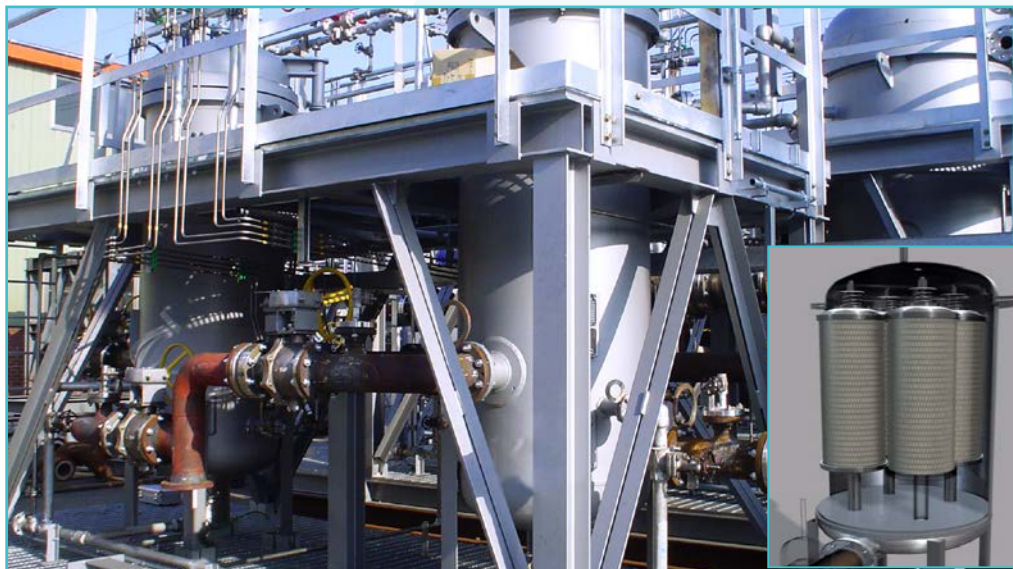
REDUCES  
WATER  
SOLUBLE  
ORGANICS BY  
80-95 %

NO WASTE  
PRODUCTS -  
NO DISPOSAL  
/ TRANSPORT  
COSTS

NO ADDITIONAL  
CHEMICALS  
REQUIRED -  
LOW OPEX

# TORR™

TORR™ hydrocarbon coalescing technology, with its small footprint and ability to replace less efficient oil removal equipment, removes 99.9% of 2 micron and larger oil droplets from produced water streams, and can be easily scaled up to address future water cut increases for operators.



## BENEFITS

- + Minimal pressure drop & maintenance
- + Recovered hydrocarbons can be <0.5% BSW
- + High turndown

## SPECIFICATION

- + Oil Density - API 16 & above
- + Fluid Temperature - Up to 95C
- + Inlet Oil Concentration - Up to 2000 mg/l
- + Oil Droplet Diameters - Down to 2 microns
- + Scalable to any flow rate

### TORR™

The TORR™ coalescing system consists of radial flow coalescing elements housed within a separation vessel to achieve the separation of fine oil droplets from water, while recovering the neat oil.

### HOW IT WORKS

Produced water entering the TORR system is passed through a series of radial flow, coalescing elements. As

the water passes through these elements, residual oil droplets >2 micron in diameter are coalesced into larger oil droplets. The larger diameter oil droplets are then gravity separated in the same separation vessel, rising to the top of the vessel to create a neat oil layer that can be periodically recovered. Any gas accumulating with the oil at the top of the vessel will be safely recovered and both the oil and gas will be returned

to a suitable collection unit.

### TREATMENT LEVELS

Schlumberger announced at OTC 2010 that they have had tremendous success worldwide, using TORR for de-oiling operations in well testing. They noted that the technology was able to reduce 20,000 ppm in the feed, to 20 ppm at the outlet, even with low-API oil.

SMALL  
FOOTPRINT AND  
LOW WEIGHT

INCREASED  
POLISHING FOR  
RE-INJECTION  
APPLICATIONS

SAME HIGH  
DEOILING  
EFFICIENCY  
DURING  
PRODUCTION  
START UP

NO ADDITIONAL  
TREATMENT  
REQUIRED FOR  
RECOVERED OIL



# OSORB® MEDIA

Osorb® Media is a revolutionary, regenerable, adsorbent used for the treatment of oilfield water and gas streams. It adsorbs free, dispersed, and water soluble hydrocarbons, as well as many non-polar oilfield chemicals from water.



## BENEFITS

- + Removal of free, dispersed, emulsified & soluble hydrocarbons
- + Regenerable - minimal loss of efficiency over numerous regeneration cycles
- + Reduced footprint and equipment size
- + Customized application options
- + Minimal consumable and utility requirements

## APPLICATIONS

- + Bulk Media Vessels
- + Canisters
- + Injection into the flowline
- + Low flow technology feasibility testing using 6" axial flow test columns

The technology also removes vapor phase, and micro-droplet hydrocarbons from natural gas streams to improve the value of sales gas.

### HOW IT WORKS

Osorb® Media is both an adsorbent and absorbent, using a unique matrix structure and intermolecular interactions to capture hydrocarbons, and organics without the creation of any permanent chemical bonds. The media has

demonstrated a high affinity for organic compounds like dispersed, and emulsified oils, water-soluble organics, volatile organic compounds (VOCs), and some oilfield chemicals.

### TREATMENT LEVELS

The media maintains treatment performance in the presence of many oilfield chemicals, and in typical temperature/pH environments. Furthermore, it is not affected

by salinity or total dissolved solids (TDS) in water.

### REGENERATION

Regeneration methods depend on the molecular weight of the sorbates. Regeneration methods include heat plus gaseous purge, steam purge, and displacement fluid purge. All adsorbed and absorbed hydrocarbons can be returned back into the process as liquid hydrocarbons to the client's production stream.

REMOVAL OF  
FREE, DISPERSED,  
EMULSIFIED  
& SOLUBLE  
HYDROCARBONS

REGENERABLE  
- MINIMAL LOSS  
OF EFFICIENCY  
OVER  
NUMEROUS  
REGENERATION  
CYCLES

FAST CAPTURE  
MECHANISM  
- MINIMAL  
RESIDENCE TIME  
REQUIREMENTS

REDUCED  
FOOTPRINT AND  
EQUIPMENT SIZE

# SEAWATER INJECTION

ProSep offers customized seawater treatment and injection systems utilizing a broad range of technologies to meet our clients' specifications.



## BENEFITS

- + Compact skidded packages ideal for offshore applications
- + Easy operation and low maintenance requirements
- + Customized designs
- + High removal efficiency of O<sub>2</sub>, solids, sulphates, TDS etc.
- + Customized design and ongoing support throughout the life of the equipment

## CAN BE APPLIED TO:

- + Seawater
- + River
- + Lake
- + Aquifer Water

## SEAWATER INJECTION

Water injection (or water flood) is mainly used for enhanced oil recovery and is accomplished by injecting water into the oil reservoir, usually to increase or maintain reservoir pressure. Current developments in CEOR (chemically enhanced oil recovery) demand even tighter water restrictions.

## TREATMENT LEVELS

ProSep offers complete, customized skid-packaged

solutions for onshore or offshore applications. Typically seawater injection systems include Coarse Strainers (on-line, automatic backwashable style) which remove up to 98% of 80-100 micron solid particles, multimedia backwashable fine filters or fine cartridge filters which provide high-efficiency (98%) removal of particulates greater than 2 microns, and vacuum deaeration designed to achieve 20 ppb dissolved oxygen content without

scavenging chemicals.

In addition, ProSep provides integrated systems with the latest Ultra Filtration (UF) membrane technology that allows for higher quality water effluent than multimedia filters (< 0.1 micron), Reverse Osmosis (RO) membranes to meet TDS specifications, and Sulphate Removal Membranes (SRM).

COMPACT  
SKIDDED  
PACKAGES

EASE OF  
OPERATION  
AND LOW  
MAINTENANCE  
REQUIREMENTS

CUSTOMIZED  
DESIGNS

HIGH REMOVAL  
EFFICIENCY  
OF O<sub>2</sub>, SOLIDS,  
SULPHATES,  
TDS

# PRODUCED WATER REFERENCES

ProSep has delivered over 65 different produced water treatment solutions with 36 different operators and service companies in 7 countries globally since 2005.

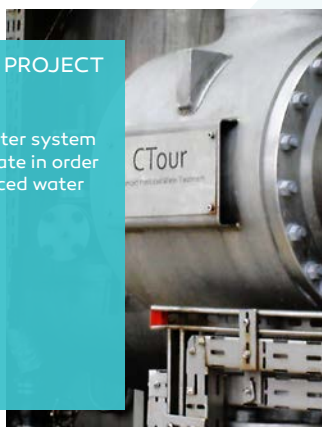
## CTOUR™ PROCESS

### OFFSHORE REDEVELOPMENT PROJECT

LOCATION: NORWEGIAN SEA  
EQUIPMENT: 8" CTOUR produced water system  
APPLICATION: Injection of condensate in order to simplify extraction of oil in produced water  
PERFORMANCE: 35,000 BWPD

PROCESS FLUID  
FLOW RATE: 20083 BPD  
INLET PRESSURE: 14 (barg)

INJECTION FLUID (CONDENSATE):  
FLOW RATE: 396.8 (BPD)  
INLET PRESSURE: 14 (barg)



## TORR™ PACKAGES

FACILITY UPGRADE & RELOCATION OF  
U/G PROCESS PIPING FOR GATHERING  
CENTERS  
LOCATION: MIDDLE EAST  
EQUIPMENT: 7 TORR Skids

APPLICATION: Produced water treatment and  
polishing  
CAPACITY: Total of 260 MBPD

FLOW RATE: 20,000 - 60,000 BWPD  
OIW FEED: 500 - 2000 PPM  
OIW OUTLET SPEC: < 50 PPM  
AVG OIW OUPUT: < 25 PPM



## INDUCED GAS FLOTATION

### FPSO INSTALLATION

LOCATION: GULF OF MEXICO  
EQUIPMENT: Vertical IGF  
APPLICATION: Produced water treatment

3.1 M VESSEL DIAMETER VESSEL

FLOW: 33,000 BWPD

OIW INLET: 200 PPM

OIW OUTLET: < 29 PPM



## OSORB® MEDIA

### OFFSHORE TREATMENT FOR DISCHARGE

LOCATION: NORTH AMERICA  
Management of offshore excursions  
10-18 API OIL  
High asphaltene concentrations  
TEMPERATURE: 79°C

The Osorb system removed an average of  
98% of the 61-600mg/L inlet dispersed oil  
over the duration of the trial.



## HYDROCYCLONE & IGF

### TGT FPSO FIELD DEVELOPMENT

LOCATION: ASIA PACIFIC  
EQUIPMENT: Deoiling Hydrocyclone & IGF

APPLICATION: Produced water treatment

PERFORMANCE: 82,500 BWPD treated to  
25MG/L OIW



## PWT PACKAGE

### HUB DEVELOPMENT PROJECT

LOCATION: ASIA PACIFIC  
EQUIPMENT: Produced Water Treatment  
(Hydrocyclones, IGF, Degasser & Desander)

PERFORMANCE: 19,300 BWPD treated to  
25MG/L OIW (CONDENSATE)

61,000 BWPD) treated to 25MG/L OIW  
(CRUDE)





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