



Industrial Water & Wastewater Treatment

Upstream Oil&Gas
Capabilities

www.akvola.com

Proven Technology. Proven Expertise.



SIEMENS

About the Company

akvola Technologies is a water technology company that provides cost-effective and environmentally-friendly solutions based on **akvoFloat™** – a proprietary flotation-filtration process– to clean hard-to-treat industrial wastewater containing high concentrations of oil (free, dispersed and emulsified) and suspended solids. These solutions can be implemented in six major water-using industries: Oil and gas, Refining and petrochemicals, Metalworking, Steel, Food and beverage and Pulp and paper.

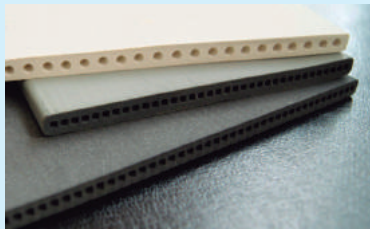
In a world of increasingly stringent environmental regulations and increasing wastewater discharge and disposal costs, our goal is to enable industrial users to become excellent water stewards by reducing their water footprint and ensuring compliance at minimal costs in an environmentally-friendly manner. **akvoFloat™** was designed to accomplish this goal.

akvoFloat™ Technology

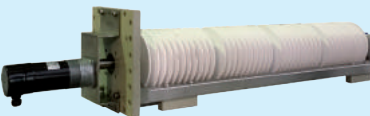
akvoFloat™ is a separation technology based on a proprietary flotation-filtration process. The process leverages the **akvola MicroBubble Generator™** and **novel ceramic membranes**, resulting in the most energy-efficient design on the market for oil, algae and suspended solids removal in hard-to-treat waters.



Package **akvoFloat™** system



Flat sheet ceramic membranes



akvola MicroBubble Generator™



Large-scale system

VISION

The only way to achieve a sustainable freshwater supply in the long-run is by making wastewater reuse affordable — a complex process that requires increasing amounts of energy. At the same time, energy generation, storage and transformation also requires increasing amounts of water. This mega trend, known as the Water-Energy Nexus, poses one of the main challenges of the 21st century. Both industrial and municipal markets require innovative technological solutions for water treatment which are both efficient and sustainable.

At **akvola Technologies** we believe that making wastewater reuse an affordable and sustainable water source is essential to the future development of mankind in terms of economy, environment and society.



VALUES

Sustainability

The triple bottom line (Planet, People, Profit) sets the tone in the way we do business. Our products, services, communication and management measures are all designed to optimize and reduce costs, environmental and societal impacts for ourselves and our stakeholders.

Technological Innovation

We deploy computer-aided design, process intensification and integration schemes, advanced materials and intelligent automation and control to achieve technological superiority.

Agility

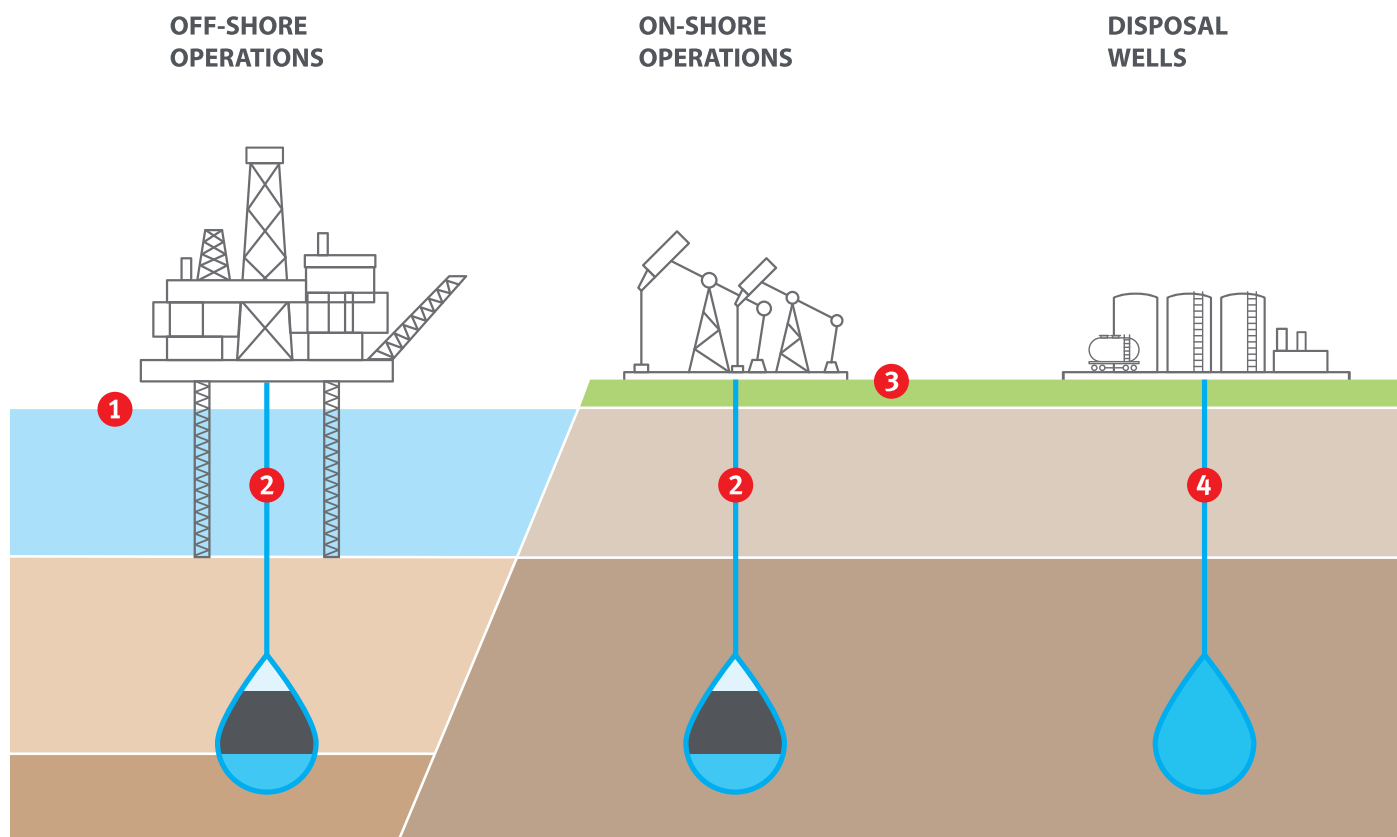
As a highly agile organization we are alert to change and move quickly and decisively to meet the challenges that emerge from such change. This allows us to react quickly to changes in the customer's requirements and environment to deliver an effective and timely solution.

Inclusion

In our team each gender as well as many age groups and ethnic & cultural backgrounds are represented. Our talent pool is equally diverse in terms of professional background, experiences, insights, strengths and special skills. Inclusion puts our diversity into action, enabling a multifaceted mix of people to complement each other in cohesive, high-performing teams.

akvoFloat™

Upstream Produced Water Capabilities



1 OFF-SHORE DISCHARGE

Problem: Non-compliance with ever stricter discharge limits due to high oil content.

Solution: An akvoFloat™ system can cost-effectively replace secondary and tertiary/polishing treatment or upgrade the existing treatment train.

2 OFF-SHORE & ON-SHORE REINJECTION (PWRI)

Problem: Insufficient removal of TSS/clay, bacteria and oil to meet water quality requirements for reinjection.

Solution: The effluent of an akvoFloat™ system can meet any reinjection water quality requirements, replacing conventional secondary and tertiary treatment technologies or upgrading the existing treatment train.

3 ON-SHORE REUSE

Problem: High oil and TSS concentrations make advanced treatment for reuse (e.g. RO) impossible.

Solution: An akvoFloat™ system is the ideal pretreatment for any advanced treatment required for any (beneficial) reuse application.

4 ON-SHORE DISPOSAL

Problem: Insufficient removal of TSS/clay, bacteria and oil to meet water quality for disposal/deep-well injection.

Solution: An akvoFloat™ system can cost-effectively replace secondary and tertiary/polishing treatment or upgrade the existing treatment train.

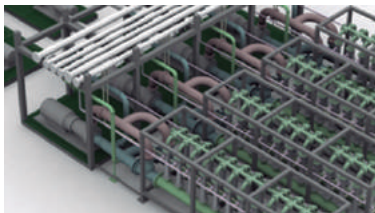


akvoFloat™ Technology Benchmarking

Secondary & Tertiary Produced Water Treatment

akvoFloat™ is a flotation-filtration process technology based on novel ceramic membranes. It has been designed to handle highly varying hard-to-treat industrial effluents in the most challenging operating conditions. It is trusted by Fortune Global 500 companies for their critical water purification and reuse needs.

Our technology integrates secondary and tertiary (polishing) treatment into a one-stop solution, offering unmatched reliability and ease of operation. Our energy-efficient solutions offer a rapid Return On Investment while minimizing waste and ensuring HSE compliance. We offer small and large-scale systems to suit any clients' needs.



	Conventional treatment trains	Advanced	akvoFloat™ Technology
Standard Technologies	Off-shore: Degasser/IGF ¹ + CFU ² On-shore: IGF + WSF ³	Polymeric Membranes (MF/UF) Tubular Ceramic Membranes (MF/UF)	
Operational Limits	N/A	Polymeric: pH =6-7, Temp up to 30 °C Ceramic: pH =2-13, Temp up to 90 °C	pH =2-13, Temp up to 90 °C
Influent Oil Concentration Limits	300-500 ppm	Polymeric: up to 20 ppm Ceramic: up to 300 ppm	Up to 5.000 ppm
Resistance to Influent Quality Variations	Low to Medium	Medium	High (integrated pretreatment)
Removal Efficiency	Medium to High	Very high: up to 99% (TSS, Oil, Bacteria)	Very high: up to 99% (TSS, Oil, Bacteria)
Recovery Rate	80 -90%	85-90%	95%
Footprint	Very High	High	Low
Weight	Very High	High	Medium
CAPEX	Medium	Polymeric: high (flux 30 l/mh) Ceramic: very high (flux 120 l/mh)	Medium (flux 150-200 l/mh)
OPEX	0,05-0,10 €/bbl	0,10-0,15 €/bbl	0,05-0,07 €/bbl

¹ IGF = Induced Gas Flotation • ² CFU = Compact Flotation Unit • ³ WSF = Walnut Shell Filter



Case Study

Produced Water Treatment


Customer:
Location:
Benchmarked Technology:
Total Exploration and Production

France

Tubular pressurized cross-flow ceramic membranes and conventional technologies (deoiling hydrocyclone, degasser, CFU)

Conditions:

Parameter	Value
Temperature (°C)	45
Oil (ppm)	100-250
TSS (mg/l)	50
Flux (lmh)	100-150

CHALLENGE

As oilfields mature, they generate increasingly large volumes of produced water. Membrane filtration technologies can considerably improve the performance of water treatment installations. By 2011, TOTAL achieved a world first by pilot-testing ceramic membranes for produced water treatment in Gabon, where the performance was 500 times superior to that of conventional technologies.

In view of that successful result, TOTAL proceeded to qualify the ceramic membrane technology for an industrial project.

Now, TOTAL has found in the disruptive **akvoFloat™** technology the advantages of ceramic membranes without the CAPEX/OPEX disadvantages of conventional tubular ceramic membranes. **akvoFloat™** has been validated at TOTAL's R&D facilities.



SOLUTION

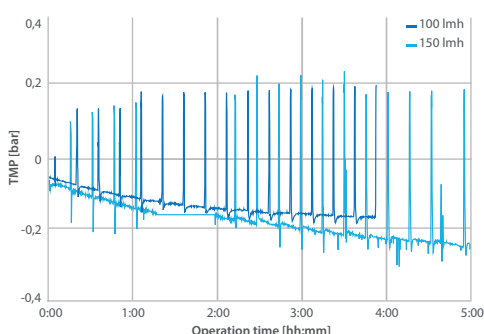
Synthetic produced water was prepared by mixing various concentrations of crude oil and suspended solid particles with tap water. A tank coupled with a mixer unit was used for preparation of the feed water for the **akvoFloat™** unit.

Stable operation is characterized by low fouling velocity (TMP increase per hour) at a high permeate flux (> 150 lmh).

RESULTS

"The technology has shown promising positive results and has been tested in our facilities to determine the optimum operating point and the cost of treatment. **akvoFloat™** has shown that a CAPEX/OPEX reduction over conventional treatment trains and systems based on cross-flow tubular ceramic membranes is possible."

Water Specialist, TOTAL E&P


✓ High removal efficiency:

- Oil < 2 ppm
- TSS < 1 mg/l

✓ High recovery (> 95%)
✓ Stable operation (TMP increase < 30 mbar/h)
✓ High flux (100-150 lmh)
✓ Low pressure drop (0,1 - 0,25 bar)

Case Study

Produced Water Treatment



Customer: DEA Deutsche Erdoel AG
Location: Lower Saxony (Germany)
Conditions:

Parameter	Value
Temperature (°C)	20
pH	7
TDS (mg/l)	32.565
Oil (ppm)	250
TSS (mg/l)	71



CHALLENGE

Managing the increasing volumes of produced water associated with oil & gas production as well as sourcing water for operations is becoming more challenging for E&P companies.

Handling oily wastewaters with high and variable contents of O&G and TSS requires complex and costly treatment trains with conventional technologies.

To evaluate **akvoFloat™**'s capability to handle such hard-to-treat effluents two different samples were collected:

- Produced water from DEA Hankensbüttel site (after gravity separator)
- Crude Oil to create synthetic produced water with different oil and TSS concentrations



SOLUTION

Tests were carried out with an **akvoFloat™** lab unit with flowrates of 100-200 l/h. Different membrane materials and geometries were tested, i.e. Al_2O_3 and SiC, hollow fiber and flat sheet.

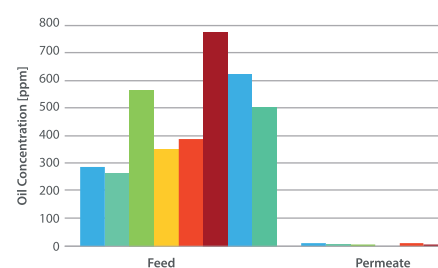
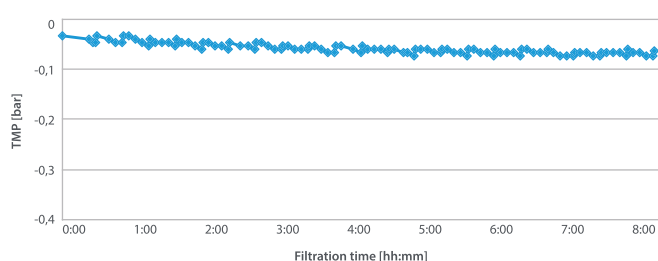
In all cases the oil concentration of the **akvoFloat™** effluent was below 10 ppm. In 90% of the cases the oil concentration was less than 5 ppm.



RESULTS

- ✓ **High removal efficiency:**
 - Oil (> 97%)
 - TSS (> 99%)
- ✓ **High recovery (>95%)**

- ✓ **8 hours of stable operation***
- ✓ High flux (120 l/mh)
- ✓ No coagulation/flocculation chemicals



*Stable Operations: TMP increase less than 30 mbar/h during 8 hours.

Business Case

Off-shore Produced Water Polishing for Discharge

Customer: Undisclosed (Major Integrated Oil Company)
Project: Revamp of produced water treatment train
Location: North Sea
Capacity: 10-18 m³/h




Challenge: After many years of operation, the installed produced water treatment train (hydrocyclones + degasser + CFU) in a mature off-shore field in the North Sea was no longer capable of delivering a compliant effluent reliably (Oil < 30 ppm). Over its lifetime the volume of the produced water had increased significantly and its composition had changed, increasing in oil concentration, salinity and temperature. The customer, a major IOC, considered several advanced polishing technologies to upgrade the treatment train in order to ensure compliance.

Solutions: This business case analyzes two alternatives for the replacement of the current CFU with two technologies based on ceramic membranes: conventional tubular ceramics and **akvoFloat™**.

Current Treatment Train

Technical Performance – current status	
Oil removal	Input: 300 - 1.000 ppm Output: > 30 ppm
Oil droplet size removal	> 10 microns
Other aspects	High energy consumption due to high produced water temperature (80–95 °C) and salinity.

Produced Water
Oil: 300-1000 ppm

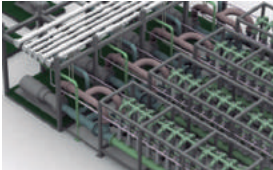


Hydrocyclone (primary) Degasser (secondary) CFU (secondary)

Discharge
Oil > 30 ppm


SOLUTION

ALTERNATIVE A
Tubular Ceramic Membranes



Economical	
CAPEX*	€3,2 M
OPEX**	0,136 €/bbl
Technical	
Dimensions L x W x H (Footprint)	11m x 4m x 3m (44 m²)
Weight (dry – wet)	40 t – 50 t

ALTERNATIVE B
akvoFloat™



40% less CAPEX
55% less OPEX
47% less footprint
40% less weight

Economical	
CAPEX*	€1,85 M
OPEX**	0,049 €/bbl
Technical	
Dimensions L x W x H (Footprint)	10m x 2,3m x 2m (23 m²)
Weight (dry – wet)	20 t – 30 t

Technical Performance – akvoFloat™	
Oil removal	Output: < 30 ppm
Oil droplet size removal	Up to 2 microns
Other aspects	Energy consumption independent of produced water temperature and salinity.

* Only equipment costs.
** Includes energy and maintenance (pumps, membranes) costs.

You see Wastewater. We see potential Savings.



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