

Water Solutions for Upstream Oil & Gas



Veolia Water Technologies is dedicated to creating water solutions for the global oil & gas industry

Oil and gas exploration and production processes are highly complex and capital-intensive. Production companies face several challenges including safety, climate, geographical hazards, and environmental constraints, especially as difficult-to-access areas become increasingly attractive to develop.

Water is a major component in all phases of oil and gas production

Veolia provides sustainable management solutions for handling and treating produced water, and for production of water injection. With innovative technologies and a long history of serving the industry, Veolia provides solutions both onshore and offshore for:

- Enhanced oil recovery (EOR)
- Treatment of injection water
- Treatment for beneficial reuse of produced water
- Treatment of produced water for surface discharge
- Treatment of produced water from gas production
- Water treatment for the midstream sector: Liquefied natural gas (LNG), Floating LNG, etc.



OPUS® technology, Chevron, San Ardo, California, USA.

Proven solutions for clean production

Injection and Enhanced Oil Recovery (EOR)



Prior to injection, produced water is often treated to remove contaminants that could otherwise plug the reservoir and/or damage injection equipment.

Veolia provides a comprehensive solution incorporating a variety of options to treat produced water and remove undesired elements.

Veolia solutions are designed to meet the high performance demands of the Oil & Gas industry:

- Efficient treatment for increased productivity
- Robust and reliable installations and processes
- Operational safety in harsh environments
- Environmental compliance through efficient removal of pollutants

A wide array of treatment technologies and process expertise is available from Veolia to provide solutions for pretreatment, primary, secondary and tertiary treatment applications.

Our treatment solutions are suitable for applications in both conventional and unconventional methods such as oil and gas field production, water flooding, chemical enhanced oil recovery (CEOR), steam assisted gravity drainage (SAGD), hydraulic fracturing, coal bed methane, and shale gas.



Beneficial reuse of produced water

Produced water reuse applications

Treating produced water for recycle and reuse purposes benefits producers, protects the environment, minimizes the need for fresh water and enables compliance to increasingly strict requirements. Successful uses of reclaim water include:

- Process water for production operations
- Injection water for onshore or offshore applications
- Distillate for use in steam generation (SAGD)
- Agricultural irrigation

Treating produced water so that it can be safely reused requires technologies that can handle oil and grease, sparingly soluble inorganic salts, volatile organic compounds, and hazardous trace contaminants. These constituents pose challenges to traditional water treatment processes. Veolia has the pre and post treatment systems that allow water treatment technologies to meet performance expectations.



Treatment for surface discharge

Produced water management is an ever increasing issue in the production sector. Producers are faced with tightening restrictions on the handling and discharge of water from:

- Conventional oil and gas fields
- Aging oil fields
- Flowback and produced water from shale gas fracturing
- Reservoir over-pressurization
- Tailings water
- Coal bed methane

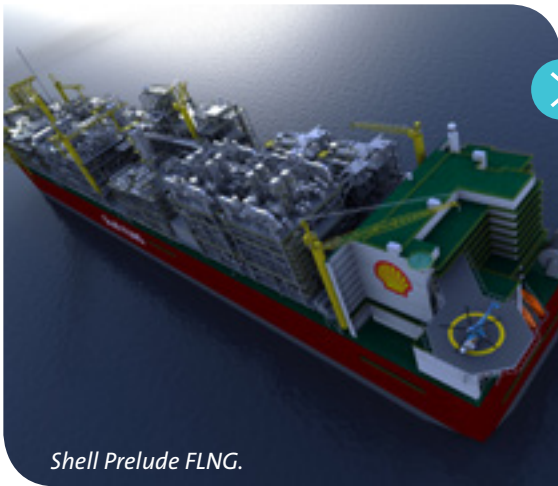
These streams are subject to quality limitations, especially concerning total dissolved solids (TDS), oil and grease, solids, organics and sodium absorption ratio (SAR). Veolia offers a wide range of solutions to the industry tailored to meet your specific treatment and reuse objectives.

Offshore

Water injection is often necessary to maintain reservoir pressure.

Offshore, the source of injection water is the sea; however seawater contains naturally occurring sulphate which may need to be removed to prevent scaling of production equipment and the reservoir itself. As world leaders in offshore desalination and sulphate removal technology (SRP), Veolia provides its clients with a full turnkey package of water injection treatment:

- Pre-treatment systems (microfiltration, ultrafiltration or multi-media filtration)
- Sulphate removal membrane systems (nanofiltration)
- Controlled salinity membrane systems (reverse osmosis / nanofiltration)
- Deaeration packages (vacuum tower or membrane type)
- Water treatment chemicals (storage, dosing, injection)
- Seawater reverse osmosis for wash and service water
- Integrated modules or skids, fully compliant with offshore engineering specifications



Regulations for produced water are becoming more and more stringent, incorporating the Zero-Harmful Discharge principle or using the risk based approach.

Veolia's Macro Porous Polymer Extraction (MPPE) system removes precisely these toxic compounds, making direct discharge after MPPE treatment possible.

Veolia offers water treatment systems that are suitable for

- Oil field produced water
- Gas field produced water
- LNG / floating LNG structures



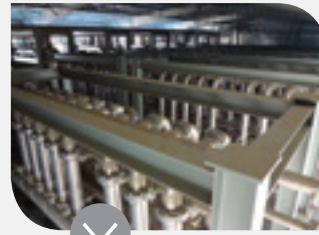
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The **OPUS® II** technology is the next generation OPUS process that utilizes CeraMem® ceramic membranes as pretreatment prior to ion exchange and reverse osmosis operated at an elevated pH. The effluent is a high quality water suitable for reuse in industrial processes.



The **SULPHATE REMOVAL PLANT (SRP)** is used to extract sulphates from seawater prior to injection. The SRP uses nano-filtration membranes to remove the sulphates while leaving the other salts unaffected, thus maintaining the stability and permeability of the formation clays.



The **ROSS™** System is a simplified, yet robust solution for the treatment of oilfield produced water. Using CeraMem® ceramic membrane technology, this system provides removal of oil and silica as well as softening of the water simultaneously in a fully modular system.



AUTOFLOT™ is a Mechanical Induced Gas Flotation (IGF) separator. Induced Gas Flotation separates oil from produced water or other oily water streams with a low retention time. An hydraulic version of our IGF is also available depending on the application.



The **SANDLINER™** de-sanding hydrocyclone efficiently removes troublesome solids such as sand, to protect against loss of production and eliminate associated costs. The system improves oil removal efficiency and reduces maintenance.



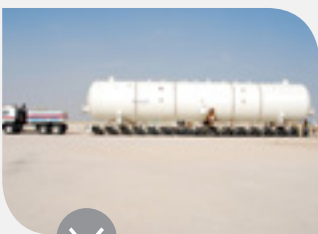
STREAMLINER™ deoiling hydrocyclones separate free oil from produced water prior to discharge or injection. Regarded as the first stage in the treatment process, deoiling hydrocyclones are one of the most commonly employed processes in a produced water treatment system.



The **COPHASE™ CFU** operates by combining the well-established principles of gas flotation, oil droplet coalescence and centrifugal separation into a single process step. Designed for ultimate reliability, and with no moving parts, the Cophase CFU is particularly suitable for offshore installations.



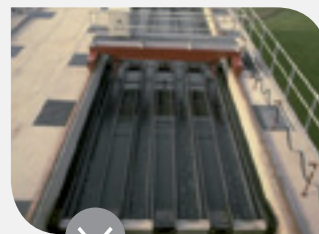
MPPE (Macro Porous Polymer Extraction) systems remove dissolved and dispersed hydrocarbons such as aliphatic, aromatic, polyaromatic and halogenated compounds. The technology is robust and compact, particularly adapted to offshore constraints and gas field produced water.



The **TIPPS™** Corrugated Plate Interceptor (CPI) is a gravity separation system for the removal of oil and solids from oily effluents. The pressurized CPI is applied for separation of oil/organic phase/solids from water when the feed is pressurized.



POWER CLEAN™ nutshell filters are effective for the removal and treatment of hydrocarbons and suspended solids from produced water and petrochemical applications. Power Clean™ filters remove 98% of all filterable contaminants to recover more oil in a rugged, compact design.



The **MULTIFLO™** process can be used in clarification or water softening applications. It combines the coagulation, flocculation and counter-current lamella settling stages in a single unit.



HPD™ evaporation and crystallization systems are effective in concentrating wastewater streams to produce high-quality distillate for reuse and volume reduction. Unique processes developed for SAGD and shale gas applications are effective for produced water containing high levels of TDS to ZLD.

Veolia Water Technologies is the leading global water and wastewater technology company and provider of a full range of services including engineering, project management, design-build, and maintenance services.

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