

**OilPaq** frac flowback, produced water and brine treatment



# DESIGN



The OilPaq is a turnkey, custom designed oil-water separation system for oil and gas fields, engineered, manufactured and supplied by APATEQ of Luxembourg. The OilPaq separates even emulsified oil from water without requiring additional chemicals compared to conventional processes. APATEQ's mobile systems can be operated close to the well site to optimize water quality for reinjection, drilling, fracturing, irrigation or discharge.

The OilPaq system is build from several modules. Depending on the source and quality of the water and the specific effluent requirements, these modules can be employed individually or in various combinations, in order to be most efficient in cost and size. By treating and / or reusing water on-site, all water related costs are reduced to a minimum.

APATEQ's oil-water separation systems only require a small footprint. They are supplied as

container plants (ISO shipping containers) or rack-based systems, both easily scalable to meet specific customer requirements for volumes. The standard containerized OilPaq for treating produced water to reach water standards for reinjection comprises of:

- heavy duty feed pumps and dedicated backwash modules,
- proprietary pre-treatment unit for oil and TSS (Total Suspended Solids) removal up to 90%,
- sludge storage tank,
- field proven, proprietary ultrafiltration post-treatment, polishing produced water with a removal rate of oil and TSS up to almost 100% (< 2 ppm),
- clear water / backwash tank and
- control units for a fully automatic operation of the plant with remote control ability.

*OilPaq: containerized ultra-filtration module in a 40' ISO shipping container*

*Schematic split of the system components into three containers (here: 2,000 barrel/day version)*

Container 1



Pre-Treatment (PrePaq)

Container 2



Ultrafiltration

Container 3



Control Cabinet / Office and Storage

In case the OilPaq is used for treating produced water to reach irrigation and discharge standards, the following items can be added:

- hardness removal,
- 2- or 3-stage reverse osmosis,
- active carbon filters,
- evaporator,
- dryer.

Should the unit be required for the treatment of frac flowback water, an additional pre-treatment module for sand removal (for instance, particles larger than 300 - 500  $\mu\text{m}$ ) is added in the front end of the system.

## TECHNICAL SPECIFICATIONS

### OilPaq performance

The OilPaq treats all kind of produced water, frac flowback and brine, regardless of salinity levels. APATEQ's systems reliably remove

- suspended solids,
- oil and grease,
- bacteria and
- depending on the raw water and effluent requirements, hydrogen sulfide, iron and hardness.

In case of low salinity produced water, an additional treatment step can be added for the reduction of TDS (Total Dissolved Solids). Dissolved solids such as

- boron,
- chloride and
- sulfate

can therefore be eliminated.



*Water samples taken during a long-term run on a gas field site, from left to right: raw produced water, effluent after treatment, pre-treated water*

## Technical specifications of mobile container plant sizes

also available: large scale stationary plants

	OilPaq 2,000	OilPaq 4,000
<b>Capacity</b> (barrel/day)	<b>2,000</b>	<b>4,000</b>
<b>Implementation</b> (sea containers)	<b>1 x 40' + 2 x 20'</b>	<b>3 x 40'</b>
<b>Power consumption</b> (kWh)	<b>30</b>	<b>45</b>
<b>Weight, dry</b> (t)	<b>30</b>	<b>50</b>
<b>Temperature resistance</b> (°F)	<b>158 / 203 *</b>	<b>158 / 203 *</b>
<b>pH range</b>	<b>2-12 / 0-14 *</b>	<b>2-12 / 0-14 *</b>
<b>Membrane lifetime</b> (years)	<b>&gt; 5</b>	<b>&gt; 5</b>

\* Polymeric / Ceramic membranes

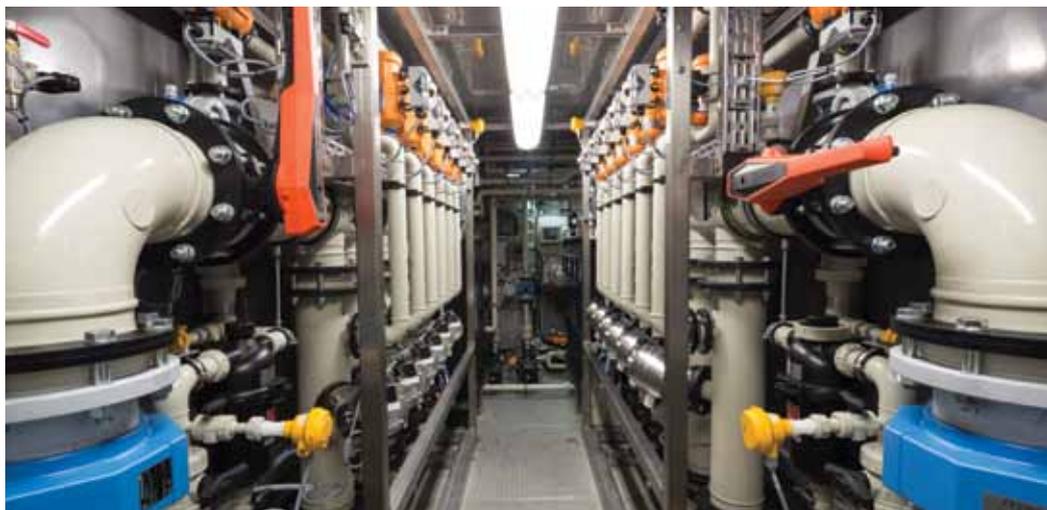
## TECHNOLOGY



For the treatment of produced water, APATEQ combines proprietary pre-treatment and ultra-filtration technology to outperform actual and long established treatment solutions. Current technologies available on the market such as electrocoagulation, centrifuges, pure chemical treatment or evaporation all have in common the use of large amounts of energy or chemicals, or both which leads to higher operational costs.

*PrePaq installed inside the containerized plant*

An extensive pre-treatment through a proprietary technology, called PrePaq, simultaneously removes heavy and lightweight particles to prevent the system's membranes from damaging or clogging. Dissolved gas flotation is combined with a settling process in which no energy and no chemicals are used, achieving an already high degree of oil-water separation. The PrePaq is made of high grade stainless steel and contains specially treated surfaces with alternating hydrophobic and hydrophilic characteristics, enabling oil to agglomerate on them and thus to separate from the flowing raw water.



*Example of rack-based ultrafiltration modules*

The subsequent separation process with oil-repellent, hydrophilic ultrafiltration membranes results in an effluent that is free from oil, oil emulsion, bacteria and filterable solids. These membranes are either ceramic or high-temperature polymeric membranes, operating in a cross-flow mode for stable operation.

The APATEQ solution enables long-term and reliable operation in the field without clogging of membranes, requiring little or no chemicals at all. Suspended solids in produced water from even the toughest formation are removed to a level of < 1 ppm whereas free and emulsified oil is reduced to levels < 2 ppm. With these low

effluent values, the OilPaq reaches already now the requirements of future legislation. The resulting water can be reused, for instance for reinjection into the formation or for direct discharge, meeting prevailing environmental standards. After the oil is separated from the raw water, 100% of the recovered oil can be sold straight to the refineries.

Due to the minimal, or in some cases no use of chemicals in the process and due to the very low energy consumption of the system, the operation costs of the OilPaq are kept to a minimum, representing only a fraction of the treatment costs of conventional processes.

**Determining factors for low operation costs of the OilPaq:**

- Minimal or no use of chemicals, only for the conditioning and cleansing of membranes (if used, then the quantity required is only 1/1,000 of the volume of other chemicals typically used in the industry today)
- Low specific energy consumption (< 0.4 kWh/bbl.)
- Inexpensive consumables
- Long intervals between CIP's (Clean-In-Place)
- Long membrane lifetime (> 5 years)

## SAFETY AND ENVIRONMENT

The OilPaq is designed to operate safely in potentially hazardous areas and meets the highest international safety standards, including IECEx.

Its safety features include, for example, the entire system being blanketed with nitrogen to suppress explosive gases. Continuously monitoring of environmental gases, sensors for light gases, heavy gases and oxygen are installed in the plant. If gas levels inside the OilPaq approach potentially hazardous levels, the plant immediately shuts down all systems automatically. Remote monitoring and communications, for both safety and operational alarms, automatically inform the operator. The OilPaq's critical operational sub-systems are redundantly duplicated to avoid processing disruptions. In this unlikely

event, a critical sub-system experiences operational failure, the OilPaq's software is programmed to take immediate action by switching from the defective device to its redundant backup counter device.

The OilPaq is developed to meet current and future legislation. The plant's effluent is in compliance with even the toughest environmental standards. As the OilPaq does not require chemicals for the oil separation, the recovered oil from the produced water can be fully used in refineries. This means that no residues pollute the effluent water, which can generally be reused, saving our most precious resource: fresh water.



*On-site control cabinet inside containerized OilPaq*

# About APATEQ

APATEQ engineers and manufactures innovative, turnkey and custom designed systems for the treatment of frac flowback, produced water and brine from oil and gas production, compact wastewater treatment plants for demanding applications and full-solution systems for industrial wastewater. With decades of experience in the water and wastewater business and global industrial product manufacturing and commercialization, APATEQ's corporate and technical team is comprised of dedicated experts whose focused goal is client satisfaction, environmental protection and water conservation.

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