

# NATURAL GAS APPLICATION

## PRODUCED WATER TREATMENT AND OIL RECOVERY

Esmil Process Systems together with our partners have conducted much research and constructed many plants gaining vast experience in the Natural Gas industry. From bench scale studies right the way through to full scale plant operations we strive to offer BAT (Best Available Technology) using state of the art membrane separation and dewatering processes.

### GENERAL PROCESS DESCRIPTION

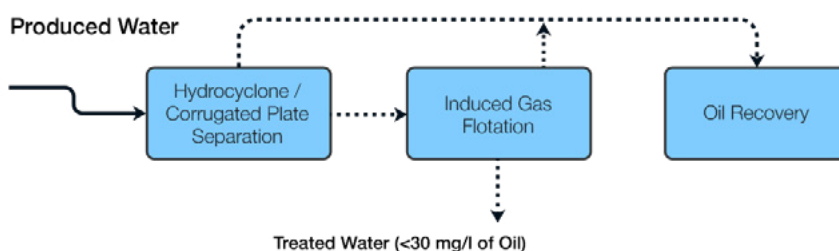
Natural gas wells contain a certain proportion of water which is extracted as a by-product of gas extraction. This is referred to as 'Produced Water (PW)' containing suspended solids, organics, oil and salts. Discharge to sea requires primary treatment on site or transportation to a suitable primary treatment facility.

Depending on the desired treated water quality, the Esmil philosophy for Produced Water Treatment utilises conventional separation processes for the removal of bulk contaminants – oil & solids or combination of the conventional separation process and state of the art membrane separation and absorption processes. This philosophy enables the plant to function reliably, even with wide ranging variations in feed quality.

### EXAMPLES OF TECHNOLOGIES

The degree of treatment is designed to meet client specified limits such that the treated water is suitable for re-use on site or discharge to overboard.

#### MODERATE DISCHARGE CONSENTS (TYPICAL FOR OFFSHORE PLATFORMS)



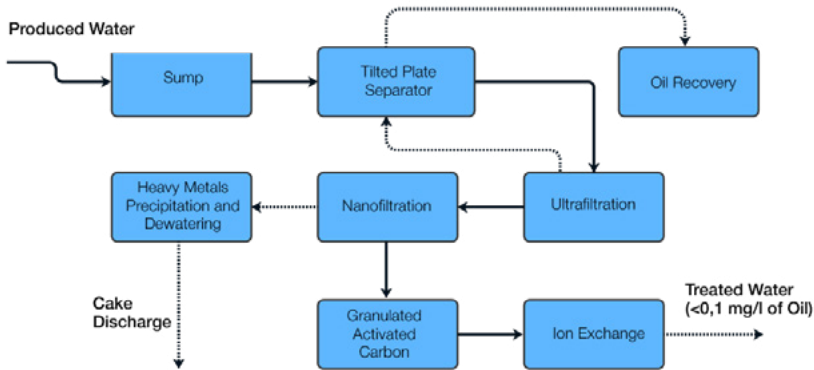
Conventional Treatment involves Hydrocyclones / Corrugated Plate Separation followed by Induced Gas Flotation and Media Filtration to remove oil and suspended solids below 10-30 mg/l limit. The treated water is suitable for on board discharge or for reinjection purpose.

#### STRINGENT DISCHARGE CONSENTS FOR THE COSTAL AREAS (ADVANCED PROCESS TECHNOLOGY)

The pre-treated water is polished by Ultrafiltration membranes, which reduces oil concentration to less than 0.3 mg/l, and suspended solids to below the limits of detection. The Ultrafiltration membranes utilise a modified Polyacrylonitrile (PAN) chemistry, which has been developed to be extremely oleophobic and thus resistant to free-oil fouling.

The oil and suspended solid free water is treated using Nanofiltration membranes, which removes the bulk of heavy metals and organic compounds. Although the pores size of the membrane is around 1 nm the nanofiltration provides negligible resistance to the passage of monovalent ions such as chlorides, so it is able to operate on high salinity waters where the inefficient productivity of Reverse Osmosis would render it uneconomical.

Trace organics and heavy metals in the Nanofiltration permeate are removed by Activated Carbon absorbers and selective Ion-Exchange resin. The pre-treatment by Nanofiltration significantly increases the bed life of these two media.



Ultrafiltration reject stream is recycled to the front end of the process and the concentrated oil is reclaimed on site from TPS unit. The various sludge and aqueous waste streams from the main process are combined before undergoing precipitation, flocculation and filtration, to produce a 'cake' for landfill, and a filtrate that can be recycled through the process.

## TYPICAL TREATMENT EFFICIENCY

Parameter	Feed (mg/l)	Treated PW (mg/l)
Suspended Solids	100	0
Oils, Fats and Greases	15	< 0.3
Mercury	1	< 0.0005
Lead	0.5	< 0.005
PAH	1	< 0.0002
Iron	185	1
Sulphate	4093	< 50
Chromium	0.5	< 0.1
Zinc	25	< 0.1

## ESMIL DESIGN PHILOSOPHY

We strive to use the most appropriate solution to suit your treatment and/or recovery requirements. We are not limited to a single technology as we have a vast range of experience in the majority of treatment technologies. This includes membrane bio reactors, aerobic treatment, media filtration, ion exchange and other membrane technologies across a range of effluents and industries.

As no two processes are equal it is essential to follow a number of steps to ensure that your tailored natural gas field PW treatment/recovery process performs as well and economically as possible to achieve your treatment goals.

- Lab scale membrane trials and selection to ensure process feasibility
- Long term site pilot trial to allow for feed variation and data gathering
- Extensive plant design and OPEX calculations
- Build, Installation and Commissioning
- Comprehensive service support including maintenance and system upgrades.

## REFERENCES

- 10 m<sup>3</sup>/h Shell, Corrib Gas Terminal, Ireland
- 250 m<sup>3</sup>/h ONGC Indian Offshore Platform, India
- 240 m<sup>3</sup>/d Produced Water, Petrofac Ltd, Siberia

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