

# Merpro® Tore®Sep - Technology Document

## INTRODUCTION

Increasing flow rates of produced water from a reservoir can limit oil production. In addition, high water cut can restrict the development of marginal wells. ToreSep has been designed to add flexibility and increased operability to the processing of raw well fluids. It is ideal for more mature reservoirs requiring front end de-bottlenecking of increased levels of produced water and marginal wells with a high water cut.

ToreSep also provides a contingency against inaccurate reservoir predictions in any field development, particularly where water breakthrough advances prematurely, or where higher water cuts than anticipated prevail.

## WHAT IS TORESEP?

ToreSep is a self-contained vertical bulk water separator that utilizes wellhead pressure to produce a rotational flow. The rotational flow set up within ToreSep provides rapid oil and water separation.

## WHAT CAN TORESEP DO?

Centrifugal separation, utilizing hydrocyclones or centrifuges, has been successfully used to separate oil and water in the offshore oil industry for many years. Such units are small compared to traditional separators, however they have always been installed as a secondary separation stage. This is due to their low residence times and their inability to tolerate any excessive variations to inlet fluid characteristics, such as gas / liquid slugs. If the inlet flow concentration is varied for any appreciable time, the discharge quality of the unit will be compromised. In order to avoid the necessity of having two such units to achieve the required separation, a system to combine the benefits of centrifugal separation with the benefits of a traditional separator is required. The need to meet these criteria and thus simplify the separation train, reduce plot area and weight led to the development of ToreSep. Installation of a ToreSep, upstream of an existing first stage separator, may de-bottleneck existing separation trains which are water constrained. A ToreSep package can be designed to treat either the entire field production or to treat several high water cut wells in order to unlock the potential of additional wells that may have been previously shut in.

Over time, the increasing flowrate of produced water in a reservoir becomes a controlling factor in the production rate of the oil. This causes bottlenecks in production due to the separation train capacity. If the majority of the water is removed upstream of the restricting piece of equipment, the reservoir can continue to be used for a longer time and can even lead to an increase in the rate of oil production. For new developments and marginal fields, subsea separation of water and oil can be considered as an alternative solution to topsides separation which will reduce the separation train capacity required and reduce the size and number of risers. These Capex savings in some cases can make the development of the marginal field viable.



- |                       |                             |
|-----------------------|-----------------------------|
| 1. Clean              | 6. Outer screen             |
| 2. Clean media return | 7. Dirty media for cleaning |
| 3. Inner screen       | 8. Tore feed water          |
| 4. Media Filter       | 9. Tore                     |
| 5. Dirty water inlet  |                             |

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## HOW DOES TORESEP WORK?

Within ToreSep, a modified Tore creates a vortex within the separation vessel. The centrifugal forces separate the inlet fluids with the heavier components (water and solids) moving to the outer wall while the less dense components (hydrocarbons) remain in the center. Separated oil flows down through the Tore's central outflow discharge pipe while the bulk of the separated water is removed to produced water clean up equipment such as de-oiling hydrocyclones. Any gas content of the inlet is removed under pressure control from the top of the vessel. Centrifugally separating liquids of differing densities is not a new concept and is currently successfully utilized in hydrocyclones and centrifuges. The ToreSep brings a new flexible approach to centrifugal separation. Conventional centrifugal separators provide excellent discharge quality but their high centrifugal forces generate high shear and their fluid residence times are very small. This means that if there is any upset to the incoming flow, even for a short time, the performance of the unit can deteriorate significantly, i.e. If 100% oil enters the unit, 100% oil will exit at the oil and water nozzles. The ToreSep is different in that it has a significant residence time compared with conventional centrifugal separation equipment and thus can handle upstream process upsets. This allows the ToreSep to be installed further upstream in the process than a conventional separator, i.e. As the front-end slug catcher or even sub-sea. The centrifugal forces within the ToreSep are lower than within a hydrocyclone (usually between 20 and 50 times the force of gravity). This, combined with the inlet geometry of the Tore, minimizes the shear forces inherent in transforming pressure energy to rotational fluid motion. The ToreSep therefore conserves the droplet distribution profile to the largest possible degree. The ToreSep can typically remove water cuts of 60-90% of incoming well fluids while maintaining an oil in water discharge of approximately 1000ppm. In combination with a deoiling hydrocyclone on the water outlet, this can be reduced to below 20ppm oil in water to comply with environmental water disposal limits.

## FEATURES AND BENEFITS:

- Compact three phase separator which enables operators to manage increased levels of produced water, providing front end de-bottlenecking of separation trains
- Flexible design allows the ToreSep to act as both a first stage separator, when low water cuts are present, or as a bulk water knockout separator when the water cut increases
- Can operate at up to 90% water cut, allowing the development of marginal high water cut wells
- Large residence times compared with other centrifugal separation equipment allows the ToreSep to absorb the effect of slugs in the inlet flow
- Shorter residence times than conventional three phase separators (90 seconds compared with approximately 18 minutes) provides a rapid separation of the fluids
- Operation is insensitive to motion making it appropriate for installation on board FPSO vessels
- No moving parts, reducing maintenance requirements
- Small size and automation provide potential for subsea wellhead applications



ToreSep - A compact bulk oil/water separator using vortex forces

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 **NATIONAL OILWELL VARCO**

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