Typhoon Valve is a low shear valve technology developed to reduce emulsification and mixing of petroleum phases. Typhoon Valve eases the downstream separation and improves the quality of oil and water, without resorting to chemicals or additional treatment processes. In contrast to conventional choke and control valves, Typhoon Valve uses the principles of a vortex to control petroleum flows. The main purpose of using the vortex is to involve a larger fluid volume in dissipating energy, which is required to control the flow. Figure 1 illustrates the differences in working principles between a conventional throttling valve and Typhoon Valve. Also the effect on a two phase flow is illustrated.

The Typhoon Valve development is financed by the Norwegian Research Council, Statoil, ConocoPhillips, Total, Eni Norge, Shell, GDF SUEZ, Petrobras and the valve vendor Mokveld.
2. DEVELOPMENT SUMMARY

Through 7 years of development, Typhoon Valve has been tested in numerous test programs involving small and large scale models used in various two and three phase flow loops. Altogether 12-13 different North Sea crudes have been used during testing. The valve has also been erosion tested twice at GL Flow Centre in the UK. Finally, there was a very successful Pilot test at Statoil’s Oseberg C in March 2012. Here is an overview of the most important tests and results of the Typhoon Valve development program:

2.1 Pilot Test at Statoil’s Oseberg C 2012

Typhoon Valve was for the first time tested on an offshore platform in March 2012. The Statoil operated Oseberg C hosted the pilot installation, where Typhoon Valve replaced an existing choke on a producing oil well. For a specified period of time the well produced to the test separator and the separation was monitored when both the existing valve and Typhoon Valve were used. The pressure drop across the choke was 70-80 bar. The main objective of the pilot test was to document that Typhoon Valve improves the separation process and especially the produced water quality. When Typhoon Valve replaced the conventional choke valve the oil in water concentration out of the test separator was reduced by averagely more than 45%.

2.2 Prototype separation testing at Statoil in Porsgrunn 2009

The Typhoon Valve separation benefit was in 2009 documented at realistic test conditions in Statoil’s multiphase flow loop in Porsgrunn, Norway (Figure 3).
In this test loop a full scale prototype Typhoon Valve was used with crude oil from the Gullfaks field, and with real gas and salty water. Tests were done at high temperature and high pressure. The most important results from this test are:

- Above 50% water cut, Typhoon valve reduced the content of oil in water by 60-90%. See Figure 4 for detailed results, which are based on water samples collected in the outlet of a downstream separator.
- The largest positive effect on water quality was found at the highest water cuts; 80-90%.
- A significant positive effect was found even at low valve pressure drop (4-5 bar).

![Figure 4. Prototype separation results and example of differences in water samples.](image)

2.3 Prototype erosion testing at GL Flow Centre UK

Typhoon Valve has been erosion tested twice at GL Flow Centre, UK (Figure 5). The erosion tests have documented that erosion in Typhoon Valve is controlled by using hard materials on valve internals, like in conventional valves. The pilot valve which was used on Oseberg C was built with internals made from tungsten carbide.

![Figure 5. Typhoon Valve at GL Flow Centre 2010.](image)
2.4  **Produced water testing in the Typhonix Laboratory**

In the prototype test at Porsgrunn as well as in the pilot test at Oseberg C, Typhoon Valve was used on three-phase flow. To investigate the potential of using this technology in control valve applications in two-phase flows, Typhonix has conducted numerous produced water tests in the Typhonix laboratory. Produced water has been made from 12-13 different North Sea crude oils and tests have been done at a variety of flow conditions, including valve pressure drops up to 30 bar. Systematically, Typhoon Valve gives larger oil droplets compared to standard valves in these tests. Typically, oil droplets out of Typhoon valve are twice as large. Examples of results achieved with the full scale prototype on some North Sea crudes are shown in the diagram of Figure 6.

![Figure 6. Produced water testing and typical effect on oil droplet size.](image)

Stokes Law is commonly used to describe separation processes involving droplets of oil in water. Twice as large oil droplets result in a four times larger settling velocity. Hence, when used as a control valve, the positive effect of Typhoon Valve could have a significant effect on produced water treatment processes.

3.  **TYPHOON VALVE - PROCESS BENEFITS**

Used as a choke valve Typhoon Valve will mix and emulsify oil, water and gas less together. Potential process benefits are:

- Less oil in separated water – less oil in discharger water
- Less water in separated oil – less water in exported oil
- Less liquid in the gas stream – dryer gas to the gas handling system
- Less need for, or improved effect of process chemicals
  - Emulsion breaker
  - Flocculants
  - Anti foam

Used as a control valve on produced water flows Typhoon Valve will break oil droplets to a less extent. Potential process benefits are:

- Less oil in treated water - less oil in discharged water
- Less need for chemicals or process means used to enlarge oil droplet sizes.

Used either as a choke or control valve in petroleum flows, Typhoon Valve will improve the efficiency of downstream separation processes without resorting to chemicals or additional treatment methods. Typhoon Valve will contribute to a cost effective and environmentally friendly separation process.
4. ECONOMICAL EFFECTS FOR THE USER

The Typhoon Valve challenges the causes to separation problems instead of repairing the effects and the process benefits would have several economical benefits for the oil companies.

- **An easier or more cost effective way of reaching emission targets**
  With regards to oil content in discharged produced water the use of Typhoon valve as a choke or control valve may result in an easier way of reaching the government-issued environmental standard. This could mean that the process plant requires smaller facilities for treatment of produced water, or that existing systems can process larger amounts of water. This would have a great cost reducing impact for the companies.

- **A more flexible process plant with less production problems and down time**
  Replacement of conventional valves with Typhoon Valves may also lead to shorter required residence time in the separators with faster processing time as a result. Another effect with great cost reducing impact would be a more flexible process plant with higher operational stability and less down time due to problems with production fluctuations or process upsets.

- **Better cost benefit ratio of the use of chemicals**
  With regards to the use of production chemicals like emulsion breakers and/or flocculants, the replacement of conventional valves with Typhoon versions could mean reduction of the use of chemicals or that a process plant could reach cleaner oil/water phases with the existing use of chemicals.

- **Longer life of mature fields**
  If the bottleneck of a mature field is high water production together with limited capacity of produced water handling, the Typhoon Valve will provide a more efficient handling of the produced water and by that contribute to a longer lifetime of the field.

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