Stevtensioner

Subsea Tensioning Services
The proof loading of a permanent mooring system for CALM buoys and FPSOs is critical for a system’s certification. The proof loads are typically 80% of the design load so that substantial crane/winch capacity or bollard pull is required. The use of the Vryhof Stevtensioner for subsea tensioning offers significant time and cost benefits as it reduces the required installation load by typically 60%. As a result mooring installations can be performed from anchor handlers or modest crane barges.

**Double pull power**
The Stevtensioner is basically a chain shortening clutch with the mooring chain connected on one side and a reaction chain running through it. A vertical pull induces more than double that pull in the horizontal leg. A repeatedly heaving up and slacking the Stevtensioner in a yo-yo action builds up the load in the mooring chain until the required tension is achieved. Typically 4-6 movements are sufficient.

**Cross tensioning**
By cross tensioning of two opposite anchor legs in the mooring spread, an even larger time efficiency is created. It reduces the number of tensioning required by 50% and may save as much as 35 to 40% on the total installation time originally required for the operation.

**An all-in package**
The tensioning services are available on a rental basis. Dedicated engineering can be performed and depending on the complexity of the project may include a feasibility or suitability assessment and the preparations of procedures. The rental package includes the Stevtensioner and hardware such as the measurement pin or acoustic load pin, the umbilical and read-out unit. The package may also include the supervisor during the tensioning operation.

**All anchor types**
The Vryhof Stevtensioner has been successfully used for over 25 years for the installation of mooring systems of Floating Production Units and Offshore Loading Buoys. It suits all types of anchors, be it drag, suction or pile and it also serves to install a complete pre-laid mooring before the unit arrives on location. Stevtensioners handle loads up to 1000 tons and accommodates chain size of 76-135 mm for the work chain, but have no limitation on mooring chain size and can thus also be used for tensioning of systems that include wire rope or fiber ropes.
The Benefits

• Reduces required installation load up to 60%.
• Obsoletes the need for bollard pull or winch capacity in excess of the installation load.
• Allows moorings to be installed with a smaller number of vessels, less capacity anchor handlers or crane barges.
• For all types of anchor points and mooring systems, including non-chain mooring systems.
• Subsea tensioning equipment is compact in size, suitable for even mobilizing by air freight.
• Cross-tensioning opposed anchors, reduces the number of tensioning operations required, taking typically 6 hours from connecting to de-rigging.
• An all in rental package includes engineering, hardware and supervision of operations.
• A typical CALM buoy 6 mooring point system only requires 3 tensioning operations.

Technical features

• Available for loads of up to 1000 tons.
• Accommodates work chain range 76-135 mm.
• No limit to mooring chain size.
• Operates on mooring chain without impairing chain performance, life expectancy or damaging links.
• On an average needs only 4-6 tension movements per mooring chain.
• Integral load pin in tensioner records tension in the anchor line, recorded in real time on deck.
• Designed to smoothly guide at least 5 links and therefore prevent chain getting stuck inside.
• The integrated shape allows for smooth passage over stern roller.
• Load measuring pin is equipped with two independent sets of strain gauges. These connections may be used for acoustic transfer of the signals.

The Stevtensioner arrangement

The active chain (2) passes through the Stevtensioner (1) on deck of the installation vessel. The passive chain (3) is connected to the measuring pin shackle (8). The dislock wire (5) is connected on shackle 4. The umbilical cable (7) is connected between the measuring pin (6) and the read-out system on deck.
How it works

The Stevtensioner is based on the principle that a vertical load to horizontal string causes high horizontal loads. To achieve the required horizontal pretension load at the anchor points, the vertical pulling force only needs to be 40% of this pretension. The anchor line tension is measured by a measuring pin inside the Stevtensioner (fig. ST-1) that is connected to a read out unit on the installation vessel by an umbilical or acoustic system for deep water.

One anchor line (passive line) is attached to the tension measuring pin, while the opposite anchor line (active line) passes through the Stevtensioner.

When the Stevtensioner is lifted it locks the chain and lifts the full arrangement off the seabed (fig. ST-2), building load to the anchor points or causing drag anchors penetrate the seabed. The Stevtensioner is then lowered over the gained chain length, so that the same action can be repeated. Tensioning is applied by repeating the yo-yo movement (fig. ST-3). The pretension is maintained for a certain time for certification (DNV 15 minutes, Lloyd’s 20, ABS 30).

Computer Calculations

Computer software can calculate the tension in the chain. Parameters such as submerged chain weight, length of mooring line as well as height of the Stevtensioner above seabed and the vertical pull load are incorporated in the calculation. By using this method the tension in the chain can be calculated at any height of the Stevtensioner above seabed, independently of the water depth.

Fig ST-4 shows the 5 movements in which tension is build up during tensioning of chains on piles.

See the animation on our website www.vryhof.com
**Wireless Load Cell**

In very deep waters the measuring pin umbilical is replaced by an acoustic load cell placed between the Stevtensioner and the passive chain. It can be utilized for loads between 25-1000 tons. The load cell can also be placed as a permanent part of the mooring line. An automatic alarm will notify when certain pre-set loads are reached, triggering action. The load cell can optionally be equipped to measure shock loads, with depth sensors and accelerometers. Inclinometers allow horizontal and vertical components of tension to be resolved.

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**Technical specifications**

<table>
<thead>
<tr>
<th>Stevtensioner model</th>
<th>Maximum horizontal load [mT]</th>
<th>Suitable* for chain size with Kenter shackle [mm]</th>
<th>Suitable* for chain size without Kenter shackle [mm]</th>
<th>Size Stevtensioner lhxw [m]</th>
<th>Weight Stevtensioner [mT]</th>
</tr>
</thead>
<tbody>
<tr>
<td>VA 600</td>
<td>600</td>
<td>76 - 84</td>
<td>76 - 87</td>
<td>2.0 x 0.9 x 0.6</td>
<td>3</td>
</tr>
<tr>
<td>VA 1000</td>
<td>1000</td>
<td>102 - 117</td>
<td>102 - 135</td>
<td>3.1 x 1.2 x 0.8</td>
<td>6</td>
</tr>
</tbody>
</table>

* The suitability only refers to the section of chain passing through the Stevtensioner. Chain or wire not passing through the Stevtensioner may have any dimension.
Vryhof Anchors has dedicated more than a generation to the development, manufacturing and supply of high holding power anchors. Their anchors are recognized worldwide as weight for weight the most powerful. The company has supplied in excess of 8000 units, the largest at 75 tons designed for 1500 tons loading capacity. Vryhof anchors are now used in every stretch of the world’s waters and oil field development areas.

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