





Next generation offshore wind tools

Construction of offshore wind farms has advanced rapidly over the last few years and is maturing into a market where subsidy funding is diminishing. Numerous companies joined in to develop the offshore wind market and are further developing their assets to provide services to this market. PES shares this insight in to one company's continued search to improve tools and equipment.

At Huisman we see this development of assets through the contracts we have received for the construction of several cranes, intended for the construction of wind farms. Part of the development of this maturing market has been the growth of the wind turbine's output, through increasing the size of turbines and blades, resulting in higher turbine towers. This upscaling of size of the different components of an offshore wind turbine, results in the need for larger installation tools: i.e. larger cranes.

Due to the larger components, installation procedures and the tools to perform these procedures are becoming more important in ensuring handling ease and safety during installation processes of offshore wind turbines. Part of our contribution to the wind installation market is our range of cranes, which are adaptable with a variety of components of various sizes. Some tools are foldable to minimise their storage footprint when stowed and others come with a flatbed interface, on which they can be mounted for storage.

Until now the development of offshore wind installation tools has been to scale tools to the growing wind turbine sizes and along with it, the design envelope of the wind installation vessel itself.

The design of the wind farm components have grown to such an extent that in jacked up condition, installation mode, the soil pressures of the legs of these Jack-up vessels are becoming excessive. This growth in pressures is caused by rising vessel sizes, higher payloads and increased overturning incidents caused by lifting heavier components. Within the Jack-up concept there are solutions to reduce these soil pressures, but they generally amount to less deck space and more obstacles to pass during installation and or handling the wind turbine components.

The "simple" solution is to not use a Jack-up vessel, but to perform installation from a floating vessel. With no legs, no soil pressures arise. However the lack of legs comes with the added challenge of vessel motions, which makes installation activities

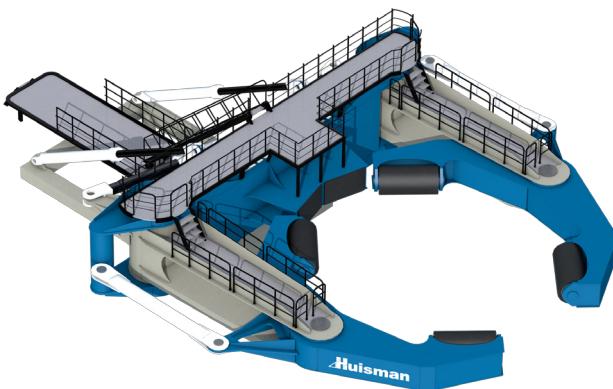




Transition piece lifting tool



Upend tool



Monopile gripper, with access



Universal lifting tool

a dynamic operation, creating the need for tools which can adjust to the wave induced vessel motions.

For this shift to dynamic installation operations Huisman has developed specific tools which can be used to handle and install components from a vessel in motion. Additionally we have made use of this opportunity to expand our range of tools to make the best use of our cranes.

Following the logistic flow of wind turbine installation, the order of installation of the various components and the equipment used gives an overview of the different tools we have added to our range of offshore wind tools:

- Deck handling equipment
- Lifting tools
- Motion compensated pile gripper

Deck handling equipment

Operations involving lifting the monopiles and other bulky items using the vessel's crane are preceded by handling these components. An operator has a few choices: either install a very large and high capacity crane, which has a very large outreach and capacity to lift the various items directly from the location where the items are stored; or install a smaller crane, which can lift the different items.

The quandary is one has a more limited outreach, which can have significant influence on the size of the crane selected. In order to lift the different items from their storage locations, the items first need to be manoeuvred within the reach of the crane.

Skidding pile conveyor

We have developed skidding pipe conveyors which can transport piles into

the reach of the crane, without the need for lifting, to manoeuvre the large, heavy items, like monopiles.

Limiting the lifting operations has several benefits: operations are less weather dependent, increasing operability and increased safety since less equipment is lifted in a dynamic environment.

A further benefit is the possibility of increasing the amount of simultaneous operations, depending on layout of the wind turbine and the required components. This can decrease the total operational time needed, for consecutive operations with the crane.

Upend stool

The upend stool is used for controlled upending of monopiles using a crane in combination with a lifting tool, flange or universal type. It prevents axial sliding of



Adjustable spreader

the monopile during upending by restraining the end or bottom of the monopile with hydraulic stoppers. The stoppers can move down to transfer loads to the crane, in order to prevent the total weight of the monopile being suspended in the upending system.

By means of two hydraulic cylinders the upending frame is kept in a vertical orientation. With the monopile in vertical orientation the crane is capable of lifting the monopile out of the upending system. The upending system is then tilted back to a horizontal orientation.

Lifting tools

Lifting operations can commence once the to-be-installed component is manoeuvred within the reach of the crane. To simplify rigging and lifting operations and minimise the effects of the wave motions on a pile, inducing relative motions between

installation vessel and the object of installation, we have developed a range of lifting tools: tools which speed up rigging operations of large items and minimise the influence of wave motions to ensure installation tolerances are met.

Containerised nacelle spreader lifting tool

The lifting tool is used for engaging, or grabbing, a monopile and additionally supporting its rotation during the lifting operation, while upending it. The lifting tool simplifies rigging operations by making rigging slings and cables superfluous. The lifting tool's functionalities reduce the time needed for rigging and the different types of rigging equipment needed to rotate the monopile from horizontal to vertical orientation.

The grabbing functionality of the lifting tool is achieved with the flange clamping

mechanism, which engages a monopile flange with its "claws", while the pivot arm is locked to prevent rotation whilst stabbing the flange. Before lifting is started the rotating pivot arm is unlocked, supporting the rotation of the monopile and flange clamping mechanism of the lifting tool while hoisting the monopile.

Under load the flange clamping mechanism is self-locking. After upending and installation of the monopile, the lifting tool is rested on the flange with slack lifting slings. With no loads on the clamps, the locking mechanisms on the flange clamps can be released and the flange clamps can be retracted. With the flange clamps retracted, the lifting tool can be lifted off the monopile.

The lifting tool is then rested on a flat surface, slackening the slings to lower the pivot arm. When the pivot arm is horizontal it is locked in position. Now the lifting tool is ready for a second upending cycle.

The described lifting tool is specific for the upending of monopiles with a flange. For multiple lifting operations, which require different lifting methods, Huisman has developed a "universal" lifting tool. This tool can be used as a spreader bar, internal friction clamp and flange clamp.

Transition piece lifting tool

The transition piece lifting tool lifts transition pieces for wind turbines in a vertical orientation. It engages the flange of the transition piece with a temporary cover construction. The long legs descend underneath the flange with the cover structure in place and then the failsafe flange grippers engage the flange using pneumatic pistons.

The lifting tool is installed on top of the transition piece. To prevent hitting access in the transition piece and ensure the correct height to unfold the lifting tray, tool position stoppers stop the transition piece lifting tool at the correct height. When the



tool is installed fail safe lifting trays unfold underneath the flange of the transition piece.

Once the transition piece lifting tool is in use, the lifting trays are locked in position by the load. For a redundancy on safety, opened and closed positions of the lifting trays are detected to provide the operator with feedback information.

Containerised nacelle spreader

The containerised nacelle spreader is an adjustable spreader which can adapt to a range of wind turbine nacelles and can be folded to minimise its storage footprint.

The spreader is fully containerised. When the spreader is folded to its minimum dimension it conforms to a standard 20ft ISO container.

It is also equipped with container corner castings for transport and handling purposes. The containerised design allows for cost effective and straightforward transport of the spreader. The required storage on board the vessel is reduced since no additional containers or transport frames are required.

The spreader is equipped with seven lifting eyes on top for standard shackles, allowing various 2-point, 3-point and 4-point rigging configurations to the crane hook. The

folding arms have a hole-pattern along the length of the arm for adjusting the rigging to the dimensions of the load. The spreader length can be adjusted with the telescopic beam actuated with a hydraulic cylinder. The beam is fixed in position using manually operated locking pins.

Motion compensated pile gripper

The motion compensated pile gripper is designed to guide piles efficiently to the required position and keep them centralised while installing from a floating vessel. The gripper can adjust to a range of diameters without needing modification, including altering the diameter to conical pile sections.

For enhanced procedures such as rotating and upending a pile, without the use of a crane, the pile gripper can be upgraded with upending and rotation systems.

To pick up a pile positioned alongside the vessel, hanging from a crane, within the reach of the gripper, the gripper is rotated from vertical stowage position to horizontal position, with arms fully opened. Once the gripper is in horizontal position with the pile between the gripper arms, the arms are closed around the pile.

The gripper's design ensures that the piles, within the operational range, are always centralised. This is done by measuring the

position of the pile gripper arms and synchronising their positions. Position feedback is given to the operator for verification and can be used to interlock with other systems.

Each gripper arm is equipped with two polyurethane coated rollers in order to protect the pile. These rollers are placed horizontally to allow the pile to move freely in vertical direction. Platforms on the gripper give a safe access to the pile perimeter and rollers.

The pile gripper is equipped with motion compensation to compensate relative motions between the installation vessel and stationary pile. This ensures that the pile remains upright while piling it into the seabed.

With future accelerated growth of the number of offshore windfarms under construction, Huisman supports its clients with offshore wind installation tools and the continued evolution of new tools. This will ensure they can excel in creating the future energy supply by building new wind farms faster, safer and more cost efficiently.

The next step of development in this range of tools will be the creation of a tool package adapted to the maintenance of these future energy farms.

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