

Technical Article

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Reducing the Downtime of Offshore Operations to a Minimum

Rexroth launches a new generation of hydraulic [Active Heave Compensators](#)

The expression ‘time is money’ is intensely relevant in the offshore, maritime and dredging sectors. When surging seas force cancellation of work, each hour of inactivity equals no production and no profit. With an innovative range of [Active Heave Compensators](#) Rexroth has the technology to optimize underwater operations even in heavy weather conditions.

Rexroth’s [Offshore & Dredge Technology](#) division develops solutions for the offshore oil and gas, dredging and the maritime sector. According to Ad J.G. de Brouwer, working with Offshore & Dredge Technology in the Systems & Engineering business group of Bosch Rexroth Corporation, the company has more than fifty years’ experience eliminating the effects of wave motion. “For example, the Rexroth Active Heave Compensators systems can respond extremely accurately and rapidly to the most changeable movements of the sea. This means that ships can continue to work for far longer, even in heavy weather and rough seas,” he said.

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In the past, excessively high waves often brought operations to a halt, leading to weeks and even months when lowering and lifting materials and equipment to and

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from the seafloor could not be done, depending on climate and location. Advanced measurement and control technology combined with modern hydraulics and pneumatics from Rexroth have added months of extra work time for offshore industries on a global basis.

Active Heave Compensators

Rexroth was involved in developing the first generation of Active Heave Compensators for Gusto BV, built around an intelligent, extremely rapidly controlled dual-function hydraulic cylinder platform. The new technology was a success for a number of reasons. “It dramatically improves a ship owner’s operating time, and earnings potential,” emphasizes Arnold Krielen, in the Offshore Technology group at Rexroth. “Better compensation of the heaving of a working vessel means that work can continue for longer.”

The Active Heave Compensation (AHC) system makes the raising, lowering and handling of loads on floating vessels much safer and easier. The wire carrying the load is routed from the towing winch through the AHC system to actively compensate, or in effect cancel out, the ship’s movements in the pitch and swell of the open sea.

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The AHC System combines hydraulic, pneumatic, and electric power and control component, integrated into the following units:

- Heave Compensator Unit (HCU), containing the Rexroth Hydraulic Cylinder Assembly, along with special front and aft wire guides called sheaves, and located in a dedicated, containerized housing that can be easily positioned on aft decks;
- Air Vessel Unit (AVU), a completely outfitted air pressure vessel unit, optional in a housing
- E-H-P Power Pack (PP) the containerized electric, hydraulic, and pneumatic power generation and control
- Operator Control Panel (OCP) contains the controls and condition readouts to operate and monitor the AHC system.

All the major components are housed in hardened, weatherproof containers, for efficient placement and integration with existing aft deck winch systems. Secure hatch covers isolate equipment from air and water penetration during non-operating conditions.

An effective Active Heave Compensator increases the safety of the ship, the cargo and the crew and significantly reduces the risk of damage to components intended for placement on the seabed.

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AHC In Operation

AHC in operation works like this: A load (undersea pipe, for example) is suspended by steel wire rope. The wire rope comes off the ship winch, and then is run through two sheaves attached to the HCU rod, which is attached to the Rexroth Hydraulic Cylinder Assembly. The wire and load are then “reeved” over an overboard sheave unit into the water.

To control the operation, the AHC Cylinder contains both an active and passive part. A passive heave compensation compartment suspends the static load – the pipes being lowered. This passive system is pneumatically powered, rather than hydraulically, and acts as a spring with a low spring coefficient. This essentially “zeroes out” the load at the end of the wire rope.

A Motion Reference Unit measures the movements of the vessel in pitch, roll and heave directions. The control system uses the output of the MRU to calculate the required AHC cylinder movement and controls the cylinder to follow the desired movement as accurately as possible. The sheave assembly attached to the AHC cylinder moves back and forth, counteracting the movements the ship is experiencing. This results in a nearly steady position of the lift point (at the location

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of the overboard sheave) and thus a nearly steady load with respect to the fixed world.

Undersea work of this type is most common in the oil and gas industry. It typically includes work such as oil and natural gas pipeline construction and repair, placement of oil and gas wellheads on the seafloor, as well as constant maintenance and repair activities. Other potential uses include underwater mining, salvage, geotechnical surveys, and dredging – essentially, any activity requiring controlling movement of loads to and from the sea floor. The loads carried on the steel cables can be up to 700 tons (for steel and concrete pipeline support structures) and be lowered to depths reaching 300 meters.

These applications frequently involve expensive, heavy components and require a high level of control, particularly when being placed with or linked to other components on the seabed. One major risk: as pipelines and other components are lowered in heavy seas, the greatest danger arises if the construction moves up and down and act as a destructive hammer – to itself, and whatever else is already in place on the installation site.

In addition to the dangers posed by wave motion, work is being conducted at increasing depth, increasing the risk that the long cables, set in motion by the

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movement of the ship on the ocean surface, can act as oscillating springs. The deeper the depth, the longer the cable, which can magnify the destructive forces if not properly controlled. If something goes wrong it may not only lead to damage to the construction, but may also have significant environmental impact caused by damaged oil or gas pipes on the seabed. Active Heave Compensation helps to prevent this type of disaster.

Secondary Control Technology

Active Heave Compensation enables the movements of the cable taking the load to the seabed to be independent of wave motion and/or oscillating movements in the cable. Rexroth is continuing to enhance AHC design and component integration, says Manager Design & Development Maarten Kuijpers. “For this purpose we have not only the proven linear system but have also developed a new range of rotating Active Heave Compensators (AHC) that also uses the energy-efficient secondary control.” In this configuration, the primary load (the element being lowered or raised) and the additional wave motion and oscillations are managed and compensated by means of a secondary control system. During the operation, the cable load and the movements of the ship are constantly monitored with accurate, fast sensors. The signals produced by these sensors are then translated by a specially designed control system into dynamic control of the secondary motor, actively

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controlling the load in real time. There are various control software packages for different load, range and pressure settings.

This system design offers an additional advantage: the use of an integrated energy recovery system based on hydraulic accumulators. “The interesting possibility provided by hydraulics is that you can convert motion into force and then store this force in Rexroth hydraulic accumulators,” Kuijpers said. The fact that the ‘brake energy’ is stored in the hydraulic battery means that the AHC systems can operate with far less installed power capacity. For example, 600 kW of hydraulic power drives a system with a total capacity of 3.6 MW. This saves you a factor of six on installed capacity.

New active winch system

“We keep listening carefully to the market and continuing to develop improvements for the system,” adds Ad de Brouwer. “On the one hand ship operators would like an AHC, but on the other hand they do not want extra equipment on deck. So compact construction is important.”

This is why the passive (pneumatic) and active (hydraulic) cylinders in the linear AHC are integrated, or “piggybacked” into a single multifunctional cylinder. It means that the system requires far less space on deck, leaving far more space for the

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storage of equipment to be installed on the seabed. According to de Brouwer, another feature of the linear AHC is that the system is relatively easy to install and remove. The containerized equipment can be moved quite simply when not needed, or if it is to be mounted on a different ship.

The linear AHC is ideal for the handling of large loads up to 1000 tons. However, the linear AHC is a little on the 'heavy side' for lighter applications handling loads between 20 and 100 tons. Rexroth has now developed a compact alternative solution for these needs: an AHC system that is built directly onto the winch and therefore requires no extra equipment on deck. This system can be installed during ship construction, offers a cost effective alternative for installing active heave compensation in the case of overhauls or retrofits of the winch system on existing vessels.

In the rotating AHC system the winches are fitted with a number of adjustable hydraulic axial plunger motors, size and quantity determined by the desired/required winching capacity. The RPM (and torque) of the motors can be adjusted with the adjustable wire rope laying plate, which varies the laying volume. The motors are also fitted with 4-quadrant control (left, right, harder, softer), to respond to pitch, yaw and roll of the ocean surface. The rotating AHC system also uses the hydraulic energy recovery and storage system. A revolving cable drum represents a significant

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quantity of kinetic energy and when the cable is slowing (= decelerating) the Rexroth motors convert this energy into hydraulic pressure and store it in a hydraulic accumulator. In comparison with the linear system this rotating AHC system requires less complex pressure regulation around the Rexroth hydraulic accumulator. This system is also more energy-efficient; the kinetic energy of the cable drum can be recovered, which is not possible with the linear system. The rotating AHC system is also easier to operate and requires less manpower to use: it is integrated into the winch controls and functions fully automatically when the desired 'mode' has been activated.

System integrator

Rexroth has been recognized as a world leader in innovations in AHC solutions, according to de Brouwer. "Especially with the rotating system, we are responding extremely effectively to the demand for Active Heave Compensation on ships placing less heavy components on platforms or the seabed."

To continue this leadership, Rexroth has created custom in-house simulation programs used to develop not only Active Heave Compensators, but also Deck mating Systems that can position platforms with millimeter accuracy. "As a system integrator we have all the techniques required to develop, build, optimize and service these systems," de Brouwer said. A further advantage is the Rexroth global

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network; potential markets and AHC users are located on every major maritime operations area, from the Gulf of Mexico to mouth of the Niger River, and Rexroth has expert resources available wherever they are needed.

Photo Captions & Thumbnail images:



(AHC.jpg) Basic impression of a Rotating Active Heave Compensator ready to lower a subsea template.



(AHC_on_deck.jpg) Top view of a Rotating Active Heave Compensator (in left corner) illustrating the compact construction, requiring far less space on deck.



(Linear_AHC.jpg) Linear Modular Active Heave Compensator Systems installed on board of Norman Installer. Photograph with courtesy of: Gusto B.V.

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(Seatrial.jpg) Seatrial of MAHCS (Modular Active Heave Compensation System).



(Norman_Installer.jpg) Norman Installer, equipped with 175 t MAHCS for installation of suction anchors at 2000 meter depth.

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