Heave Compensation Systems: Keeping loads steady under any conditions
Enlarging your window of operation for handling loads

Since mankind started using sea-going vessels, the heaving of ships caused by waves has made it dangerous to handle loads safely without damages. Even today, waves are still a limiting factor. Every day, ships or offshore platforms have to wait until the sea calms to load and unload. Heave Compensation Systems from Rexroth finally minimise this time wasting tradition by enlarging the window of operation.
Rexroth has been a leading supplier of components, modules and engineered-to-order systems for the maritime and offshore industries for more than 60 years. The electric and hydraulic drives and electronic controls prove their reliability and robustness in thousands of applications around the world. As a system supplier, Rexroth develops and manufactures complete automation solutions.

We built the first Heave Compensation Systems decades ago. Since then we have been realising complete drive and control systems for Heave Compensation of any design and size: from a single 5 metric ton winch to the world’s largest working vessels that can lift loads of up to 48,000 metric tons. Based on our experience and expertise we have created a large portfolio of proven components. Additionally, a newly developed control platform allows us to deploy standard solutions to cranes and winches for the first time. Your benefits: lower system costs, shorter time to market and one stop shopping for proven Heave Compensation Systems.

We offer more than tried and tested components and modules, certified by the leading classification societies. We share our expertise with you from the sketch of your very first idea until the final commissioning. We help you to reduce the installed power needed for an Active Heave Compensation System up to 65%, saving floor space and fuel. Our engineering support includes the most sophisticated simulation software, meaning that our systems always work perfectly the first time around.

After commissioning your system, we remain available to you – everywhere and anytime. Our global service in more than 80 countries and at all major maritime and offshore hubs ensures that you get excellent service throughout the complete life cycle of your equipment.

Get further information at www.boschrexroth.com/heave-compensation
Passive Heave Compensation: The first step

Limiting loads in suspension systems while handling loads at seabed level is a basic requirement in the offshore industry. Even small waves make it difficult, and, as soon as they are higher than a few feet, it becomes critical to work safely. Passive Heave Compensation Systems (PHC) from Rexroth improve your economic capabilities for offshore and marine operations with minimal costs.

A passive heave compensation device acts as a spring device with a predefined, relatively low stiffness. It allows relative motion while keeping load variations in wires, suspending the load within acceptable limits. Passive heave compensation systems normally require no power supply for their operation.

A typical PHC device for riser systems consists of a hydraulic cylinder and a gas accumulator. Other types of passive heave compensation systems are drill string compensators, marine riser tensioners and hoist systems. Our well designed PHC devices can achieve efficiencies above 80%.
Active Heave Compensation: State of the art technologies

Fast reacting and stable, even when waves are considerably high; Active Heave Compensation Systems (AHC) significantly enlarge your window of operation and work safely under severe conditions. Rexroth has realised various types of AHC and is the only supplier for complete solutions with all drive technologies, hardware components, control systems and software.

AHC systems utilise actively controlled devices, which can operate in various modes depending on the required characteristics. They maintain a constant vertical position (AHC-mode) of a free hanging load or a constant tension (CT-mode) to a supported or fixed load.

In all AHC systems a Motion Reference Unit (MRU) measures actual vessel motions. Based on this data, the control software calculates the necessary counter motion of the hydraulic system and controls it in real time. By compensating more than 90 per cent of a ship’s movements, it’s possible to realise unparalleled precision and safe operations at any depth.

AHC systems can be based on hydraulic cylinders, on primary and secondary controlled rotary hydraulic motors or on electrical motors. We have already carried out all these designs, ranging from 5 metric tonnes to 48,000 metric tonnes. The reliability and versatile functionality of any AHC is a direct result of customizing all drive and control components. Only Rexroth can supply all these customized components from a single source, and has the experience for quality turn-key solutions.
Primary Rotary Active Heave Systems: Compact and accurate

Primary Rotary Active Heave systems (PAHC) are integrated into the winch drive system and require minimal space on deck. No additional operator is needed to achieve high accuracy and reliability.

PAHC systems from Rexroth are based on proven hydraulic pumps and motors that are manufactured in large numbers. The Motion Reference Unit sends its data to the main controller, which calculates the set point and, in real time, controls the hydraulic variable pump that is connected to a fixed motor. This involves adjusting the winch speed and direction by varying the swivel angle of the pump, thus regulating the volume flow rate. Hence, the primary active heave compensator is a closed loop hydraulic system.

State of the art PAHC systems are designed to recover energy in different phases of compensation by feeding it back to the electric grid, or store the energy in capacitors or fly wheels. The system adapts to varying load and operating conditions to maintain safe and efficient compensation, without overloading the winches. One special advantage: PAHC can also be integrated into already installed winches and cranes, enlarging the window of operation with minimal effort and cost.
Secondary Rotary Active Heave Compensation Systems: Saving up to 65% on energy costs

Fuel costs, green shipping and valuable deck space: Energy efficiency definitely is a major concern in the maritime and offshore industries. Secondary Rotary Active Heave Compensation Systems (RAHC) recover energy with every wave and reuse it. Ultimately, these systems use up to 65% less energy. Your advantage: a reduction in installed power, smaller footprint for the hydraulic power unit and tanks, less fuel costs and reduced exhaust emissions.

More than one hundred RAHC systems from Rexroth are in service in cranes and winches, positioning loads of up to 400 tonnes safely. Their principle is simple but genius: during the upward movement of the vessel the drive unwinds the winch cable that works like a pump. In the following downward movement the drive works like a motor, reusing the stored energy from the accumulator. RAHC systems respond dynamically, which is crucial in wave motion conditions that vary constantly.
Electric Rotary Active Heave Compensation: Fully electric up to 4 MW

Electric Rotary Active Heave Compensation Systems (EAHC) work similarly to RAHC, in that they also recover, store and reuse energy. Their hardware controls are identical to the hydraulic variants, simplifying operation, diagnosis and spare parts management. This makes our electric solutions compact, silent, excellent controllable, easy to install and to maintain.

More than 35 years ago, Rexroth developed the world’s first maintenance free AC-servomotor. Since then we have been a leading supplier of electrical drive technology. Today, we supply a complete portfolio of electric drives from 11 kW up to 4 MW of power. Our electro-mechanical drives are adapted to the special requirements of the maritime and offshore industries.

IndraDrive ML: Large electric drives from Rexroth for power up to 4 MW
Linear Active Heave Compensation Systems (LAHC) are intelligent solutions for standard winch-driven cranes and hoists that deposit loads to cavernous locations or onto the seabed. The system fits with nearly every existing winch system as an add on, consuming considerably less energy than other active heave systems.

In LAHC the Motion Reference Unit measures the heave motion at the location where the winch rope leaves the vessel, then compensates it with a special cylinder that combines both active and passive compensation capabilities. This cylinder pays out the wire when the vessel lifts up, and hauls the wire when the vessel lowers.

The LAHC concept provides the opportunity to further reduce the required power by combining both passive and active compensation in one system. The passive part accounts for the average load while the active part compensates for the wave-induced load variations.

One important advantage: we designed LAHC to be modular, making it easy to integrate it into nearly every vessel arrangement. It consists of four main modules:

- Cylinder-based integrated cable actuation system
- Hydraulic Power Supply
- High Pressure Air System
- Integrated Control System incl. Motion Reference Unit

Based on a closed force loop LAHC requires only a simple mechanical interface for the vessel structure, compensating more than 90% of the heave motion. Choosing our containerised option enables you to use LAHC anywhere in your fleet of similar vessels. The modular approach allows built-in flexibility for your individual systems.
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Custom Tailored Motion Compensation Systems: Mastering multiple degrees of freedom

In recent years Rexroth has been a pioneer in developing motion compensation systems, mastering the six degrees of freedom. First used in simulators for aviator training, we revised this concept to fit maritime and offshore applications. We already have applied this concept to helicopter decks on ships and to cranes on flat-top barges and supply vessels.

Our motion compensating platform for crane applications, developed in close collaboration with a marine company, is a highly economical solution. In order to prevent the crane-carrying platform from moving, the dominant three degrees of freedom – heave, roll and pitch – are compensated, while the other degrees of freedom – sway, surge and yaw – are restrained. The remaining three degrees of freedom are compensated by the trio of hydraulic actuators.

The first platform is installed on a standard flat-top barge, carrying a standard crawler crane with a maximum lifting capacity of 400–600 tonnes. It’s a self-sufficient system that is ready to be installed with its own controls, software and power supply.
Next generation controls platform: Modular in Hard- and Software

In the maritime and offshore industries an error-free and safe controls design is the most important requirement. We applied a modular design that was based solely on proven technologies and software modules in our next generation controls platform for Lifting Appliances and Active Heave Compensation Systems. The design features all functions and safety provisions as required by leading classification societies.

**Versatile software concept**

Our modular approach enables you to use a standard controls system, minimising maintenance and training effort. The software supports hydraulic drives with primary control, secondary control, linear actuation and electric drives. Prior to installation simulation models verify whether your drive system will reach the required performance within the given power constraints. The software covers the complete spectrum from simple winches without AHC and a single motor, up to large winches with many motors and redundant sensors.

A large set of proven technology functions encompasses:

- Standard operating modes and safety functions
- Normal hoisting and lowering in speed and position control
- AHC Active Heave Compensation mode
- ART Active Rope Tensioning mode
- ASP Anti Slack Protection mode
- MFM Monitored Freefall mode
- CT Constant Tension mode
- AOPS Automatic Overload Protection System
- MOPS Manual Overload Protection System

**Scalable proven hardware**

With our scalable controls hardware we can insert exactly the kind of digital performance your application needs. For stand-alone hydraulic winches we offer a cost-effective and extremely compact integrated control system for the HPU and a single winch drive. It provides analogue and digital I/O, closed loop axis control and integrated safety functions, such as a 2-channel stop function up to Performance Level d. This extremely robust hardware is used too by tens of thousands of construction and agricultural machines.

For larger systems, including multiple winches or complete crane functions, Rexroth offers a modular and powerful PLC with motion control functionality that uses the international standardised programming languages IEC 61131-3. It adds modular extensibility for controlling multiple winches as well as other electric or hydraulic axes and cylinders. It supports a large selection of communication interfaces like Profinet, Ethernet/IP, Modbus/TCP and others.

As an add-on, the safety PLC (SIL3) IndraLogic can be integrated. With its larger memory, excellent diagnostics and data logging functions it’s perfectly suited for customer specific extensions.
Energy Efficiency

Systematically combining energy efficiency and productivity, the four levers of Rexroth 4EE act across all technologies and applications. They guide us in the development of new products and system solutions. We already keep this systematic approach in mind, from its concept development phase up to installation and retrofit.

Safety on Board

Machines must not constitute a hazard to people: around the globe, this principle is implemented with more and more severity through international standards and regional laws. We help the maritime and offshore industries to fulfil their responsibilities with regard to the protection of man and machine in a standard-compliant and economical manner. Our integrated safety systems can even increase work ergonomics and productivity.

To ensure machine safety the entire system needs to be taken into account. From the drive level to the superordinate machine controls. With 'Safety on Board' we help you by providing standard-compliant products and system solutions for functional safety on all levels of automation and in different technologies. Safety principles as defined by ISO 13849 are applied.

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The four levers of Rexroth 4EE

- Energy System Design
- Efficient Components
- Energy Recovery
- Energy on Demand
**Fly wheels turn down costs**

Our active heave compensation systems are already designed to reduce energy consumption up to 65%. But when it comes to the high amount of power needed to lift several hundred tons, even the remaining potential is very interesting.

With respect to energy recovery for heave compensation systems the focus is on storage devices with typical charging times of 2.5 to 15 seconds. Apart from conventional approaches we have developed innovative solutions like applying a fly wheel. It can be used in both hydraulic and electric drive systems, and covers a wide range of cycle periods. Fly wheels are typically a very interesting solution in applications with more than 500 kW installed power.

This solution is not only ecological (less emissions) but also interesting economically, because it decreases the total cost of ownership significantly by:

- Reducing installed power and therefore investment costs
- Reducing energy consumption and therefore fuel costs
- Reducing exhaust emissions of prime mover

▶ Offshore winches with AHC fly wheel system: Interesting for applications with more than 500 kW fly wheels charge within 2.5 to 15 seconds in hydraulic as well as in electric drive systems
Saltwater-resistant and protected against explosion: The right components in the right place

Technical components on ships and offshore installations are exposed to extreme loading. Highly corrosive salt water, extreme temperature fluctuations and explosive atmospheres demand solutions that are specially conceived for this application. Rexroth offers a broad spectrum of components which are resistant to salt water and arctic conditions, thanks to the cutting edge Enduroq surface technology, as well as explosion-protected variants.

Protected against corrosion
Preventing corrosion and upholding function for many years and decades, Rexroth employs corrosion-resistant materials and durable coatings for its saltwater-resistant component and assembly groups. Furthermore, clever details protect the functional capability, like specially designed electrical connections. Saltwater-resistant valves, control blocks and cylinders have been demonstrating their durability and reliability in Heave Compensation Systems for decades.

Enduroq surface technology from Rexroth combines cutting edge coating processes, custom tailored sealing technology and state of the art tribology expertise - resulting in longer life spans and maximized availability of your hydraulic cylinders.

Suitable for arctic conditions
Temperatures down to minus 40 degrees Celsius demand special technical solutions. Rexroth offers a range of arctic-
resistant hydraulic valves and actuators that perform their functions reliably – even at extreme temperatures.

**ATEX-compliant explosion protection**
Gases, vapours, solvent fog and dust. Whenever technical operating materials are deployed in explosive or potentially explosive conditions, lawmakers and certification societies around the world stipulate special precautions, such as ATEX, in order to eliminate potential risks to people and to the environment. Rexroth has a broad range of components and solutions that will help you fulfil explosion-protection regulations. All the necessary components have successfully documented type examinations, and are marked accordingly. Rexroth guarantees the quality assurance and traceability of its products. Supplies always include the complete documentation, and are specified in numerous different languages.
Engineering partnership: Together with you from concept to commissioning

Ever more capable and more complex technology is changing the entire engineering process. Rexroth can support you all around the world with the expertise and resources of a global partner. Rexroth specialists use specially developed simulation programs to make sure the design of your Heave Compensation System is right for your application.

It often starts with a simple question: can’t we use a new, more efficient and reliable solution? The Heave Compensation System specialists at Rexroth love these challenges. They put all their knowhow and application experience into developing exactly the right solution, together with you.

As a multi-technology specialist, we approach every task with an open mind. Whether electric or hydraulic drive technology, controls or software. We examine every option until we have identified the most technologically and economically rational variant. We use simulation programs that we developed ourselves, which also take into account the special characteristics of fluid technology that help us examine all the options. Your benefits? Even before installation, you can rest assured that our solution will satisfy your specifications.

Experienced engineers will support you through the installation and commissioning process. As your project partner, we will prepare the documentation and program the software. That leaves you to focus on your core competences and still reduce your time to market.
Global service: Competence available when you need it

Rexroth Service is the competent partner for the entire life cycle of your equipment – from planning to service life extensions. Rexroth offers a broad range of suitable service products that help to prevent or at least significantly reduce downtimes.

Spare parts service: The right parts at the right place
If a component fails it’s important to get the right spare part without delay. That’s especially true for older machines and systems. Our experienced specialists will find the right solution in Rexroth’s extensive product range – quickly and anywhere in the world.

Product overhaul: Fast, economical and good as new
Why wait till a component fails? It’s often rational to replace worn or defective components during an already planned maintenance period as a preventive measure. That will increase the level of availability of the motor with minimal expense.

Repair service: Industrial services when you need them
It doesn’t always have to be a replacement. An economical repair is often possible – especially with expensive components and modules – if you choose Rexroth as your partner. Our service workshops will get your components back into working order quickly and as efficiently as possible.

Warranty: More security for your investment
After repair work has been performed, you will enjoy a new parts warranty on all components for a period of twelve months.
Heave compensation systems comprise a multitude of individual solutions. Each of them requires the same attention and must meet the highest requirements with regard to reliability, performance and safety – over the entire lifecycle. We support you with a service network specialised in offshore applications at all major marine hubs in the world.

Bosch Rexroth has been an established partner for the international marine and offshore industry for more than 60 years. We have planned and installed tens of thousands of large cylinders and complex drive systems around the world. We know that this also implies long-term responsibility.

From our location in Boxtel experienced specialists coordinate our offshore service locations in Houston, Singapore, Rio de Janeiro, and Changzhou. They have the expertise and the resources of significantly extending the availability of your heave compensation systems. You can contact them directly at specialized.service@boschrexroth.nl.

Be it large hydraulic cylinders, winch control blocks, axial piston units, heavy duty drives, hydraulic systems and controls or project partnerships for your next big idea. Send us a brief email or call us so that we can discuss how Rexroth can help you reliably increase your company’s performance.

Get further information at www.boschrexroth.com/service
Exactly

Tough application, ingenious solution

Your benefits

- Certified components
- Proven reliability
- Increased performance

- Fulfilled safety
- Preserved environment
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