IHC MERWEDE

IHC Merwede

Insight

Dredging | Mining | Offshore

Autumn 2012 | E 1

God of the sea

Sound engineering for underwater piling

Dredge hoses and floating discharge lines

Cutter suction dredger SHANTI SAGAR XVI

The technology innovator.

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Welcome

Dear reader,

Welcome to the first edition of *IHC Merwede Insight*, the new name for our long-standing title, *Ports and Dredging*. You may have noticed a fresh design for the last issue and we will be combining this with other improvements for 2013. These include the launch of a sister publication in the form of an all-new digital version of *IHC Merwede Insight* (see page 11).

Our aim is to broaden your understanding of IHC Merwede's innovative vessels, advanced equipment and life-cycle support. This issue is no exception, bringing you an insight into the development of the dredging, mining and offshore industries and projects from around the world.

The first feature is about GeoSea's (part of the DEME Group) new turbine transport and installation self-elevating heavy-lift jack-up vessel, the NEPTUNE. She is able to autonomously transport and install offshore wind turbines in a single operation. IHC Merwede delivered the intricate vessel on schedule, allowing her to complete her maiden job on the far shore wind turbine farm at Thornton Bank. Some special features were incorporated into the design of the NEPTUNE, such as autonomous, DP2-certified propulsion capability and a safe crane rest for the impressive 600 tonnes @ 26m crane's boom.

IHC Merwede delivered another IHC Beaver® 9029, the SHANTI SAGAR XVI, to a rapidly expanding customer, Adani Ports and Special Economic Zone, established at Mundra, India. The new vessel has two new features, she has been equipped with IHC Drives & Automation's variable frequency drives and the task of her operators has been simplified by the latest generation of IHC Systems' Automatic Cutter Controller.

As the SHANTI SAGAR XVI was delivered with a substantial number of IHC Parts & Services' floating pipelines, the third feature focuses on this subject. It highlights the innovative aspects of these components, their reliability and high availability, accompanied by affordable prices and beneficial perspectives.

IHC Hydrohammer® and IHC Offshore Systems have joined forces for the realisation of sound mitigating measures and systems for underwater piling systems. The subject only has a brief history, but the companies have succeeded in thorough research and development, resulting in a large sound-insulating system for piles of up to and over 6m in diameter. The results are promising and provide a new perspective on the integration of economic and sustainable development in underwater piling technology.

Raymond Hendriks
Manager Corporate Communication

IHC Merwede Insight

Coordination:
K. Jansen
Corporate Communication IHC Merwede

Production:
Red International Communication, UK

Editorial committee:
Y. van Beek, M.O. Boor, H.J. Cornegé, R. Hendriks, K. Jansen, S.G. Mensonides, M.P. van der Sluijs, F. Vrooland, J. van Overhagen, E. Put, N. Stam

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IHC Merwede Insight is published by IHC Merwede.

Editorial and correspondence address:
IHC Merwede, PO Box 204,
3360 AE Sliedrecht, The Netherlands.

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For more information about any article, please contact **IHC Merwede**.

Huge finance agreement for IHC Merwede

A ceremony for the largest ever working capital guarantee issued by Atradius Dutch State Business – on behalf of the Dutch Government – took place on Thursday 5 April 2012 at IHC Merwede's shipyard in Krimpen aan den IJssel. With this finance agreement in place, IHC Merwede will start work on the construction of two pipelaying vessels for its Malaysian customer SapuraCrest.

The ships are part of a recent offshore order worth €450 million and will install flexible pipelines in Brazilian waters, where large quantities of oil have been discovered. The delivery dates for the vessels, which will be built in The Netherlands, have been set for May and August 2014 respectively.

IHC Merwede has signed a working capital finance facility of €200 million with its bank consortium, formed by ABN AMRO, BNP Paribas, Deutsche Bank, ING and Rabobank. The banks are providing the capital because Atradius Dutch State Business covers the repayment risk through a working capital guarantee in the main. The facility will be used by IHC Merwede to cover the construction costs.

The guarantee has been developed after close cooperation with the Dutch Ministries of Finance and Economic Affairs, Agriculture and Innovation, banks and exporting business. The overall aim is to promote the provision of working capital to Dutch capital goods exporters, so that they can have access to the required financial resources. Since the introduction of this facility in 2010, hundreds of millions of euros have been provided as coverage. The SapuraCrest order is the largest financing facility covered by a Dutch State working capital guarantee.

"We are delighted to have received this huge order in recognition of IHC Merwede being a supplier of high-quality technological vessels and equipment," says IHC Merwede's President Govert Hamers. "Apart from the technology at our disposal, being able to offer a financial package was decisive in securing this sale."

"The funding of this important transaction came about thanks to the joint efforts of IHC Merwede, its banks and Atradius," says Johan Schrijver, the CEO of Atradius Dutch State Business. "Our coverage has made a competitive financing package possible, and due to this, the order has been awarded to a Dutch company. This puts our country on the map as an export nation."

IHC Merwede increases revenue and profit

IHC Merwede's international outlook and expanding portfolio have helped it to record increased revenue and profit figures for 2011, and maintain its strong order book for 2012 and beyond.

In the past year, IHC Merwede's revenue has increased by four per cent to reach €1.05 billion. The company's net profit has also increased to €103 million with a solvency ratio of 40%, demonstrating that IHC Merwede is in strong financial health and able to implement its growth strategy. With sales amounting to €1.057 billion, IHC Merwede assured itself of a substantial order book of €1.18 billion – the equivalent of more than one year's workload.

Internationalisation continues to be an important priority for IHC Merwede as it succeeds in reducing costs and meeting the needs of its markets. In addition, the company offers a one-stop shop approach of fully integrated vessel and equipment packages, which have proved to be a powerful business proposition. IHC Merwede is continuing to expand its capabilities and portfolio through acquisitions and by forging links with other organisations to help build long-lasting customer partnerships.

"The financial results for IHC Merwede represent a great achievement for all concerned," says IHC Merwede's President Govert Hamers. "This is a clear sign that our strategic approach is making a significant impact with an integrated offering of innovative vessels, advanced equipment and life-cycle support across the dredging, mining and offshore markets. The long-term future also looks good for the business as a whole and the expectation is that IHC Merwede will maintain its revenue over the next financial year."

Introducing IHC Tidal Energy and Wave Rotor technology

On 30 May 2012, IHC Merwede signed an agreement to acquire Wave Rotor technology from Ecofys, which is renowned for its expertise in sustainable energy solutions. The technology, which will be managed by the newly established company IHC Tidal Energy, enables IHC Merwede to further secure its position in the renewable market.

In contrast to most tidal turbines, the Wave Rotor is vertically oriented. It converts power from tidal currents and wave motion directly into electricity. It is a patented innovation from Ecofys that has been developed over the past ten years and successfully demonstrated in a 30kW pilot plant in the Westerschelde.

After the Wave Rotor was developed, it was brought through the pre-commercial stage by OceanMill. The company proved that the technology has enormous potential and is commercially viable. IHC Tidal Energy has set its goal to successfully bring the acquired technology to market.

The Managing Director of IHC Tidal Energy, Willem Steenge, says: "The acquisition of Wave Rotor technology enables IHC Merwede to launch a fully integrated system to generate electricity using tidal energy. IHC Merwede will contribute to the sustainability of our world. The investment in this market also fits well into the company's strategic portfolio."

DCI DREDGE XIX destined for Hooghly River

IHC Merwede has successfully named and launched the 5,500m^3 trailing suction hopper dredger, DCI DREDGE XIX, in a ceremony on 2 April 2012 at the company's shipyard in Krimpen aan den IJssel, The Netherlands. It is building the innovative vessel for Dredging Corporation of India Ltd.

The contract for the design, construction and delivery of the vessel was signed between Dredging Corporation of India Ltd and IHC Dredgers on 29 April 2010. The keel was laid on 12 September 2011 and the vessel will be delivered in the third quarter of 2012.

DCI DREDGE XIX is the first vessel from a series of three (including the DCI DREDGE XX and DCI DREDGE XXI) and will be built under dual class (Lloyd's Register and Indian Register of Shipping). IHC Merwede has previously delivered ten vessels to Dredging Corporation of India Ltd.

The vessel will be deployed for the maintenance dredging project on the Hooghly River, which is a tributary of the Ganges River in West Bengal. The DCI DREDGE XIX is specially designed for this task, taking into account the Hooghly River's soil properties, strong current and shallow depth. The DCI dredgers will have high productivity, reliability and efficiency capabilities, as well as low power consumption and operational costs.

IHC Lagersmit renamed IHC Sealing Solutions

IHC Lagersmit B.V. has changed its name to IHC Sealing Solutions B.V. This change, which came into effect on 6 July 2012, is the result of the continued international growth that the company has experienced in recent years. Additionally, the company's focus has shifted from the manufacture of bearings to the production and marketing of seals for rotating shafts.

The origins of the company date back to 1856, when the machine factory DLS was established in Kinderdijk, The Netherlands. From 1956 onwards, the company – which produced bearing bushes and stern tubes – changed its name to Lagersmit, to which IHC was later added.

From that time on, the company increasingly focused on manufacturing seals for, among other things, stern tubes, thrusters and pumps. Two years ago, the company moved from

Kinderdijk to Alblasserdam, where a fully automated production facility operates in brand new premises.

Willem Steenge, Managing Director of IHC Sealing Solutions, says: "It is important that we use our name to let people know what we are good at, which is specifically finding the right solution for the customer as far as seals are concerned. Also, IHC Lagersmit was difficult to pronounce – let alone understand – for our international business partners."

Impressive new facilities for IHC Merwede

IHC Merwede officially opened its new Singapore office on 12 April 2012 at the PSA Building (right). This will be the headquarters for IHC Offshore & Marine's South East Asia businesses.

The new venture will focus on promoting IHC Merwede's Offshore & Marine vessels and technology solutions. In addition, it aims to secure building capacity to complement its Dutch yards and add to the considerable marine engineering capability.

Regional CEO Denis Welch says, "IHC Merwede is not just a shipbuilder per se, but also an aggregation of engineering and manufacturing companies, which combines to provide unique and value-added solutions to its customers."

The new office was the venue for the official opening party attended by HE Mr Johannes W. Jansing, Ambassador for the Kingdom of The Netherlands, as well as business partners and industry leaders.

Meanwhile, IHC Merwede has also opened a new facility in Broussard, Louisiana, USA. The yard will operate under the name of Hydro-Ram, Inc., and with this expansion, IHC Merwede now has a regional office in North America.

Hydro-Ram, Inc. consists of IHC Hydrohammer®, IHC Handling Systems and IHC Fundex Equipment. It will be the main distributor covering the North American piling markets for the oil and gas, offshore wind, construction and coastal and civil industries.

The new site's facilities include storage for a large rental fleet, maintenance operation and the main strategic spare parts hub for all of IHC Merwede's pile installation equipment. With the local presence provided by Hydro-Ram, Inc., from 1 January 2012, Bauer Pileco is no longer representing IHC Merwede in the North American market.

Latest cutter suction dredger named MIONDO

The stationary cutter suction dredger, MIONDO, was named and launched by IHC Merwede in a ceremony on 16 May 2012 at its shipyard in Sliedrecht, The Netherlands. The company is building the innovative vessel for Marina & Ports Services Ltd, which is based in England.

The contract for the design, construction and delivery of the vessel was signed between Marina & Ports Services Ltd and IHC Beaver Dredgers in March 2011. The keel was laid on 6 October 2011 and the ship will be delivered in the third quarter of 2012.

The MIONDO is a custom-built IHC Beaver® with a capacity of 4,836kW and she is capable of dredging a wide range of materials. The vessel is equipped with two Cutter Special® dredge pumps, which are specially designed with a large sphere passage for cutter suction dredging operations. The anchor boom allows her to operate in remote areas with limited support equipment.

Goddess of the hunt sets sail

The IHC Merwede shipyard in Sliedrecht, The Netherlands, hosted a ceremony to name and launch the self-propelled cutter suction dredger, ARTEMIS, on 30 June 2012. The ARTEMIS, which is being manufactured for Van Oord, is one of the largest cutter suction dredgers ever built in The Netherlands for a Dutch dredging company.

The contract for the design, construction and delivery of the vessel was signed between Van Oord and IHC Dredgers on 20 December 2010. The ship will be delivered in the first half of 2013. The name is consistent with Van Oord's tradition of naming its cutter suction dredgers after legends in Greek mythology. Artemis is known as the goddess of the hunt.

A particular feature of this vessel is the spud carriage with hydraulic buffering which makes it possible to work for longer periods in bad weather. As a result of the close cooperation between Van Oord and IHC Merwede, much attention has been paid to the ergonomic design of the ARTEMIS. For example the deckhouse will be mounted on air springs to minimise noise and vibrations in the accommodation section.

Purchasing agreement with Berg Propulsion

IHC Sealing Solutions and Berg Propulsion have further strengthened their cooperation by signing a General Purchase Agreement (GPA). The agreement was signed by Mr Willem Steenge, Managing Director of IHC Sealing Solutions, and Ms Marit Börjesson, Managing Director of Berg Propulsion, during the SMM exhibition in Hamburg (see picture).

The GPA officially grants IHC Sealing Solutions the status of preferred supplier, based on its reputation of high-quality seals and fast international deliveries. The signing of the GPA underlines the close, worldwide cooperation that both companies have established over the years.

Working agreement signed with Jaya

IHC Asia Pacific, a subsidiary of IHC Merwede, has signed an agreement with Jaya Shipbuilding and Engineering Pte Ltd, which enables IHC Asia Pacific's high-specification offshore vessels to be produced by Jaya at its yards in Singapore and Batam, Indonesia. As part of the wide-ranging terms, IHC Merwede will also provide engineering support services to Jaya.

The agreement creates the opportunity for future cooperation between the two companies. It is compatible with Jaya's strategy of building sophisticated and modern offshore vessels and IHC Merwede's plans for further expansion of its integrated shipbuilding and equipment manufacturing operations in the region.

World's largest backhoe dredger

The largest backhoe dredger in the world was launched by IHC Merwede on 31 August and later named ALBERTO ALEMÁN ZUBIETA on 28 September 2012. Both ceremonies took place at the shipyard of its cooperation partner, NMC, in Nieuw-Lekkerland, The Netherlands. IHC Merwede is building the vessel for Autoridad del Canal de Panama (ACP).

The contract for the design, construction and delivery of the backhoe dredger was signed between ACP and IHC Global Production on 9 April 2011. The keel was laid on 13 December 2011 and the vessel will be transported to Panama in the fourth quarter of 2012.

The vessel has been designed and built using the latest technological developments. The width of the pontoon is greatly enlarged in connection with the stability of the dredger. The backhoe dredger will be equipped with a diesel-hydraulic modified Komatsu PC5500 excavator. Due to this, the dredger has a maximum dredging depth of 19.5m with a 13.5m^3 bucket. The vessel has been designed to be equipped with an even larger excavator in the future: the modified Komatsu PC8000.

The backhoe dredger will initially be used for the expansion of the Panama Canal and subsequently for its maintenance. It's not the first vessel that IHC Merwede has built for ACP. With the successful delivery of the cutter suction dredger QUIBIAN 1, IHC Merwede has already proved itself to be a professional and reliable partner.

Huge piling hammer for Seaway Heavy Lifting

IHC Hydrohammer® has been awarded a contract by Seaway Heavy Lifting to design and manufacture the S-2500 piling hammer, which is the largest ever built by the company. IHC Hydrohammer is delighted to be chosen as the supplier of this equipment and the order highlights the strong and reliable cooperation that has developed between the two companies over more than 20 years.

The order also includes a 6,500mm guide sleeve and other equipment needed for offshore operations in both the oil and gas and offshore wind markets. The piling equipment will primarily be used for the installation of monopiles with an outer diameter of 6,500mm.

The S-2500 piling hammer is suitable to reach 2,500KJ of impact energy. The 6,500mm guide sleeve is the largest available in the world. This new and unique order takes IHC Hydrohammer to the next level in providing piling solutions, now and in the future.

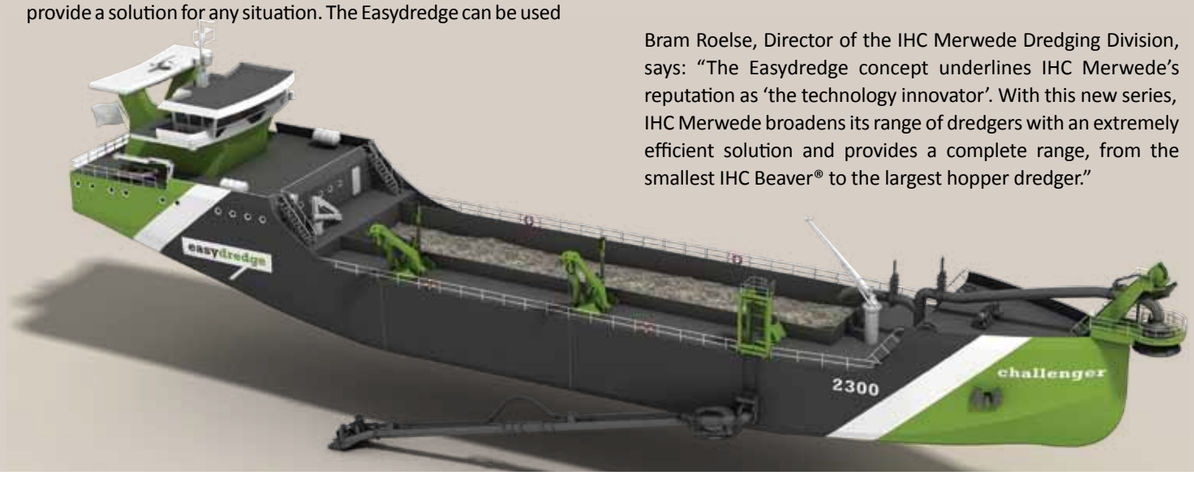
IHC Merwede reveals Easydredge

IHC Merwede has launched a new budget range of small hopper dredgers under the name of Easydredge. This is in response to the increasing global demand for smaller dredgers. The sophisticated design, standardised components and smart production choices make this an extremely cost-effective concept with a short delivery time. The Easydredge series bridges the gap between the existing line-up of IHC Beagle standard hopper dredgers and the standard IHC Beaver® cutter suction dredgers.

Available in three sizes (Easydredge 1300, 2300 and 3300), the new vessels are tailor-made using option packages and can provide a solution for any situation. The Easydredge can be used optimally for maintenance dredging, land reclamation, and the extraction of sand and gravel at sea. The option packages can also be added later to the ship, making it a highly flexible concept. The vessels are produced using the IHC Merwede network of partner sites or on a local-for-local basis.

The range incorporates the latest technology and engines to ensure green propulsion and durability. This reduces fuel consumption and will help the dredging market to meet increasingly stringent environmental regulations. The vessels already comply with the requested requirements for 2016 (Tier 4) and are suitable for 'unrestricted navigation'.

Bram Roelse, Director of the IHC Merwede Dredging Division, says: "The Easydredge concept underlines IHC Merwede's reputation as 'the technology innovator'. With this new series, IHC Merwede broadens its range of dredgers with an extremely efficient solution and provides a complete range, from the smallest IHC Beaver® to the largest hopper dredger."



Successful launch ceremonies for DOHUK and KARBALA by IHC Merwede

The 500m³ grab hopper dredger, DOHUK, and the 3,500m³ trailing suction hopper dredger, KARBALA, were unveiled in two ceremonies on 25 July 2012 at IHC Merwede's shipyard in Krimpen aan den IJssel, The Netherlands. The DOHUK was launched early in the morning, followed later by the ceremony for the KARBALA.

The vessels were named by breaking a jar of yoghurt over the bow. They are being built for Toyota Tsusho Corporation, although the operator will be the General Company for Ports of Iraq (GCPI). Both ceremonies were performed by Mr Hussain Mohammed Abdullah, GCPI's Project Director.

The contract for the design, construction and delivery of both vessels was signed between Toyota Tsusho Corporation and IHC Dredgers on 21 October 2010. The keel of the trailing suction hopper dredger was laid on 10 January 2012 and of the grab hopper dredger on 9 March 2012. Both vessels will be delivered in the fourth quarter of 2012.

The vessels are functionally equipped and solidly built, with much attention paid to low maintenance costs. They will be used mainly for maintenance work in various Iraqi ports, although the KARBALA can also be used for land reclamation projects.

IHMQ certificate awarded to IHC Merwede for health management

IHC Merwede has received a silver certificate for its health policy for employees. This prestigious certificate was issued by the International Institute for Health Management and Quality (IHMQ) following an extensive health audit of the company.

Health management at IHC Merwede refers to the rules, measures and arrangements that are set up in order to enable employees to work well, in a healthy and responsible way, and has long-term benefits. IHC Merwede has appointed a health manager, who can offer employees preventive medical examinations, provide individual diet and sports programmes, and even recommend changes to the menu in the canteen. The goal of health management is twofold and results in a greater feeling of wellbeing for IHC Merwede employees and less absenteeism for the company.

The purpose of IHMQ's accreditation is to improve health at work using the principles of health improvement, management and quality. One of the building blocks of this approach is the health audit. This is intended for organisations that value the health and wellbeing of their employees and want to develop a health management system that is fully integrated into their business. An organisation receives the Model of Good Practice Certificate when it is proven through the audit process that the goals for the health of employees have been reached.

"This certification for IHC Merwede is an enormous appreciation of the personnel policy," says IHC Merwede's President Govert Hamers. "Health is a state of complete physical, mental and social wellbeing, and not merely the absence of disease or infirmity. The results of the health audit for IHC Merwede represent a great achievement for all concerned."

Digital *IHC Merwede Insight* goes live!

IHC Merwede has launched an interactive online digital magazine aimed at owners, operators and enthusiasts of its innovative vessels, advanced equipment and life-cycle support services. *IHC Merwede Insight* shares its title with and is designed to complement this edition (and future issues) of the printed version of the magazine.

The digital variant uses the latest software techniques and technology to create a multimedia-rich platform that is available to view in desktop and tablet device formats.

IHC Merwede Insight includes dynamic movies and stunning photography from the world of IHC Merwede within the dredging, mining and offshore industries. To receive the new digital magazine, please register at www.ihcmerwede.com or complete the enclosed reply card.

The first edition, which will be distributed in conjunction with this magazine, includes video content from the turbine transport and installation self-elevating heavy-lift jack-up vessel, the NEPTUNE, and a member of the successful IHC Beaver® 9029 family, the SHANTI SAGAR XVI. The full-length articles are in this issue of the print magazine.

"This is an exciting new way for IHC Merwede to communicate with its customers," says IHC Merwede's President Govert Hamers. "It brings stories to life with movie material and interactive features. It also provides a quick and easy-to-use format for those who do not have time to read full-length articles, or those who prefer to access such content online."

Riser pull-in spread ordered for FPSO

IHC Merwede has signed a contract for the design and manufacture of a riser pull-in spread to be placed on a MODEC Floating Production Storage & Offloading vessel (FPSO). The delivery is scheduled for the first quarter of 2013. Part of this system will be built in Brazil to meet the local content requirements for the project.

The riser pull-in package consists of the following innovative products: a riser pull-in winch (designed for a 550mT maximum line pull); an auxiliary pull-in winch (150mT maximum line pull); and a sheave trolley system, which will be constructed in Brazil.

The MODEC FPSO will be capable of processing 150,000 barrels of oil and 280MM-standard cubic feet of gas per day. It also has a total storage capacity of 1,600,000 barrels of fluid and will be moored at a pre-salt oil field off the coast of Brazil, at a depth of 2,300m.

The award of this contract – being the third in a row – provides further evidence that IHC Merwede is well established in the design and development of advanced equipment for the FPSO market and offshore industry. This is testimony to the company's reliability and the trust placed in it.

New merchandise range

A wide and stylish range of IHC Merwede-branded merchandise will be available from the beginning of 2013. The new apparel, gifts, sports and leisure equipment, and event and office items can be viewed and ordered online via a one-stop webshop, which will be open for business at the beginning of next year.

IHC Merwede is raising the fashion stakes with its new red and white baseball caps, polo shirts, T-shirts and jackets. In addition, a tie and pashmina will complete the corporate look.

The distinctive IHC Merwede logo will also be displayed in the office environment via mousemats, table flags, USB sticks, ballpoint pens and key rings. A range of leather items, such as A4 document holders, wallets and cardholders, is also available. There is an impressive collection of corporate gifts, from watches and clocks, flasks and lunchboxes, to mugs and coasters. Then, after work, IHC Merwede will help you unwind with its selection

of leisure bags and back packs, golf umbrellas and balls, travel wash bags and beach towels.

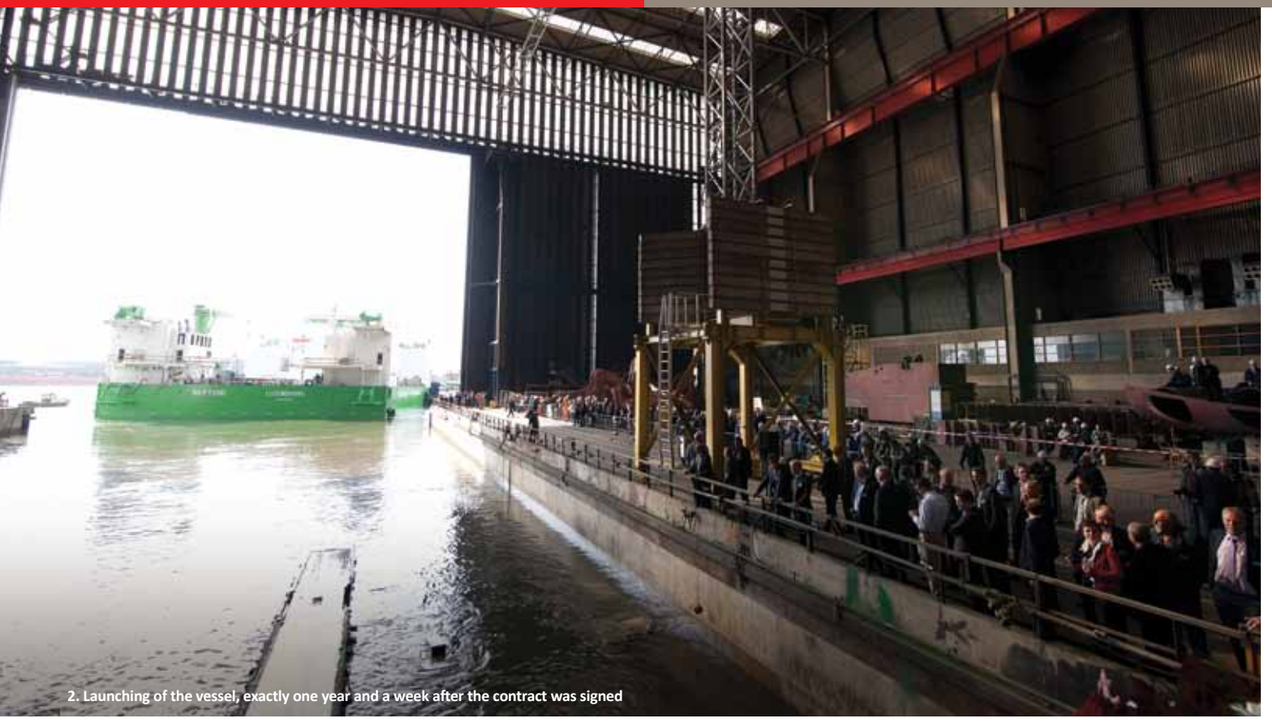
NEPTUNE: turbine transport and installation self-elevating heavy-lift jack-up vessel

IHC Offshore & Marine had to develop a very distinct version of a known design, a vessel with her own propulsion, DP-2 capability, and one of the largest cranes and accommodation capacities ever installed on such a platform

Sustainable energy and GeoSea

Sustainable and renewable energy are developing markets, stimulated by governments in their efforts to reduce CO_2 emissions. The European Union, for example, intends to use renewable sources (also known as renewables) for 20% of its energy requirements by 2020. In practice, this implies the building of sizeable wind and solar power farms. It also suggests that a recently delivered innovative IHC Merwede vessel, designed for the installation of wind turbines, will be extremely busy in European waters over the next few years.

1. The NEPTUNE during sea trials



2. Launching of the vessel, exactly one year and a week after the contract was signed

3. The lower ring is suspended from the upper ring by heavy IHC Vremac hydraulic cylinders

4. Lifting tests confirmed the jacking system works perfectly

Onshore wind energy has some limitations, and consequently it seems advantageous to generate wind energy at sea. Key players in this field are the countries surrounding the North Sea: the United Kingdom, Germany, Denmark, The Netherlands and Belgium. There are plans to install between 52 and 88GW offshore wind farms by 2020. Depending on the size of wind turbine generators (WTGs), these plans require the installation of up to 17,000 turbines and foundations of various types and sizes. The reliability, lead time and cost of the installation of these turbines are important factors in the construction and subsequent exploration and maintenance of offshore wind farms.

These activities appear to be challenging because turbines can be installed in water depths of up to 50m and up to 200km offshore. The consequences for the technology and the logistics are great. Large and heavy constructions, such as monopile foundations, gravity-based foundations, jacket or tripod foundations, floating units, nacelles and rotor blades for example, must be transported over substantial distances and installed on the sea floor and high in the air.

Dimensions and weights are astonishing. Monopiles can measure 5-7m in diameter and have masses of well over 800t, for instance, and jackets may have dimensions of approximately 20 by 20 by 80m. Turbines of 5MW at 3.3kV are not uncommon today, and examples of over 6MW at 6.6kV have already been installed. These boast rotor diameters of approximately 130m and hub heights of nearly 100m above sea level. In the future, 10MW turbines are considered feasible. These mastodons are expected to have weights of over 1,000t and rotor diameters of about 150m.

It is evident that efficient seaport and construction capacity for the construction of these huge structures, as well as sufficient and reliable installation capacity for both turbines and foundations, are strategically important conditions for the mobilisation of wind energy [1]. This is where GeoSea enters the scene (*figure 1*).

A subsidiary of the Belgium-based Dredging, Environmental & Marine Engineering (DEME) Group, GeoSea focuses on offshore works around the globe. It specialises in the drilling or hammering of large diameter piles, the erection of intricate offshore structures in a wide variety of environments, sophisticated soil investigations from bathymetric surveys to vibrocoring, and service and maintenance activities.

It is involved in nearly every aspect of the oil and gas and renewables sectors, including: management, support, logistics, survey, inspection, maintenance and repair services. Its variety of skills, technology and equipment, staff and experience make the company, supported by the synergetic structure of the DEME Group, an ideal partner in wind energy farm erection and maintenance.

It is therefore no surprise that GeoSea/DEME is an active shareholder in the large C-Power project, also known as the far shore wind turbine farm at Thornton Bank off the Belgian coast. Other partners include EDF Energies Nouvelles, Z-Kracht, RWE Innogy, Socofe and SRIW Environment.

A host of prominent technology designers and manufacturers are involved, too. DEME companies are engaged in the construction of gravity-based foundations (GBFs) in the port of Ostend, the accurate dredging, flattening and refilling of foundation pits up to the consistent layers of the sea floor, the heavy lift work, transportation and positioning of the GBFs, the trenching, laying and backfilling of the cable network and construction of shore landings.

After completion, Thornton Bank will comprise 54 wind turbines at mutual distances of 500-700m, located 30km from the Belgian coast in average water depths of 16m. The project is expected to generate 1,000GWh of electricity annually, the equivalent of the power consumption of 600,000 people, transferred to the coast by cables measuring 38.7km. Nacelles as such have masses of 316mT, whereas a complete wind turbine amounts to 695mT. Beside the GBFs for the deepest locations, which mass up to 3,000mT each, considerably lighter, dividable jacket foundations are applied for the locations at lesser depths.

The optimum vessel

The installation costs of wind farms form a considerable part of the total capital expenditures (capex) and consequently have considerable influence over their operational expenditures (opex). This situation calls for the most efficient, reliable and all-weather method of installation [1].

GeoSea has a good solution for this challenge by applying the jack-up vessels VAGANT, GOLIATH and BUZZARD, which, in combinations, could offer all transportation, stability and lift capacity required. The experience with these vessels ultimately and almost naturally led to the requirement for a vessel that could unite all functionality in one unit: full DP-2 propulsion capability, a stable working platform, heavy lift capacity and a large free deck space of sufficient strength.

With a clever sequence of loading and unloading the turbine parts: pylon in two parts, nacelle and complete rotor, such an innovative vessel could do the whole thing autonomously. To build the vessel, the company found an ideal partner in IHC Merwede's Offshore division, which built similar vessels in the first decade of the 21st Century, the PAULINE and the VAGANT.

Laconic origins

According to the technical specification, the laconic description of GeoSea's request from IHC Merwede was a "four-legged general purpose self-elevating unit, Gusto Marine Structure Consultants (Gusto MSC) type SEA2500, arranged for installation of a pedestal mounted heavy lift crane and suitable for future installation of a helideck for operation of a Super Puma or equivalent.

"The unit basically consists of a hull, four circular legs and four hydraulic jacking systems. Prime movers are to be provided to supply power for auxiliary propulsion, positioning, jacking, crane operation and domestic purposes. One 600 tonne/26m heavy lift crane is to be arranged on a pedestal at starboard of the vessel.

"The unit is equipped to remain self-contained in an offshore environment for 15 days with respect to fuel, lubricating oil, water and food for a full complement of 60 people."

5. Full propulsion capacity under DP-2 classification

6. Boom rest for supporting the 85m hoisting beam

7. The NEPTUNE at work...

Draconian efforts

This concise description, however, required rather lengthy and draconian efforts from IHC O&M. The request sounded simple enough, but: “between dream and reality, laws and practicalities stand in the way”, to paraphrase renowned Flemish author Willem Elsschot (1882-1960), who would know from experience. He worked in the shipbuilding industry for years under his real name, Alfons de Ridder, and was actually employed by a predecessor of Gusto MSC, the Gusto shipyard in Schiedam, The Netherlands, a ‘founding father’ of IHC Holland from 1943 to 1965.

These great efforts concerned both technology and the building schedule. To begin with the latter: the contract for the detailed design, construction and delivery of the vessel was signed between GeoSea and IHC Merwede on 16 September 2010 and the keel was laid on 25 March 2011. She was launched on 23 September 2011 (*figure 2*).

From the date of her naming as NEPTUNE (after the ancient Roman god of the sea) on 7 March 2012 in the port of Ostend, she was mobilised for real operations on the Thornton Bank project. This equates to an impressively short lead time of less than 17 months – from signing the contract to delivery – for this complex, high-tech and unique vessel, built in Europe. This fact again proves that the Dutch offshore and technology building industry and its supportive infrastructure around the port of Rotterdam can fully outperform competition from low-wage countries.

The technical specification further stated: “MSC will provide [IHC Merwede] with a set of drawings, comprising among others a general layout of the unit and the construction below deck, basic construction plans of the hull, hull leg-wells incl. design tolerances, jack-houses and a tank arrangement plan, deck-house, legs.”

And that wasn’t all: “Detailed engineering, procurement, classification and statutory approvals, installation and testing of all equipment, piping, ducting, cabling, trunking, cable trays, bulkhead- and deck penetrations, etc. and all systems described in this specification lie entirely with the [IHC Merwede] yard... the yard shall produce all required detailed section and arrangement plans as well as necessary calculations and hand them over for approval to the Owners and to the ABS [American Bureau of Shipping].”

So IHC O&M had to develop a very distinct version of a known design, a vessel with her own propulsion, DP-2 capability, and one of the largest cranes and accommodation capacities ever installed on such a platform, leaving nevertheless the largest possible workable deck space of 1,600m^2 for an allowed load figure of 10mT per metre squared. And all that on an extremely tight schedule to allow the vessel to participate in the Thornton Bank activities. And it has to be said: IHC O&M succeeded triumphantly.

Technical highlights

Jacking-up system: at the corners of the platform, four proven GustoMSC hydraulic, positive engagement jacking systems have been installed. The systems are similar to the ones applied on other GustoMSC jack-up units in operation and fully comply with ABS regulations.

Every system is built in a so-called jack-house and comprises a set of two rings, flexibly suspended from the hull. The upper ring has a connection to the upper deck of the jack house and the lower ring is suspended from the upper ring by heavy hydraulic cylinders (*figure 3*). Both rings have been equipped with a set of hydraulically operated locking pins, which fit in boreholes in the circular legs.

By (automatic) sequential operation of the pins and rings, upward and downward steps of the platform can be initiated, as well as preloading of the sea floor. The system can achieve climbing speeds of approximately 0.7m per minute.

A special feature of the MSC design/IHC Hytop hydraulic system/IHC Vremac cylinder arrangement is that the NEPTUNE’s legs can be preloaded in diagonal pairs to the full capacity of 2,750mT in order to verify the bearing capacity of the sea floor with GeoSea-developed leg penetration models. If the preloading holds, the other pair of legs is tested.

Subsequently, all four legs are standing on the seabed and the total load is reduced to a safety factor of two times the preload. This is a very important feature for undisturbed installation of turbines.

One operator can fully operate the jacking system. Integrated inclinometers ensure the level position of the platform and redundancy in the design guarantees continued operation in the event of a failing hydraulic pump. Rubber pads, used in the flexible suspension, protect the legs and rings from mechanical damage and provide a kind of play that prevents extreme forces. Full lifting tests during harbour trials have attested the perfect working of the system (*figure 4*).

Propulsion and DP-2 capability: sometimes platforms like the NEPTUNE have some kind of propulsion for positioning them in the working area. In such cases, however, escorting tugs are always needed to provide communications and other nautical functions. GeoSea and IHC O&M opted for a more innovative solution, by promoting the propulsion arrangement from being an auxiliary into a full main propulsion system, with even a full Class 2 Dynamic Positioning (DP-2) System (*figure 5*).

Four non-retractable 1600kW full-azimuth thrusters are arranged at the bow and stern of the NEPTUNE. They run at constant speed while variable thrust is obtained by controllable pitch. Each thruster is directly driven by a single diesel engine. Cooling of the diesel engines is provided by means of one combined LT/HT box cooler per engine.

DP-2 classification requires that no single failure may result in loss of the specified position. The single failure is defined as any failure in the total chain of power generation, power conversion, propulsion means and control equipment, except for flooding or fire of a complete space (the latter two belonging to DP-3 classification). The implication of such requirements is that not only the DP control computers and interrelated equipment such as GPS systems, gyrocompasses, etc. must be executed as redundant, but also that as a maximum only one of the diesel engines, couplings, gearboxes may fail due to electric or hydraulic failures, for example.

IHC Merwede and GeoSea have ingeniously solved this requirement by designing each engine/propeller combination as fully independent of the rest of the engine room systems. That means that for the rest of the engine room, redundancy

is no issue and in case of electric mains failure, the thrusters will still be available and controllable from the bridge.

To be independent of other engine room components, the engine/propeller combinations have been equipped with, for example, direct-engine driven or hydraulic auxiliary systems for propeller pitch and azimuth angle control, ventilation, cooling and lubrication, fuel supply and fuel return. In this way, the vessel could achieve ABS DP-2 classification as a MODU unit. ABS is the world's principal classification bureau for jacking units and drilling platforms. MODU is a generic term for several classes of self-contained floatable or floating units such as jack-ups, semisubmersibles and submersibles.

During operations, the NEPTUNE does not need any assistance from propelled vessels for positioning herself in the correct working area. The DP system and the azimuth thrusters are able to position the platform, after which the legs can be lowered to the sea floor. In shallow waters, where the thrusters are less effective, additional positioning capacity can be delivered by four hydraulic mooring winches with a maximum pulling force of 450kNm, mounted on top of the jack houses. A CCTV system provides a direct view on these winches from the wheelhouse.

Cooling water provision: the generator sets for power provision to the jack-up system, the crane, HVAC and other auxiliary systems are too large for the application of the usual air-cooled diesel engines, they have to be water-cooled. A clever solution has been developed for the cases in which the NEPTUNE is elevated from the water. This consists of a system of buffer tanks, hose reels and submersible pumps. The latter are automatically suspended from the main deck as soon as the vessel loses contact with the water and can provide unrestricted cooling capacity up to the NEPTUNE's main deck elevating up to 25m above sea water level.

Crane rest: the 600mT pedestal-mounted fully revolving crane from Huisman Equipment, located forward of the starboard aft jack-house, delivers a main hoist capability of 600mT at 26m of outreach. This wind turbine installation crane consequently has a main hoisting boom of 85m in length. Of course, it considerably protrudes from the NEPTUNE's bow and must be supported during sailing.

As a challenge, the boom rest had to be positioned around the beam's centre of gravity with all its consequences for dynamic forces, oscillations and fatigue behaviour. It has been solved by a boom rest, some pre-tension on the main hoist and a 'garage' for the hoisting blocks, which is integrated in the boom itself (*figure 6*).

First operations and perspective

NEPTUNE has already proven her efficiency on the Thornton Bank project (*figures 7 and 8*). A complete cycle of loading a turbine, sailing to the offshore location under own propulsion, and mounting the complete turbine and sailing back to Ostend fitted well within budget duration targets. These results are promising for the subsequent works in, amongst others, the German North Sea and the Baltic Sea. The comments in industry periodicals have been equally positive: "The Neptune will leave a definite mark as crucial renewable energy enabler within the frame of the European renewable energy commitment." [2, 3].

Principal characteristics NEPTUNE	
Built	IHC Offshore & Marine
Owner	GeoSea, member of DEME Group
Classification	American Bureau of Shipping (ABS) ✠A1, Self-elevating Unit + AMS + ABCU+DPS-2 + CRC; self-propelled under MODU
Length overall (hull)	60m
Breadth	38m
Depth	6m
Design operational draught	3.9m
Operational water depth	5-45m
Jacking legs	4 pcs. Ø3.5mx80m (92m)
Jacking preload capacity each	2,750mT
Jacking speed maximum	0.7m/min
SWL wind turbine installation crane	600mT @ 26m
SWL auxiliary crane	10mT @ 25m
Main deck	1,600m², max allowed load 10mT/m²
Helideck preparation	suitable for Super Puma or equivalent
Total installed power	8,962kW
Accommodation	60 people, including all usual facilities

References

[1] "IHC Merwede in offshore wind". *Ports and Dredging 174*. IHC Merwede, Sliedrecht, The Netherlands, 2010. 20-25

[2] *Offshore Industry,* Volume 5, issue 1. Yellow & Finch, Vlissingen, The Netherlands, 2012. 12-17

[3] *Shipbuilding Industry*, Volume 5, issue 1. Yellow & Finch, Vlissingen, The Netherlands, 2012. 22-25

8. ..on the far shore wind turbine farm at Thornton Bank off the Belgian coast

SHANTI SAGAR XVI: a new dredger for a rapidly expanding customer

Adani Ports and Special Economic Zone

The Adani Group started as a trading house in 1988, operated by only one man with a great vision, Gautam Adani. Since then it has grown to become one of India's most trusted and fastest growing conglomerates with diverse ventures spanning commodity trading, the development of infrastructure and energy. Its businesses include coal trading, coal mining, oil and gas exploration, ports, multi-modal logistics, power generation and transmission, and gas distribution.

1. The Adani Group deploys an impressive fleet of IHC Beaver® dredgers and boosters

The Adani Group is India's leading private coal importer, ports operator, thermal power producer and edible oil producer – the latter activity is through a joint venture with Singapore's Wilmar. Over the years, the group has moved from trading to infrastructure to integration of resources, logistics and energy. Adani's integrated model is well adapted to the infrastructure challenges of rapidly developing countries such as India. It offers security of supply for coal and other essential imports, while mitigating price and political risk. Integration multiplies the benefits for synergies and economies of scale, both for Adani and its customers.

Some of the Adani Group's key statistics for 2011 include: approximately 36mmT of coal imported; 64mmT of cargo handled; and 4,660MW of generation capacity. Revenues amounted over $8 billion and the company employs approximately 8,000 people. All these figures are expected to experience double-digit increases by 2020, due to, among other factors, global expansion. The company's growth has always been accompanied by a sense of responsibility. So it takes care to reinvest in protecting and developing the communities within which it operates.

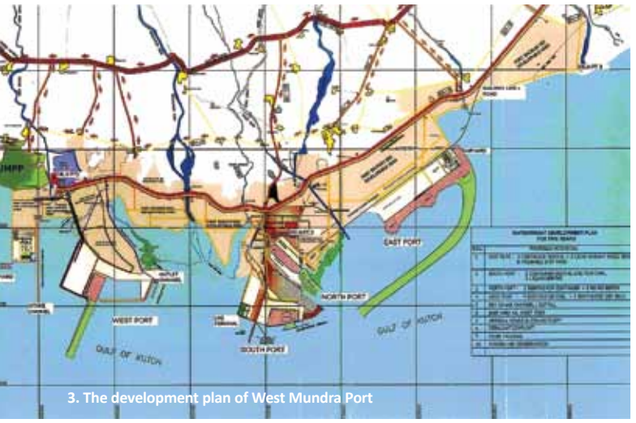
For the purpose of *IHC Merwede Insight*, the Adani Group's most interesting activity is the Adani Ports and Special Economic Zone Ltd (APSEZL), former Mundra Port and Special Economic Zone Ltd, on the west coast of India. In this zone, the group is the sole developer and operator. A total of 95% of India's international trade comes through its ports. Mundra benefits from deep draft, first-class infrastructure and SEZ status. It is connected via road, railway and pipelines to the economic heartlands of north and west India. Adani is planning five other ports in India and Australia, aiming to increase annual cargo handling capacity from 64mmT to 200mmT by 2020.

In the SEZ, the company encourages a walk-to-work culture and is trying to enhance the quality of life for the growing middle-class of the area, with amenities like a shopping mall, community centre, library, swimming pool, sports arena, resorts, golf course, eateries, hotels, etc. [1].

As the main developer and operator of such a large port, the Adani Group faces the challenge of dredging. After surveying the market, it opted for IHC Beaver® dredgers with their high production rates and benefits at the lowest energy consumption levels and the lowest cost per cubic metre of sand reclaimed.

Innovative vessels

2. A new dredger for the Adani Group passing the Erasmus Bridge in Rotterdam



3. The development plan of West Mundra Port

4. Built at the IHC Beaver Dredgers yard in Sliedrecht...

5. ..and launched 6 December 2011...

The IHC Beavers manufactured for the Adani Group meet some specific requirements. They are suitable for different dredging depths and discharge distances, for example, and they can cope with densely compacted sand and high abrasiveness associated with the presence of silex and very hard soil spots. By 2011, Adani had no fewer than eight IHC Beaver® 65s, one IHC Beaver® 75 and four IHC Beaver® 1,600kW booster stations in successful operation (*figure 1*) [2].

The appropriate dredger

Since 2010 the plans to further develop the West Port of Mundra have gradually come into realisation (*figure 3*). The West Port will be developed as a break bulk cargo port for material like coal and iron ore. Three berth pockets have already been constructed at the right side of the harbour. Six berths need to be constructed on this side within the next three years where presently the first two berths are operational.

The basin at the first two berths has already been dredged to an average of -14.7m chart datum (CD). At the third berth, the water depth is still -12.5m CD. The plan is to dredge the basin near the first three berths up to a depth of -19m CD and -21m CD at the berth pockets. The water depth at the first two berths is already -18m CD. The total surface to be dredged is about 1,100 x 900m.

Analysis of soil reports suggested that the intended depths and the existence of a consistent and thick layer of sandstone and clay would make working with the existing fleet less effective.

Therefore, Adani will benefit from its new dredger (*figure 2*), which was ordered from IHC Merwede in wise anticipation in November 2010. The SHANTI SAGAR XVI was built at the IHC Beaver Dredgers yard in Sliedrecht, launched 6 December 2011 (*figures 4-5*) and delivered May 2012. Delivery was accompanied by the supply of a substantial length of IHC Parts & Services' newly developed floating pipelines (see page 26 in this issue) and a TID training programme for key personnel.

The SHANTI SAGAR XVI is a member of the successful IHC Beaver® 9029 family (*figure 6*). Similar vessels have previously been supplied to Chinese dredging contractor Sinohydro and to the Panama Canal Authorities (see references [3, 4] for more details). The principal features of these versatile dredgers can be summarised as follows:

- non-propelled mono pontoon vessel with well-balanced cutter power versus pump power for multipurpose dredging and extremely competitive high soil production figures
- high efficiency, good fuel consumption figures, easy maintenance, high availability
- electrically driven cutter and high-efficiency submerged dredge pump on the cutter ladder
- two diesel-direct high-efficiency driven double-walled inboard dredge pumps, located on deck for easy maintenance and to prevent the risk of flooding
- bimetallic suction and discharge pipes, inner diameter 900mm
- electrically driven swing winches, anchor hoisting winches and anchor boom winches
- hydraulically operated spuds, tiltable by own means: fixed auxiliary spud, main spud in spud carriage
- equipped with high-level dredging instrumentation and automation
- application of proven modern materials
- completely tested and attested dredging performance before delivery.

Electric installation

IHC Drives & Automation (IHC D&A) has standardised and integrated all electrical equipment provided internally by IHC Merwede, such as generators, main switchboard, electric control of the cutter, submerged pump and winch drive motors by air-cooled and water-cooled variable frequency drives (vfd), as well as the alarm and monitoring system. IHC D&A vfds in particular distinguish themselves (*figure 7*) from the competition by:

- proven electronic switching (IGBT) units
- integration of the sophisticated water cooling system in the vessel's cooling system
- modular layout for the entire frequency drives series
- seamless interface with the dredging automation makes available all relevant drive and machine data throughout the vessel
- dust-proof housing – the drives can be located in 'dirty' rooms
- possibility to install in warm locations because of internal cabinet cooling
- integration in the construction process of the vessel, JIT delivery of plug-in modules, making expensive cleaning operations before commissioning superfluous.

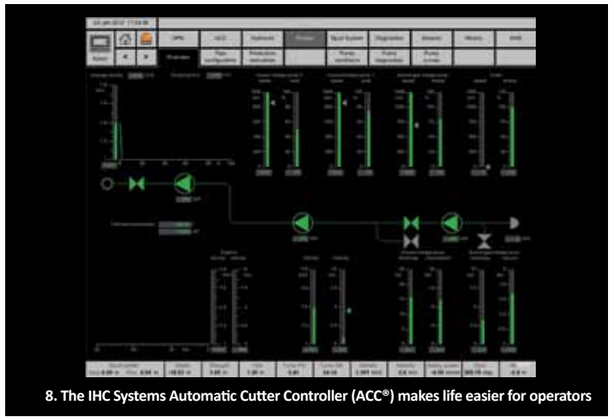
All systems were fully integrated with the dredging automation and control system, and the complete electric installation.

Dredging automation

The SHANTI SAGAR XVI has been equipped with an extensive dredging instrumentation and automation package from IHC Systems. Not only the usual depth and position measurements (DPM function) were installed, but also a dredge track presentation system (DTPS) and an Automatic Cutter Controller (ACC®).

6. ..the new IHC Beaver® 9029 SHANTI SAGAR XVI is the appropriate dredger for the current developments

7. IHC Drives & Automation's vfds have distinguishing features



8. The IHC Systems Automatic Cutter Controller (ACC®) makes life easier for operators

9. The SHANTI SAGAR XVI perfectly illustrating her name: tranquillity at sea

DPM collects the signals of the position measurements of the ladder, ladder trunnion, spud carrier and DGPS-gyro. DTPS is used to enable the dredge operator to see the dredger and cutting tool in side, back and plain view, in the profile to be dredged, related to actual geographic coordinates. The bathymetric electronic is updated by the cuts the cutter has actually made. The system uses the on-board position measurements and couples it to positioning information from DGPS and sophisticated presentation techniques.

As to the IHC Systems ACC®: operators of cutter suction dredgers continuously juggle numerous operations, such as the swing movements in relation to the anchor positions and the desired dredging depth/profile, the cutting and pumping processes and the field of forces around the spud carrier. In addition to managing all of these factors, the operators have to maintain high production rates throughout the shift. And on top of manning this 'technical' interchange, they also need eyes in the backs of their heads to watch out for passing traffic. It's a daunting challenge.

The ACC® relieves at least three of these headaches (*figure 8*). It includes an array of instrumentation, hard- and software, presentation, functional and operational facilities that allow operators to divert their attention from the stressful – and sometimes monotonous – tasks and to concentrate on the efficient functioning of the dredgerand the output of the process as a whole.

So the ACC® is a practical tool for less experienced operators, allowing them to make a success of the job. More experienced operators can achieve major yield improvements with the ACC®: as much as 30% in optimum circumstances. The corresponding reduction in mental pressure helps to facilitate the easy monitoring of traffic, which results in improved safety.

The ACC® monitors and controls the individual processes and the links between them unremittingly. It establishes the best combination using conventional control methods and – even more importantly – Artificial Intelligence (AI) and Model Based Control (MBC).

The soil mechanics expertise supplied by IHC Merwede's research institute MTI Holland, and the operational and technical experience with IHC Systems' dynamic CSD training simulators, were also called upon to maximise dredger performance and optimise dredger processes at the lowest possible cost. Installing the ACC® results in major reductions in fuel costs, subsequent emissions, and wear and tear.

Finally...

SHANTI SAGAR, the common name of all Adani Group dredgers, is derived from words in the Sanskrit language of the classical Indian civilisation. *Shanti* (< *santih*) can mean 'tranquillity', 'peace' or 'bliss': a state of satisfaction, happiness and joy; and *sagar* is the word for 'sea'. SHANTI SAGAR subsequently denotes ideas of tranquillity at sea, peace at sea, sea-peace, sea-bliss, happiness at sea, calmness at sea (*figure 9*). It is an inspiring name.

IHC Merwede Insight appreciates such inspiration and wishes the Adani Group every success: "May this new flagship and her sister ships bring bliss, peace and tranquillity in every sea and other waters they enter, and to all people working on them."

Principal characteristics SHANTI SAGAR XVI	
Built	IHC Beaver Dredgers, Sliedrecht
Type	IHC Beaver® 9029
Length overall (hull)	approx. 103.9m
Length over pontoon	81.4m
Moulded breadth over pontoon	18.6m
Mean draught	3.65m
Dredging depth	maximum 29m
Suction and discharge pipe diameter	900mm
Generator engine power	3 x 1,717kW
Dredge pump power	1 x 1,500kW + 2 x 3,700kW
Cutter power	1,500kW
Total installed power	13,000kW
Accommodation	26 people

References

[1] Adani *Corporate Brochure*

[2] "Cutter dredgers for India". *Ports and Dredging 174*. IHC Merwede, Sliedrecht, The Netherlands, 2010. 6-9

[3] *Ports and Dredging 175*. IHC Merwede, Sliedrecht, The Netherlands, 2010. 4

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IHC Merwede dredge hoses and floating discharge lines

A complete chain of service

Widely used hydraulic dredgers, such as trailing suction hopper dredgers, cutter dredgers and wheel dredgers, would be of little use without the means to deliver the material they have extracted from the sea floor to a suitable reclamation area. The dredgers as such are only the first link in a complete chain that includes the cutting and/or fluidation process, the suction process and pressurising by dredge pumps, transportation, and finally, delivery of the dredged material.

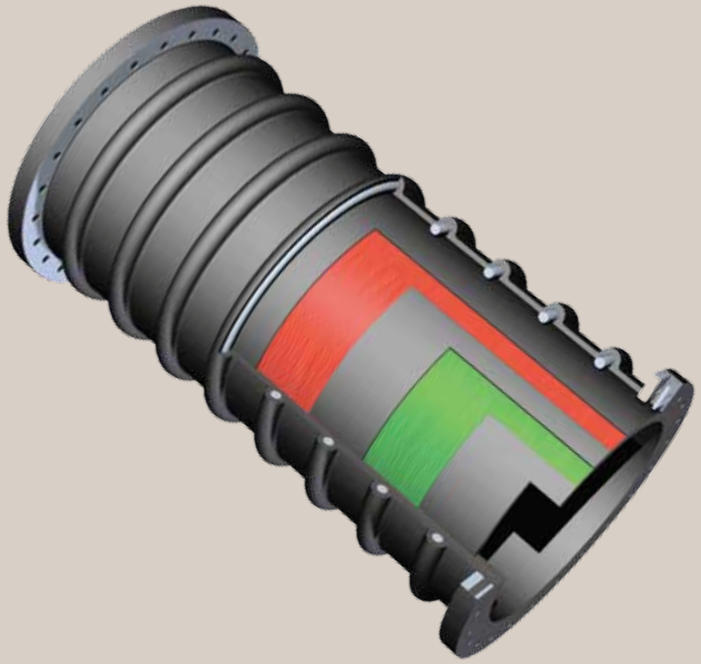
Therefore, in almost every dredging project, the dredgers themselves are accompanied by an arrangement of pipelines, both offshore and onshore. This arrangement facilitates transportation and delivery of the dredged material to mineral treatment plants or required reclamation sites, where it is used for several purposes. These can include mineral processing, creation of new industrial estate, nature restoration or recreation areas, or mollusc culture areas, for example [1].

> "The in-house knowledge, acquired after thorough investigation of market demands, has enabled the company to make every type of hose"

1. Adani's IHC Beaver® 9029 CSD SHANTI SAGAR XVI was delivered with a substantial amount of innovative floating pipeline, also supplied by IHC Merwede

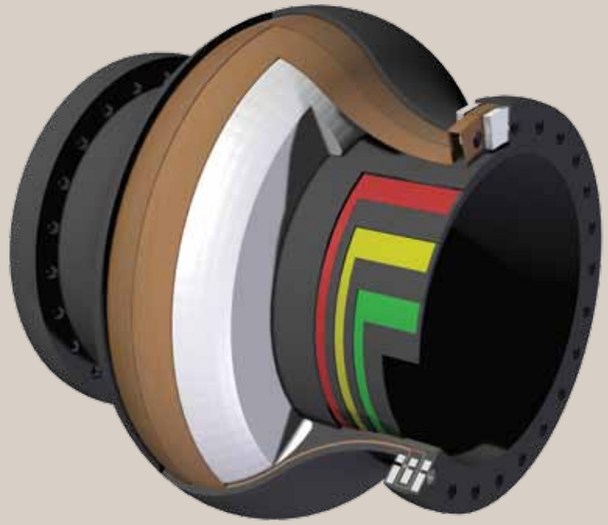
2. TSHD ISANDLWANA efficiently unloading her hopper through an IHC Merwede floating pipeline

> The company focused on quick installation, quality and safety of floating pipelines and dredge hoses, and succeeded in the development and sales of substantial amounts of a product, which claims to improve lifetime of hoses significantly



3. The IHC Standard® version is suitable for sand and less abrasive materials and offers a maximum lifetime

4. A high level of performance is provided by the IHC BoneCrusher®



5. The highly innovative IHC expansion joint combines leak-free operation with radial freedom of movement and wear-indicator layers

The offshore part of the transportation system is often executed as floating pipelines, either arranged as self-supporting floating pipelines (*figure 1*), or composed of steel or synthetic pipes, kept afloat by pontoons or buoyancy elements. Trailing suction hopper dredgers can deliver material by rainbowing, but as soon as substantial distances are involved, the combination of floating pipelines (*figure 2*) and land-based pipelines is the indispensable means to deliver the sand to the right spot.

IHC Merwede is principally a builder of dredgers, the first link in the aforementioned chain. However, because of its ambition to be an innovative supplier and one-stop shop for the dredging industry, IHC Parts & Services (IHC P&S), renowned as an expert in all kinds of dredging equipment, felt the need to do more in the transportation chain as a whole. Therefore, it developed an innovative range of sophisticated dredge hoses and floating discharge lines, to connect hydraulic dredgers with, for example, floating treatment plants, or, in combination with pipelines onshore, a reclamation site.

Entering into a competitive market

The floating pipelines and hose market is extremely competitive. From its early beginnings in 2009, IHC P&S decided not to become a 'me too' supplier, but to build upon the IHC Merwede concept of technology innovation in this market, offering added value to customers and focusing on high quality deliveries, instead of competing on price only.

This implied they had to acquire extensive knowledge of the subject and move to the forefront of developments in the field – which they did indeed. The company focused on quick installation, quality and safety of floating pipelines and dredge hoses, and succeeded in the development and sales of substantial amounts of a product, which claims to improve lifetime of hoses significantly, compared to conventional versions available.

Based on research and marketing information, IHC P&S dredge hoses and floating discharge lines primarily serve the upper segment of the market, which is characterised by larger diameters, extremely high peak pressures up to 3.8MPa (38bar), medium, heavy-duty and highly abrasive materials. However, the delivery of conventional hoses is also included in its portfolio.

Every hose includes natural rubber abrasion-resistant liners, enveloped by ozone and UV-resistant exteriors that can be used in all weather and sea conditions. Dependent on type, coloured indicator layers and special forged (patented) steel reinforcement rings are incorporated. The hoses comply with the highest standards and normalisation in the dredging industry. There is even an innovative solution for the intricate so-named 'bucket hose', applied in very abrasive and wear-inducing mixtures.

The range includes IHC Standard® types of suction and discharge hoses up to lengths of 3,250mm (*figure 3*). For medium duty, hoses are available in the IHC Caprock® version and the highest level of performance is offered by the IHC BoneCrusher® hose (*figure 4*). Jetwater discharge hoses are available with rubber and steel flanges. Flexible discharge hoses and lines are provided, either in standard versions, as well as the floating IHC BoneCrusher® and IHC Integra® versions, which incorporate floating capability within the same hose body that conducts the transported sand and soil mixture, combining it with high wear resistance. A highly innovative product is the IHC expansion joint, which combines guaranteed leak-free properties with high radial flexibility (*figure 5*).

Technology

The technical concept of the IHC P&S dredge hoses rests on the smart and strategic combination of excellent rubber expertise and integrated manufacturing in The Netherlands and China. That is to say, people involved with this product usually spend half of their time in either of the two countries.

The in-house knowledge, acquired after thorough investigation of market demands, has enabled the company to make every type of hose, which is reflected in the range of standards that can cover every dredging need at affordable price levels. Within the ranges, different compositions of rubber types and polymer material layers, combined with individually manufactured high-tensile forged steel rings, incorporated at carefully designed spaces to each other, offer every desired balance between price and quality, coarse-material conduct and high-wear resistance profiles. These properties especially feature low masses, which allow for the integration of buoyancy material between the layers, resulting in integrated floating pipelines that need no external buoyancy elements, and may maintain all properties of the 'common' types.

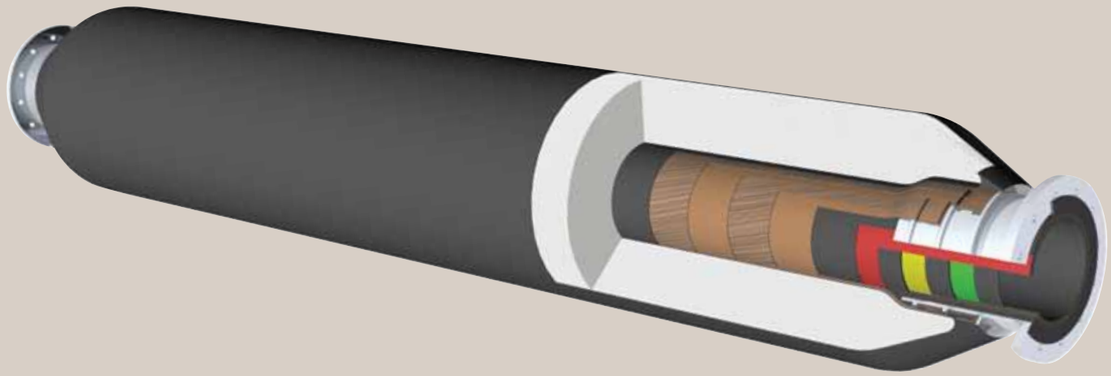
The flagship products of the technology are represented in the IHC BoneCrusher® types, which are suitable for use with medium and large, heavy-duty cutter suction dredgers, pumping highly abrasive material. These are applicable inboard as well as outboard (floating).

Like the IHC Caprock®, this type is provided with individually manufactured high-tensile forged steel rings for long life expectations, and axial and radial flexibility. But in order to cope with the high forces occurring with these applications, the rings have an 8-shape profile, enlarging the vulcanisation area and offering extremely high resistance to forces, trying to break them out of the hose body. These patented lightweight rings require less buoyancy, which in turn reduces cost price. The IHC BoneCrusher® was also designed with offshore and deep-sea dredging and mining applications in mind, which are expected to come into existence over the coming years [2].

Most types of IHC P&S dredge hoses can withstand a design pressure of 3.2MPa (32bar), a peak pressure of 3.8MPa (38bar) and a proven unrestricted burst pressure, in straight position 9.6MPa (96bar). Before delivery they are hydrostatically tested at twice the nominal pressure. The IHC BoneCrusher®

6. Visual of the OrcaFlex simulation programme that assists customers in arranging floating pipelines

8. Created for the benefit of efficiently delivering the right material to the right location...



7. The self-floating IHC Integra® has a low mass

9. ..as is proven in daily operations

boasts durability against explosion-level pressures. These features are unique within the industry. Even the floating examples of the IHC BoneCrusher® fit in 40' containers.

Added value

The added value of IHC Merwede dredge hoses for dredge contractors is illustrated by the keywords safety, lifetime cost and high quality.

The safety of hoses is determined by mass, resistance against bursting and maintenance of flexibility. These factors have all been considered in the IHC Merwede hose package. Everything has been done to keep masses as low as possible, which prevents dangerous movements during handling.

> "Safety, simplicity of connection, quality, lifetime cost and reliability are the distinguishable features"

Clearly, resistance against bursting is essential for safety and environmental considerations.

The unique individual testing of every piece at twice the operational pressure is a guarantee in this respect, as is the high wear resistance and the design pressure of four times nominal pressure. IHC P&S is even planning to do more on safety: for example, there are testing devices under construction, with which torsion, stress and fatigue trials can be executed, like the IKEA machines that test chairs using millions of mechanical movements, for example.

Lifetime cost refers to availability, maintenance, and durability as a result of excellent quality. These are served by the well-considered design and utilisation of rubber, polymer and steel properties into an integrated design that combines the best of three worlds. Significant lifetime improvements against current standards have been demonstrated.

Planned progress in both safety and efficiency is the development of sophisticated quick-connection and lining-up equipment, which intends to considerably simplify and diminish handling and mounting time, and consequently the risk for the crews doing the job. Known as NeXus, it aims to enhance efficiency by solving the problems of manipulation with flanges, bolts and nuts, and alignment in wave conditions and under water.

IHC P&S runs a dedicated version of the well-known OrcaFlex maritime analysis and dynamic simulation package, which not only serves the design of the hoses as such, but is also a means to provide customers with calculations of forces and movements of floating pipeline arrangements in relation to wave heights, wind and current forces, anchoring points, dredger movements, connection to sinker pipelines, etc. (*figure 6*). This will also contribute to safety and cost by preventing dangerous and 'impossible' arrangements. As the only company in the industry to use it, IHC P&S is able to advise customers about the optimum configuration, fitting demands and requirements.

Perspective

The strategy of IHC P&S to supply excellent and innovative dredge hoses provides dredge contractors with highly wear-resistant and versatile transportation products for mixtures with wide-ranging properties and variable degrees of abrasiveness and coarseness. Safety, simplicity of connection, quality, lifetime cost and reliability are the distinguishing features.

Thanks to continuous research and development, wonderful products such as the self-floating IHC BoneCrusher® and IHC Integra® hoses (*figure 7*), may be accompanied by even more useful innovations within years – for the benefit of efficiently delivering the right material to the right location (*figure 8*). Adani's brand new IHC Beaver® 9029, the SHANTI SAGAR XVI (see pages 20-25 of this issue), already proves this to be the case in her daily operation (*figure 9*).

References

[1] "Versatile dredging tools: IHC Beaver® dredgers in practice". *Ports and Dredging 172*. IHC Merwede, Sliedrecht, The Netherlands, 2009. 22-27

[2] "Deep-sea mining technology in progress". *Ports and Dredging 179*. IHC Merwede, Sliedrecht, The Netherlands, 2012. 26-31

Sound engineering for underwater piling

IHC Hydrohammer® decided to be the world's leading knowledge centre in piling-originated underwater sound

Synergy for sustainability

Sound is easily conducted by water and underwater sound can reach distances up to 30km from its source. This enables many sea creatures to 'see by sound', either passively or actively. This ability is known as echolocation. For such animals, both fish and mammals, sound is a means to find food or a partner, and to orient themselves or avoid encounters with enemies.

1. Mankind adds several noises to the natural underwater sound, e.g. by piling

Mankind has added several sounds to the natural backdrop, induced by waves, rain and animals: seismic blasting, navigation, echo sounders, drilling platforms, offshore wind farms, dredging and piling (*figure 1*). Due to growing industrialisation, this anthropogenic sound has increased in the last few decades, causing the continuous background noise level in seas and oceans to rise [1].

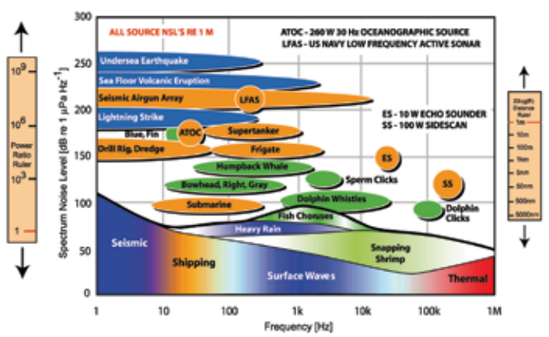
For example, a common echo sounder sends repeated bursts of sound downwards in the range of 230-245dB in the frequency range of 11-100kHz, and a typical trailing suction hopper dredger generates a continuous omnidirectional sound wave of approximately 186dB in the range of 30Hz-500kHz. Pile driving can reach levels exceeding 175dB, in frequencies of 100Hz-200kHz that are expected to be influential, and in all directions [2].

Recently, awareness of the fact that the sounds caused by piling could disturb the food finding and orientation abilities of sea creatures has grown. This is recognisable in *figure 2*, where anthropogenic sound almost drowns out natural sound levels except those caused by disasters, so to say, and where piling appears at around the centre of the graph [3].

For that reason, authorities have developed legislation on noise mitigation. In light of this, IHC Merwede business units are in the process of creating solutions for sustainable underwater piling, serving both ongoing economic development and environmental legislation.

Synergy for sustainability

IHC Hydrohammer® is the market leader in hydraulic piling knowledge and equipment for both onshore and offshore underwater application. In view of this position, the company decided to be the world's leading knowledge centre in piling-originated underwater sound. For onshore piling, it had already developed a bellows solution. This innovation helped



2. Anthropogenic noise usually exceeds natural sound levels (Courtesy CEDA, © Seiche Measurements Ltd)

3. Sound mitigation solutions provided by IHC Hydrohammer® played a role in the piling activities of the Eemshaven project (2010-2011)

it to receive orders for equipment in the Dutch Eemshaven power stations programme, where sound had to be restricted in order not to disturb a nearby seal habitat (*figure 3*).

In light of this ambition, the company organised an international seminar, 'Sound & Sizes', for the offshore wind turbine market, where lectures and feedback of users and builders of wind turbines generated a lot of new insights and enthusiasm. However, as IHC Hydrohammer had to focus on its main activity – the building, sales and lease of outstanding hydraulic piling hammers [4] – it found an excellent partner for the design and manufacturing of practical sound-mitigating equipment in IHC Offshore Systems [5].

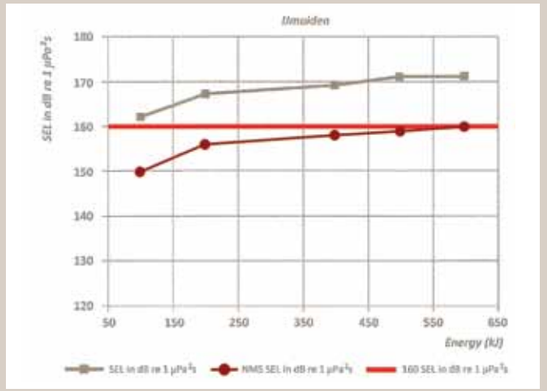
Further synergy was found in joining the innovative Far and Large Offshore Wind (FLOW) consortium, which enabled it to participate in projects and knowledge from a broad spectrum of Dutch companies and universities. It gave IHC Hydrohammer the opportunity to conduct a series of tests and experiments on several designs and constructions in many conditions. The preliminary results allow them to continue with innovative noise-mitigating systems (NMS).

The origins of underwater piling sound

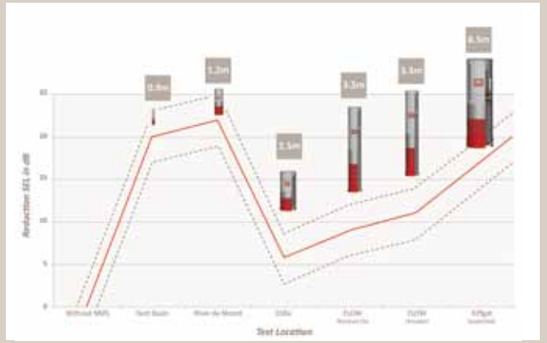
The majority of underwater piling sound does not come from the piling hammer but from the pile itself. As it absorbs energy from the hammer, a pulse is generated through the pile wall with a speed of about 5,000m/s, making it 'sing'. The intensity and composition of the emitted sound primarily depend on the blow energy induced by the hammer, the soil resistance, the pile dimensions and the conditions under which the pile is installed.

In a number of tests, conducted during the installation of two meteo masts for RWE in IJmuiden and Nordsee Ost, IHC Hydrohammer found that the maximum noise production tends to flatten out as the blow energy reaches more than 600kJ and asymptotically reaches a value of approximately 175dB against a reference of 1µPa2s. This is illustrated in *figure 4*. The noise level without NMS is represented in grey and with NMS in dark red. The red line represents the prescribed 160dB limit.

The resistance between the soil and the pile also determines the sound levels. Other influential factors include the sea state, soil constitution and rainfall. For example, a rough sea tends to muffle sound, thereby decreasing the perceived far-field noise. The constitution of the surrounding soil and the application of scour protection has an impact on the acoustic radiation and wave propagation. And rainfall significantly increases measured sound levels.



4. Noise levels tend to flatten out at higher blow energies



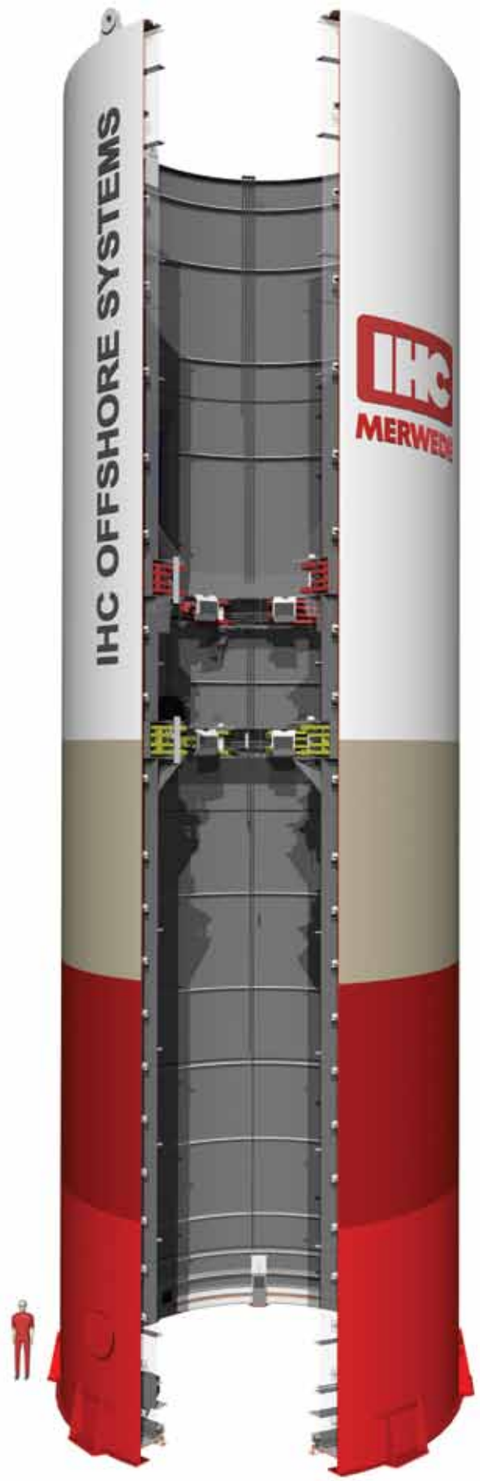
5. Tests involve several projects and scaling-up of pile diameters

Development of noise-mitigation systems (NMS)

The development of NMS types started in 2007 and the first experiments with scaled-down models were carried out in 2009. From basin tests, an actual-size NMS was manufactured and tested at the IHC Merwede yard in Kinderdijk. Offshore testing in the ESRa Baltic Sea and FLOW projects began in September 2011 and IHC Offshore Systems' NMS-6900 is currently being deployed and tested during the construction of the Riffgat offshore wind farm near the German isle of Borkum. Simultaneously, scaling-up from 0.9 to 6.5m pile diameters is involved (*figure 5*). The piling activites for Riffgat are finished and the NMS performed well below 160dB.

The NMS basically consists of a thin walled steel tube with a smaller thin walled steel tube inside. The space between the tubes is sealed at the bottom and top, thus creating an air gap. The difference in acoustic impedance between the air and the outer tube causes a high reflection of the acoustic wave travelling from the pile outwards. This results in a reduced excitation of the outer tube, so the amplitude of the structural vibrations is lowered and the acoustic radiation is decreased.

In addition, a tube ring with small holes is fitted on the sea floor between the pile and the NMS. When air is pumped into the ring, bubbles ascend to the surface and form a 'bubble screen' acting as an extra acoustic barrier. Yard experiments with a 2,200mm diameter prototype showed the potential of this



6. Artist's impression of the NMS-6900...

7. ..and its realisation by IHC Offshore Systems, inside and...

8. ..outside view

9. Another impressive IHC Merwede-built product, the OLEG STRASHNOV will work with the NMS-6900 near Borkum, off the German north-west coast

concept. Although the conditions were not yet representative for offshore operation, the screen yielded a massive drop in emitted sound pressure.

Current example: NMS-6900

The full-scale IHC Offshore Systems NMS-6900 for the Riffgat project is suitable to enclose pile diameters from 4.9 up to 6.9m and is designed in close cooperation with IHC Hydrohammer (*figures 6-8*). This NMS uses the pile for support, for which a diaphragm-shaped gripper with glide pads connects the inner screen to the pile.

To avoid the shortcut of vibrations to the outer screen, the connection between the inner and outer screen is isolated with rubber elements. Furthermore, the air cavity between the inner and outer screen is increased significantly. Its width is designed to reflect and dampen the dominant frequencies in the noise spectrum.

Between the pile and the inner screen of the NMS-6900, a multi-level air injection system is constructed. This system produces an air-water mixture of increased width by air bubbles of different sizes, having a damping effect over the whole frequency range. Both features are expected to have a beneficial effect on performance.

The NMS-6900 is currently involved in an extensive test programme, in which both the close-range and far-field noise will be measured. The results are expected to provide information on the fluid-structure interaction and noise propagation for further modelling. In the Riffgat project, the NMS-6900 will be applied in close collaboration with the world's largest monohull offshore lifting vessel, built by IHC Merwede (*figure 9*), the OLEG STRASHNOV [6].

Perspective

Sound mitigation will be an important subject in the future. It is expected that the German regulations will serve as an example for the EU and worldwide treatment of the issue. Within IHC Merwede, several programmes have been designed to serve its development strategy.

For example, in the short term, a change in the piling process, increasing the blow frequency at reduced blow energy and a PhD study in cooperation with Delft University of Technology are part of the FLOW programme, facilitating the modelling of sound emission and propagation, which should ultimately enable prediction of the phenomenon and further improvement of the NMS. This is obviously a long-term project.

Principal characteristics NMS-6900	
Built	IHC Offshore Systems
Allowed pile diameter upper guidance	4,960-6,930mm
Allowed pile diameter lower guidance	5,700-6,500mm
Height	30m
Outside diameter	10m
Estimated mass	360mT
Design water depth	26m
Significant wave height (Hs)	1.5m
Design current	1.0m/s

References

[1] Derived from: Sytske van den Akker. *Sound Solutions: Future offshore wind installation techniques without underwater noise.* The North Sea Foundation. 2011 and other loci on the Foundation's website

[2] *Underwater Sound in Relation To Dredging.* CEDA position paper. Central Dredging Association. Delft, The Netherlands, November 2011, Table 1. All mentioned dB-values have been referred to the well known 1µPa underwater sound reference level

[3] Frank Thomsen (DHI). CEDA position paper on underwater sound. Presentation at CEDA Dredging Days, Rotterdam, The Netherlands, 2011. Available at http://www.dredging.org

[4] "Piling with a pencil: IHC Hydrohammer®, for superb pile driving". *Ports and Dredging 176.* IHC Merwede, Sliedrecht, The Netherlands, 2011. 16-19

[5] "Oil, steel and passion: the story behind two remarkable IHC Merwede companies". *Ports and Dredging 172*. IHC Merwede, Sliedrecht, The Netherlands, 2009. 18-21

[6] "Monohull heavy lift vessel: OLEG STRASHNOV, the largest of its kind in the world". *Ports and Dredging 176*. IHC Merwede, Sliedrecht, The Netherlands, 2011. 10-15

On order

Yard number	Name	Specifications	Country
TRAILING SUCTION HOPPER DREDGERS			
CO 1260	CHANG JIANG KOU 02	12,000m³	China
CO 1264	DCI DREDGE XIX	5,500m³	India
CO 1265	DCI DREDGE XX	5,500m³	India
CO 1266	DCI DREDGE XXI	5,500m³	India
CO 1269	KARBALA	3,500m³	Iraq
CO 1272	ALBATROS	1,500m³	The Netherlands
STANDARD CUTTER SUCTION DREDGERS			
02490	IHC Beaver® 1200		Congo
02785	IHC Beaver® 1200		Portugal
02767	IHC Beaver® 6518C		UAE
CUSTOM-BUILT CUTTER SUCTION DREDGERS AND WHEEL DREDGERS			
02798	MIONDO	4,836kW	UK [1]
15043	DRAGA 18	1,600kVA WSD	Columbia
15044	DRAGA 19	1,600kVA WSD	Columbia
SELF-PROPELLED CUTTER SUCTION DREDGER			
CO 1262	ARTEMIS	24,000kW	The Netherlands [2]
BACKHOE DREDGER			
11.0002	ALBERTO ALEMÁN ZUBIETA	2,000kW	Panama
GRAB HOPPER DREDGER			
CO 1270	DOHUK	500m³	Iraq
PIPELAYING VESSELS			
727	Pipelayer	550t	UK
728	Pipelayer	550t	Malaysia [3]
729	Pipelayer	550t	Malaysia

1

2


3


4

Recently delivered

Yard number	Name	Specifications	Country
TRAILING SUCTION HOPPER DREDGER			
CO 1259	CHANG JIANG KOU 01	12,000m³	China [5]
STANDARD CUTTER SUCTION DREDGERS			
02736	IHC Beaver® 300C, LITTLE ORME		UK
02752	IHC Beaver® 40		Nigeria
02786	IHC Beaver® 1200		Bangladesh
02761	IHC Beaver® 50		Philippines
02762	IHC Beaver® 50		Brazil
02475	IHC Beaver® 6518C		Russia
02770	IHC Beaver® 6518C		South Korea
CUSTOM-BUILT CUTTER SUCTION DREDGER			
02784	SHANTI SAGAR XVI	13,000kW	India
SELF-PROPELLED CUTTER SUCTION DREDGER			
CO 1268	AMBIORIX	26,100kW	Belgium [4]
WORKBOATS			
11032	DMC 1200		Portugal
11035	DMC 1400		Ecuador


5

Main features

- ✓ **NEPTUNE: turbine transport and installation self-elevating heavy-lift jack-up vessel**
- ✓ **SHANTI SAGAR XVI: a new dredger for a rapidly expanding customer**
- ✓ **IHC Merwede dredge hoses and floating discharge lines**
- ✓ **Sound engineering for underwater piling**

IHC Merwede is focussed on the continuous development of design and construction activities for the specialist maritime sector. It is the global market leader for efficient dredging and mining vessels and equipment – with vast experience accumulated over decades – and a reliable supplier of custom-built ships and supplies for offshore construction.

IHC Merwede has in-house expertise for engineering and manufacturing innovative vessels and advanced equipment, as well as providing life-cycle support. Its integrated systematic approach has helped to develop optimum product performance and long-term business partnerships. The company's broad customer base includes dredging operators, oil and gas corporations, offshore contractors and government authorities.

IHC Merwede

P.O. Box 204
3360 AE Sliedrecht
The Netherlands

T +31 184 41 15 55
F +31 184 41 18 84

www.ihcmerwede.com
communication@ihcmerwede.com