Insight

Dredging | Mining | Offshore Spring 2015 | E 6

The expert in pipelaying systems

A new approach to deep-sea drilling

Ports and power projects in Brazil

Cost-effective remote monitoring and support

The technology innovator.

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Welcome

Dear reader,

This issue of *IHC Insight* casts a spotlight on some of the most recent developments within Royal IHC, and customer experiences of its innovative vessels and advanced equipment.

IHC acquired SAS Offshore earlier this year as part of its strategy to become a total solutions provider. Find out on pages 18-23 how IHC SAS contributed to the 550t pipelaying vessels delivered to Sapura Navegação Marítima in Brazil, and how its expertise is helping to strengthen IHC's global position in this sector.

Also in Brazil, IHC dredging vessels are currently involved in two significant infrastructure projects – port maintenance and the construction of a hydroelectric power plant. The exclusive report on page 4-9 highlights the customers' experiences and their ongoing partnership with IHC.

Closer to home, two R&D projects have the potential to make huge steps forward in the deep-sea mining and dredging industries. The difficulties surrounding the vertical transportation of solid materials over large distances is the focus of one IHC study, outlined on pages 28-33. And the potential to save fuel at the design stages of dredging vessels is the subject of another fascinating project – find out more about its implications on pages 14-17.

Highlighting IHC's innovative capabilities, a report on the launch of IHC SWORD is on pages 34-39. This subsea remote-controlled drill is an invaluable tool for oil and gas geotechnical survey and site investigation in deep and ultra-deep water.

Another recent technological development is the introduction of IHC Connect, a secure information acquisition and communication platform for the remote monitoring and support of vessels. Its benefits for customers in the offshore, dredging and wet mining sectors are illustrated on pages 10-13.

And finally, on pages 24-27, Vuyk Rotterdam presents a conceptual design for a vessel that can be used as an offshore accommodation and support facility as well as a standalone unit for independent operational activities. This multi-purpose solution increases efficiency, and provides advanced and innovative services to customers.

We hope you enjoy this issue!

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Pipelay tower of the SAPURA DIAMANTE

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Close partnerships in Brazil

The IHC-built CATARINA at work in Brazil

IHC customers are currently involved in two economically significant dredging projects in Brazil. Triunfo Participações e Investimentos SA is maintaining a busy port channel on the southeast coast, while Santo Antônio Civil Consortium is responsible for the civil construction work at an important new dam build in the west of this rapidly evolving country.

With a national coastline measuring over 7,000km in length, Brazil boasts a large port sector with an annual turnover of around 700 million tonnes. Therefore, port infrastructure is vitally important to its national economy – currently the seventh largest in the world.

Meanwhile, the Brazilian Government's programme to reduce dependence on imported petroleum has led to the country becoming one of the leading producers of hydroelectric power in the world. In fact, hydroelectric power plants currently produce over 90% of Brazil's consumable electrical energy.

IHC has had a presence in the country since the 1970s, and since then a number of positive and cooperative relationships have flourished. The company continues to supply vessels to Brazil's dredging and offshore markets, along with equipment and technical support.

CATARINA: a consistently efficient TSHD

The city of Navegantes and the municipality of Itajaí sit side-by-side on the edge of Santa Catarina state in southern Brazil, a highly important location for the administration of imports and exports in the region. Both areas operate their own individual ports, and in terms of the movement of containers, the Port of Itajaí is the second largest in the country.

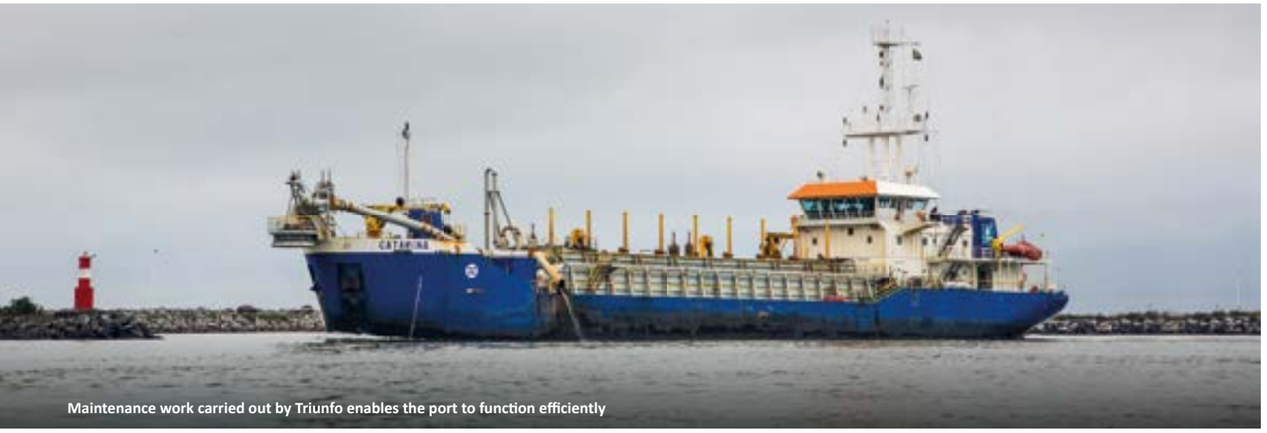
Triunfo Participações e Investimentos SA (Triunfo), a Brazilian firm specialising in road building, ports and public infrastructure, owns the private Portonave terminal in Navegantes. It is also responsible for the maintenance of the entrance channel – a demanding job requiring a 24/7 operation.

In order to allow good access for the significant number of ships that pass through every day, it is necessary to maintain the route's seabed level to a minimum depth of 14m. To achieve this, the company relies on the CATARINA, an IHC-built trailing suction hopper dredger (TSHD), which has already completed over 5,000 round trips in and out of the port since February 2012.

The captain of the CATARINA has worked with dredgers for 14 years and says: "The vessel is incredibly versatile, and able to easily perform all of the tasks required for the project. We are able to dredge a number of different materials, and the on-


On board systems help make the process even more productive


The CATARINA's 2,400m³ capacity hopper


Maintenance work carried out by Triunfo enables the port to function efficiently

board systems help make the process even more productive."

A 24/7 operation

During the dredging process, the CATARINA naturally spends much of its time travelling up and down the channel, and so manoeuvrability is important. The vessel's first mate is responsible for navigating the ship.

"With the bow thrusters, we're able to dredge within 1.5m of the side of the channel," he says. "And it's just as easy near the edges as it is in the middle. In addition, we have excellent all-round visibility from the bridge, which means that we can operate easily during the day or by night."

As port maintenance involves the dredging of silt and clay, the draghead was installed with an integrated relief valve, which helps to increase suction capabilities and mitigate blockage. "The draghead and suction pipe are extremely powerful and offer a high level of efficiency," adds the first mate. "They are also easy to maintain, and so this vessel is more cost-effective when compared to similar dredgers."

After the targeted area of the seabed has been reduced to the desired depth, the dredged materials are taken out to sea to one of two dumping sites. These are carefully defined by local environment agencies in order to avoid any negative impact. The northern site is located 2.4 nautical miles from the coast, and the southern is 1.25 nautical miles.

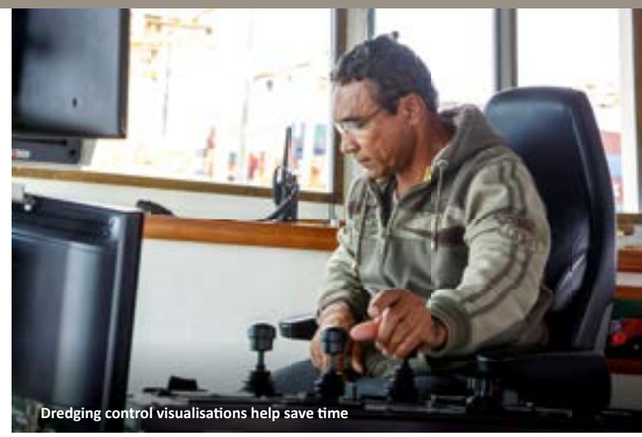
The dredgemaster of the CATARINA, who has worked in the industry for 15 years, highlights ease of operation as one of the main benefits of the CATARINA: "The dredging control visualisations save time and simplify the entire process. Furthermore, the high-quality suction arm, and hydraulic system are very efficient."

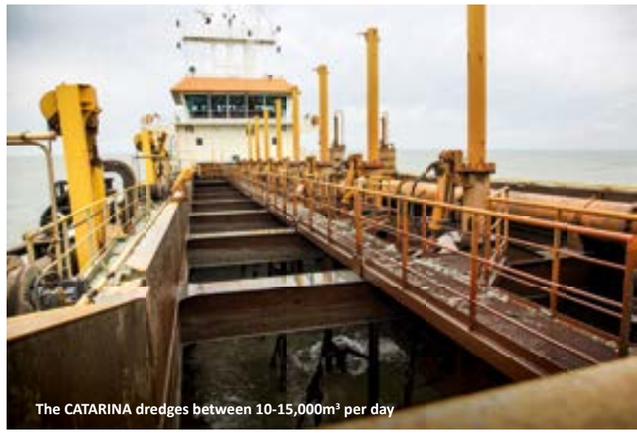
The vessel's automated and intelligent systems offer the crew a sense of reassurance, as the correct protocol must be followed in order to carry out operations. "The ship has a very safe working environment," he adds, "and because we feel more secure, we are more productive."

Strong cooperation

The biggest priority to any captain is his crew, and with 14 members, he cites good relations as an important aspect. "Despite being very robust, the ship is compact, which means that the crew is living and working closely together," he says. "We are a tight-knit group and there's a strong sense of teamwork."


The CATARINA's pump room


Dredging control visualisations help save time


The CATARINA dredges between 10-15,000m³ per day

Triunfo's technical superintendent in Itajaí is responsible for the maintenance of the CATARINA and the ordering of spare parts. Working directly with the captain, he identifies any issues and, if necessary, contacts IHC, "I always receive a prompt response when I contact the support team. Even just for troubleshooting, the advice we receive is very good."

The maintenance work carried out by Triunfo is enabling the port to function efficiently. Depending on the channel traffic, the CATARINA dredges between 10,000 and 15,000m³ per day. According to the technical superintendent, the dredged materials are of the required standard more than 90% of the time.

JATUARANA I and JATUARANA II: a dynamic duo

The Santo Antônio Dam, located six kilometres southwest of Porto Velho in Rondônia, is a new run-of-river hydroelectric power station that began production in August 2008. More than 15,000 people are currently employed on the site. Due for completion in 2016, the station will output 3,500MW of electricity to millions of people.

Santo Antônio Civil Consortium (CSAC), the group responsible for the civil construction work at the dam, initially approached IHC to conduct research studies at the site. CSAC then ordered two standard IHC Beaver® cutter suction dredgers (CSDs) to perform vital work on the Madeira River running through the dam.

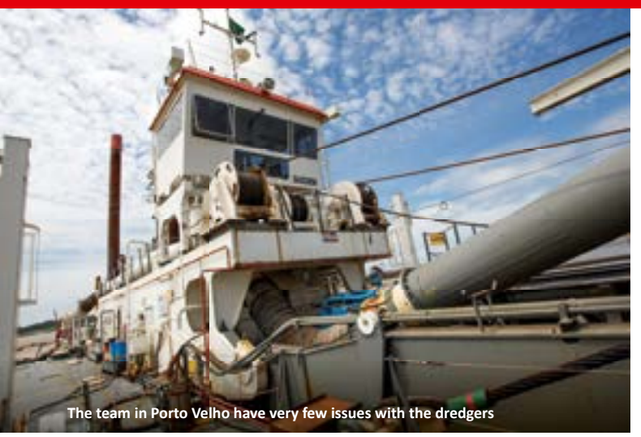
Early studies

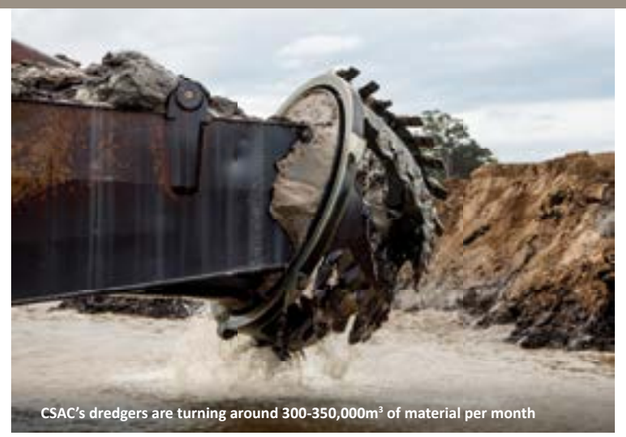
Early in the project, dredging specialists began a soil study and, through the use of computer simulation models, provided an estimate of the production curves before work began. These figures were based on the materials studied, the size of the area and the depth of the river.

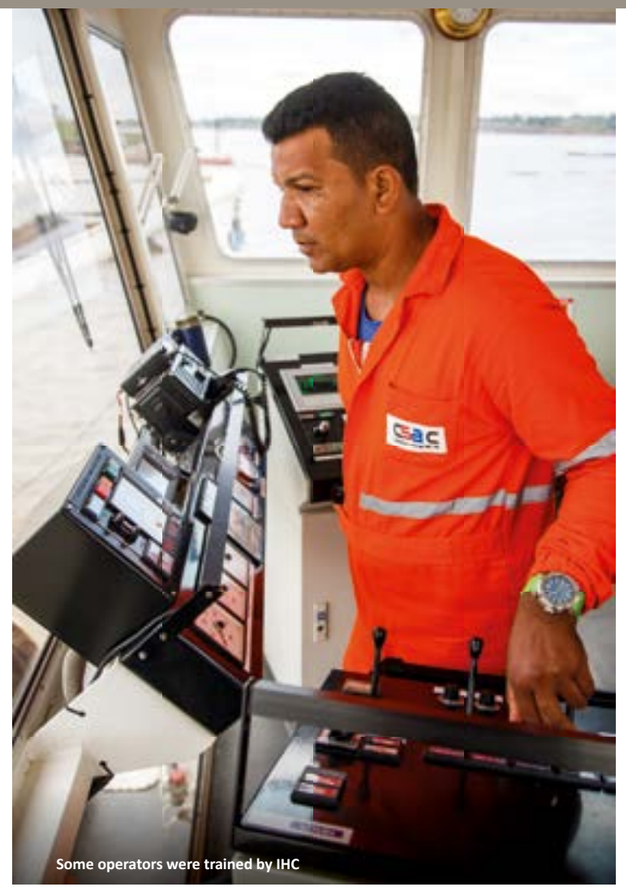
The study showed that areas of the surrounding river would need to be widened and the riverbed lowered to reduce water resistance. This would enable the water to flow through the turbines properly and allow the dam to function at full capacity

Due to the swamp-like nature of the environment, it was decided that it would be too dangerous to use traditional trucks and excavators. Therefore it would be much more efficient, practical and safer to employ water-based dredgers.

Life-cycle support


The team in Porto Velho have very few issues with the dredgers


CSAC's dredgers are turning around 300-350,000m³ of material per month


Some operators were trained by IHC


Operators find the dredgers' cabins comfortable, and the controls ergonomic


The JATUARANA I and JATUARANA II were delivered in 2010 and 2011


CSAC highlights the significance of precise equipment

The best solution

Once the project had reached the point where further development of the river and riverbed was required, the two vessels were shipped from The Netherlands to Brazil, a journey that lasted three months. The ability to easily dismantle the vessels before transferring them as separate packages to the site meant transportation was a straightforward process.

The JATUARANA I, delivered in February 2011, is a 47.2m IHC Beaver® 6518 C CSD with a catamaran-shaped hull, and two Caterpillar diesel engines located at deck level. It is equipped with a single high-pressure submerged dredge pump, mounted on the ladder.

The dredge pump is directly driven by the diesel engine, and operates via the IHC Pivoting Gearbox. It is positioned directly behind the cutter – closer to the suction mouth – enabling good suction capabilities at larger dredging depths. The diameter of the delivery pipeline is 650mm, and the maximum dredging depth is 18m.

The second vessel, delivered in November 2010, is a 32.3m IHC Beaver® 50, the JATUARANA II. Smaller than the JATUARANA I, it is ideal for working closer to the river bank in shallower water.

Perfect performance

For the dredgemaster who operates both vessels, additional options such as a spud carrier and anchor booms are invaluable. "These increase our ability to move forward with the vessel," he says. "Sometimes you don't have this option, so it's very efficient and useful, and saves us so much time."

On such a large-scale project with a need for high levels of productivity – a turnaround of 300-350,000m³ of material per month – safety and ease of operation are vital. Many operators required training in order to carry out their work.

"I was trained by IHC for three months," says one of the operators, "and I now find these vessels very easy to use. They have comfortable cabins, and perfect ergonomic control systems. This makes it easy to reach our targets, and so far everything is going to plan."

A high output

The general supervisor of the dredging operation has worked in the construction industry since 1969. He is currently responsible for managing operations and maintenance, and makes decisions on pipelaying.

For him, it's important to have durable equipment that requires only regular, routine maintenance, "We have very few issues with these dredgers, which means that the crew are available to do their normal work rather than spend some of their time fixing things. With this reduction in downtime, we are able to reach our deadlines and plan for the future."

He also highlights the significance of precise equipment, "It is easy for us to reach areas that land-based excavators cannot. This is vital, as we need to actually widen the river and remove large amounts of material."

Despite such positive production numbers, it is important that the work carried out does not violate the agreed terms with regards to the potential environmental impact of the project. To that end, steps have been taken to monitor the river to ensure the wellbeing of local wildlife.

Underwater sensors analyse the river's characteristics in real-time, measuring the qualities of the water, including temperature, oxygen levels and how much excavated sediment moves down the river. These figures can then be compared to measurements made before construction began, and adjusted if they exceed maximum allowances. To date, no adjustments have been required.

Of course, nature can create potentially dangerous situations. "Our biggest challenge on this site is the unpredictable river conditions, and so we have made simple modifications to the vessels ourselves," says the equipment manager.

"IHC was on hand to support us when we made these modifications. We had many discussions with them and our ideas were analysed by their engineers. Then they provided us with all of the information and support we needed to make it happen."

Bright futures

Working in close partnership with its customers, while delivering a high level of service, is central to the philosophy of IHC. The dredging operation at the Santo Antônio Dam is due for completion in March 2016, and IHC will continue to work alongside the team to the end.

Meanwhile, Triunfo needed a dredger that could work efficiently for long periods with a minimum of downtime. As a perfect response to these requirements, the CATARINA has proved to be an easy-to-operate TSHD with low maintenance requirements, capable of working continuously 24 hours a day.

A vital connection

Remote monitoring and support can significantly increase the uptime of a vessel's operations

In response to the latest advancements in modern communications technology and the growing demands of the maritime industry, IHC has developed IHC Connect, a secure information acquisition and communication platform. IHC Connect has been designed for the remote monitoring and support of vessels in the offshore, dredging and wet mining sectors, and enables customers to access a vessel's operational data, improve maintenance provisions and decrease repair response times.

As more and more industries worldwide move towards increasingly ICT intensive environments, the technology for developing remote access capabilities for a number of useful applications has evolved. In the maritime industry, this includes the ability to access all on-board automation systems and obtain information on vessels via the internet from anywhere in the world.

The overall benefits of an integrated remote connectivity platform include enhanced flexibility and considerable cost savings, while improving the operational performance of a vessel. In addition, the facility for the safe access of on-board data means many potential issues can be quickly investigated and solved remotely.

IHC Connect features multi-channel technology which is able to interface with any type of automation system on board, including third-party equipment, in order to monitor, log and report all useful data to the customer via a ship-to-shore connection.

It serves as the framework for several advanced applications available to customers, which can be defined into two categories: monitoring and support. The modular system can be combined and tailored according to customer requirements in order to provide users with a comprehensive and bespoke package, which can help to improve the efficiency of their entire operation.

A support network

The support function of IHC Connect employs progressive technology to establish a link between the vessel and the support team at IHC by using any pre-existing on-board TCP/IP data link, including satellite, GPRS or WiFi. Furthermore, as most modern vessels are equipped with wireless or satellite communications systems, the cost for installing IHC Connect can be kept to a minimum.

The connection enables the support team at IHC to remotely access automation systems on the vessel in order to diagnose, log and assist with any problems encountered by the customer. Networks available for connection include the integrated vessel automation system, such as IHC DIVA, mission equipment automation, and the integrated dredge control system (IHC DCS). If used in combination with IHC's integrated vessel automation for dredging and offshore vessels, there is almost no limit to the number of systems that

Life-cycle support

IHC Connect provides secure access to all onboard automation and electrical systems via the internet

Screenshot of a live IHC Connect service job

OEM monitoring can be integrated into the IHC Connect System

The IHC PLSV SAPURA DIAMANTE in Brazil is equipped with IHC's integrated vessel automation and is ready to use client remote support and/or monitoring

can be accessed remotely.

In order to ensure information security, IHC uses communications protection technology supplied by one of the world's leading providers. Each vessel employing IHC Connect will be issued with its own firewall appliance, ensuring that only authorised data traffic, both inbound and outbound, is permitted.

Less downtime

"The ability to access diagnostic information remotely from anywhere in the world offers the customer a number of important benefits," says Martijn van Eeten, Product Specialist for IHC Systems. "For example, while small issues on board a vessel can be fixed by the customer, bigger problems may be beyond their scope."

Normally, this requires a service engineer to visit the customer directly. For long-distance visits, this can mean long periods of downtime and a corresponding loss of income. With IHC Connect, an engineer can remotely identify faults online and offer possible solutions, which also eliminates potential waiting periods by circumventing the need for work permits or visas. This reduction in downtime can help to make significant savings.

It is also feasible for the engineer to execute the repairs remotely, by accessing the vessel's on-board system and carrying out maintenance activities, which can also include software upgrades and firmware updates.

"In addition, the IHC support team comprises a large pool of specialists who are available to provide advice or information at any time," Martijn points out. "This means the customer benefits from having a larger support network at their disposal, with more accumulated knowledge. It's an effective remote solution to engineering support, with a very fast response time."

IHC Connect is not strictly limited to integration with IHC equipment, nor is the connection to the IHC service centre a requirement, as third-party equipment, for example diesel engines, can also be connected to the system. This allows authorised contractors and suppliers to log in to a state-of-the-art web portal – with permission – and monitor specific assets using software token authentication. As such, the customer benefits from a single, unified system and a secure turnkey solution for life-cycle support requirements.

Monitoring progress

Data traffic for IHC Connect is handled by the Connect Management Centre, a centralised information storage centre, which can be located either at the customer's facilities or a data warehouse. The customer is able to monitor vessel activity in real-time from a standard web browser or a tablet connected to the Connect Management Centre via the internet.

Customers can monitor fuel consumption, bunkering information, fuel reserves and virtually any other operational data, which can be tailored to customer requirements on a project-by-project basis. The information monitored is shared with the customer via the IHC Connect web portal, and the interface is easily scalable and customisable.

Increasing productivity

"The ability to monitor things like trends in fuel consumption and pump velocity in real time or via an automated report allows customers to optimise their profiles in order to save costs," says Martijn. "It increases productivity levels and allows for better maintenance predictions and planning. In addition, the facility to study all aspects of a vessel's operational systems can help with crew training."

The Connect Management Centre, which benefits from low infrastructure costs, is also able to send alert notifications and periodic reports to customers via email or SMS. Again, these notifications can be tailored to the customer profile and adjusted at any time based on changing requirements, while historical reports are easily retrievable.

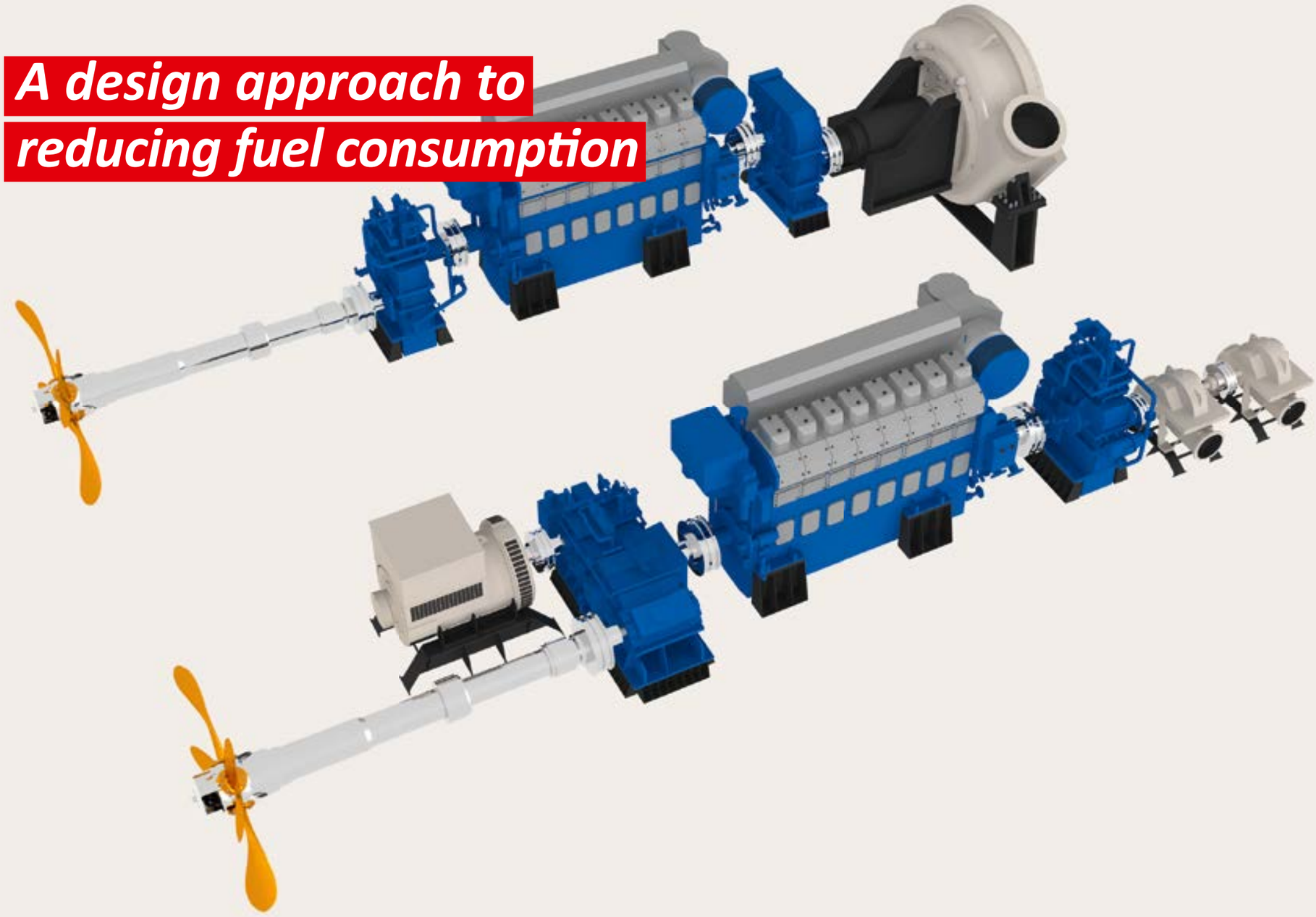
The interface between the vessel and the Connect Management Centre on shore is the Connect Box, a single, easy to install component that can be retrofitted into a vessel at a low cost and connected to whichever systems the customer requires. Additionally, the integrated calculation module is able to translate raw analogue data into useful information before it is sent to shore.

A secure solution

IHC Connect represents a secure and cost-effective investment for monitoring vessels and receiving support from either IHC or a third-party supplier based on the customer's preferences or requirements. IHC's vision is to introduce the tool as standard on all of its vessels.

Through innovative developments such as IHC Connect, IHC is able to respond to the maritime industry's growing demand for advanced support and monitoring technologies. Not only does the ability to monitor a vessel's systems from a location on shore have benefits to the customer, it also allows IHC to provide optimal support in a competitive and rapidly evolving market.

A design approach to reducing fuel consumption



An R&D project investigating fuel-saving opportunities for dredging vessels has been under way for two years at IHC, driven by financial and environmental concerns. Dredging companies are eager to reduce fuel costs to lower their operational costs, while industry regulations on exhaust gas emissions are becoming increasingly strict. Erik van der Blom and Leonard den Boer of IHC Holland's R&D department explain why it's important to consider fuel consumption at the design stage of a vessel and outline the progress made in the project.

IHC is constantly improving the efficiency of its dredging vessel designs and aiming for a lower cost of ownership for its customers. This can be measured as a cost price per dredged cubic metre of soil. An important part of the cost price per cubic metre is fuel expenses. These account for approximately 20-30% of the operation costs of a trailing suction hopper dredger. This explains why any parties interested in buying new vessels are constantly looking at fuel consumption, without wanting to make a significant increase in investment.

As well as a major cost driver, fuel consumption is topical because of the current trend of sustainability within the dredging industry. At the same time, regulation and legislation are becoming more stringent: in the USA, the EPA Tier 4 emission regulations are becoming effective, requesting another major step in the reduction of emissions, especially for NO_X. Worldwide the IMO is preparing the Energy Efficiency Design Index (EEDI), defining steps in the reduction of CO_2 emissions. "In The Netherlands, for example, the Ministry for Infrastructure and Environment [*Rijkswaterstaat*] is encouraging CO_2 reduction in dredging projects with the CO_2 performance ladder [*prestatieladder*]," says Erik.

As fuel consumption is the major contributor to the environmental impact of dredging equipment, it should therefore be a starting point in the design of dredging vessels. This is why the R&D department at IHC Holland has been investigating the impact of vessel design on fuel savings.

"Every dredging customer is looking to reduce fuel costs because of its impact on operational costs," says Leonard. "And almost every company is looking at fuel-saving possibilities. We are looking at possibilities specifically for dredging vessels, with specific designs and operational profiles."

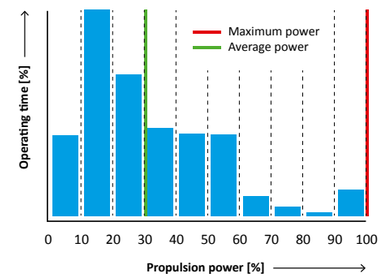
Measurements of operational profiles

To understand the fuel consumption of a dredging vessel, its operational profile during the dredge cycle is essential as a starting point. For example, dredging gravel at a depth of 50m is completely different to sucking up mud in a small harbour and discharging it just outside the jetties (*figures 1 and 2*). Water depths, soil to be dredged, sailing speed limitations and the amount of manoeuvring required – all have an effect on the operational profile influencing the fuel consumption per cubic metre.

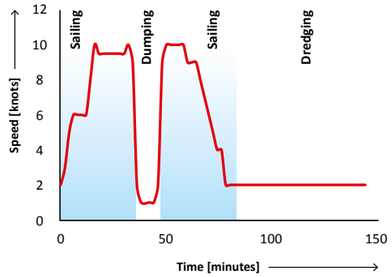
To get an insight into the operational power consumption of dredgers, IHC took measurements from different vessels on various dredging activities (*figure 3*). These included harbour maintenance and land reclamation, and the findings were that the average power consumption was significantly lower than assumed.

Innovative vessels

1. Dredging cycle, typical maintenance

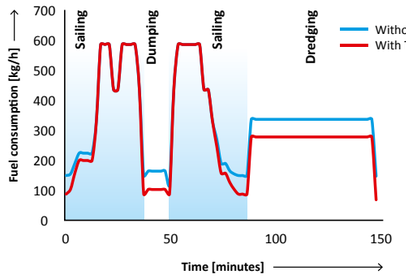


3. Example of a measured operational profile



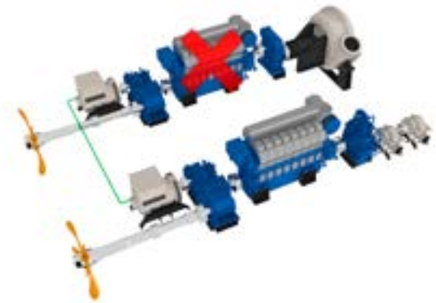
2. Typical operational profile

5. Common drivetrain concept (direct driven CPP)



6. Fuel consumption with and without using the two-speed propulsion gearbox

8. FPP drivetrain concept



7. Hybrid drivetrain concept

9. Electric FPP drivetrain concept

"To collect the data, we took measurements on vessels working in the field. It was a real eye-opener to discover that for much of the time, the vessels were operating at partial power – more than we thought," said Leonard. "The partial power conditions present a great opportunity for fuel saving."

These insights can be translated into the effects on the dredgers' systems and the fuel consumption, using knowledge of mechanical and electrical engineering, hydrodynamics and soil mechanics. Once all the parameters and relations have been established, the design variables that play a significant role in the overall fuel consumption of a dredger can be identified.

Fuel consumption tool

Comparing dredging vessels on fuel consumption involves many factors, so tools are required to estimate this accurately. IHC has developed a fuel consumption estimation tool, which combines a lot of information from different fields of expertise.

It can be used to calculate and optimise the fuel consumption for a specific dredger with a certain operational profile, by combining data on the diesel engine, propulsion, electric efficiency, dredge pump and operational profile. The calculation tool gives an overview of the results of the comparison of the concepts like fuel consumption, cost per cubic metre of soil and production per year. The tool can also be used for existing vessels.

"Using the fuel consumption tool and any given operational profile – measured or estimated – as input we can compare different drivetrain designs," explains Erik. "The fuel consumption estimation tool has proven to be invaluable during the design of trailing suction hopper dredgers. It enables us to choose the optimal drivetrain and give specific advice to customers when building new vessels, comparing alternatives on both the cost and fuel consumption per cubic metre." (*figure 4*)

Optimisation of drivetrain design

Based on the insights gathered, the IHC research then focused on the design of alternative drivetrains (*figure 6*) in order to find opportunities to reduce fuel consumption per cubic metre (*e.g. figure 4*). As a reference point, a direct driven controllable pitch propeller (CPP) was used because this drivetrain configuration (*figure 5*) is commonly used in dredging vessels.

A variety of features were identified that could contribute to reduced fuel consumption. These included a two-speed propulsion gearbox (TSG), a combinator curve (CC) and a hybrid drivetrain.

The TSG (patented) saves fuel by lowering the speed of the propulsion from maximum to medium speed and also increasing the propeller pitch. It shifts automatically at 50% propulsion power without interruption. The TSG operates during all operating modes, including dredging, sailing and discharging.

The CC saves fuel by lowering the speed of the engine and propeller, as well as increasing the propeller pitch. This gives the engine and the propeller a more fuel-efficient working point. The CC is only active during sailing.

A hybrid alternative saves fuel by shutting down one of the two engines when sailing at low engine power. This way, the other engine works at a higher power, so is more fuel-efficient. When one engine is shut down, one propeller is directly driven and the other is electrically driven (*figure 7*).

The IHC research also evaluated fixed pitch propeller (FPP) alternatives, comparing a direct-driven FPP with a CPP. At partial power, the FPP has a higher efficiency than the CPP. However, the disadvantage is that all components are directly driven by one engine and many engines are needed. This means the engines run often on partial power, so have a lower fuel efficiency (*figure 8*).

The electric-driven FPP saves fuel due to the efficient FPP propeller, but it has the disadvantage of electric losses. It also has fewer installed engines than the direct-driven FPP (*figure 9*).

Eco Control Package developed by IHC

Intelligent automation can help customers to operate TSHDs in a fuel-efficient way by adapting the system to varying work and soil conditions, and optimising within the limits set by those conditions. Tested in real dredging scenarios, a combination of IHC's Trailspeed Controller (TSC) and Eco Pump Controller (EPC) have shown a significant increase in production, leading to shorter loading times and a significant reduction in fuel consumption.

Possibilities and opportunities

The work carried out by the R&D department at IHC Holland is enabling the company to advise individual customers on fuel-saving opportunities on their existing dredgers, as well as during the design phase of new vessels.

"There are many possibilities for fuel saving, with both environmental and financial benefits," concludes Erik. "It's different for every vessel and depends on the project, crew and conditions – there is no single answer. However, if you assess the drivetrain, use our calculation tool, and look at the operational profile and measurements, then you can reach the right answer for each individual customer."

	CPP	CPP Two-speed gearbox	CPP Combinator curve	CPP Hybrid	CPP TSG+ CC+H	FPP	e-FPP
Consumed propulsion power	100%	82%	89%	100%	80%	77%	77%
Total fuel consumption	100%	91%	93%	97%	85%	89%	94%
Energy label	D	C	C	D	A	B	C

4. Opportunity for fuel saving specific to a certain profile and ship design. The outcome can differ strongly for other ships and/or operational profiles

Laying foundations for the future

The traction winches on all the SAPURA vessels were specially designed to be mounted vertically on the tower leg

From loading a pipe on to a vessel to laying it on the seabed, IHC SAS (formerly known as SAS Offshore), supplies complete systems that are relied upon by the offshore oil and gas industry. Find out how its technological expertise in pipe tensioners has helped to strengthen IHC's position as a supplier of integrated pipelaying vessels, and also secure a greater foothold in the growing Brazilian market.

In January 2015, IHC announced its acquisition of SAS Offshore, a Dutch company that specialises in the design and manufacture of deck equipment for the offshore oil and gas market. Based in Alphen aan den Rijn, SAS Offshore was established in 1896 and has a long history in delivering pipelaying systems and winches, ancillary equipment and services.

Since its first pipe tensioner was manufactured in 1968, the company has become renowned for its technological expertise in this field, and gained a strong position as the developer and manufacturer of turnkey and custom-made S-lay and flex-lay systems. At work in every sea and ocean, its systems are supported by sales and service offices in the USA, Singapore and Brazil.

Before the acquisition, SAS Offshore had worked with IHC on numerous projects. Most recently, the two companies cooperated on the delivery of the tensioners and winches for the pipelaying systems for the Sapura Navegação Maritima integrated pipelaying vessels, which were designed and built by IHC.

Two of these vessels – the SAPURA DIAMANTE and SAPURA TOPÁZIO – are already operational, developing deep-sea oilfields at depths up to 2,500m in Brazilian waters on behalf of Petrobras. The third vessel has completed sea trials, and the remaining three are to be delivered within the next 12 months.

"The Sapura vessels in operation have a very high efficiency rating which has exceeded customer expectations," says IHC SAS Sales Director Erik Hoogakker. "We are very proud of this figure."

Challenges and innovative solutions

In total, the six flex-lay vessels (five 550t and one 300t) represented the largest order to date in 2012 and 2013 for IHC SAS. They also presented the company with some significant challenges to overcome.

The pipelaying spread, designed and supplied by IHC Engineering Business (IHC EB), comprised two below-deck storage carousels, with capacities for 2,500t and 1,500t of product respectively. A vertical tiltable lay system, with a 550t top tension capacity was required for the deployment of flexible products, varying from a diameter of 100 to 630mm.

For the 550t vessels, IHC SAS will supply in total: ten 300t four-track tower tensioners; five 625t A&R traction winch systems including storage winches for 3,500m of steel wire rope; five 200t A&R traction winch systems including storage winches for 3,500m of steel wire rope; ten 30t spooling tensioners;

Advanced equipment

IHC SAS Sales Director Erik Hoogakker


The tensioners and winches for the pipelaying system of the SAPURA DIAMANTE were supplied by IHC SAS


The storage winches capable of storing 3,500m of steel wire rope with integrated spooler. This spooler also acts as a compensator


The SAPURA TOPÁZIO has a tower with two tensioners installed


The traction winch of the SAPURA TOPÁZIO

ten 30t spooling winches; and five 40t initiation winches. In addition, it supplied electrical power units for all of the above and sophisticated control systems developed in-house.

“The 550t vessels have a tower with two tensioners installed; the 300t vessel has a tower with a single tensioner,” explains André Rexwinkel, IHC SAS R&D Director. “The large tensioners mounted in the tower have four tracks, but they can work in two-track mode as well. The small 30t spooling tensioner on deck has only two tracks.

“The four-track is arranged in a ‘plus’ shape and is used to squeeze the product to hold the pipe on the outside but also to create sufficient friction between the internal layers of the product,” he explains. “The two-track mode is for smaller pipe diameters.”

One of the challenges was low friction force, both inside and outside the product. “The low friction coefficient of 0.07 means that you have to squeeze very hard or that you need a very long tensioner in order to be able to hold the pipe,” says Erik. “The overall clamping capacity of the tensioner [4,285t] is a result of the required tension [300t] divided by the friction [0.07].”

The 550t vessels have tensioners that are designed for a maximum squeeze force of 150t/m/track. The 300t vessel has a tensioner designed for 100t/m/track. “With the same friction coefficient of 0.07, this resulted in a design of tensioner that is 50% longer,” adds Erik.

Another challenge was the high level of integration required for the components, lay equipment, tower and vessel itself. “Various IHC units were involved in the design and build of these vessels,” says Erik. “The mounting of the tensioners into the tower, the limited underdeck space for the storage winches – it all involved a high level of integration.”

IHC SAS worked closely with IHC EB on the integration of the tensioner system to ensure a successful result. “Together we created storyboards to illustrate the various steps of each operation,” explains André. “This is a really useful document to discuss functioning of the system with the customer.”

IHC SAS also carried out an extensive FMECA (failure modes, effects and criticality analysis) study on the operations performed by the equipment, which highlighted the measures required to avoid hazardous situations. This suggested the need for interlocks in the controls to prevent a certain operation being performed while the vessel is carrying out another task.

“Sensors in the controls can assess a situation and so certain controls are blocked to prevent hazardous circumstances,” says André. The mechanical, hydraulic and electrical design of all the equipment on the vessels followed the results of the FMECA study. The control system had to ensure that the product would not be lost due to a single point of failure.

The assembly of the machine in the factory also presented a challenge, adds Erik. “A lot of work was involved in the assembly. We rely on a flexible and experienced workforce for assembling and testing the equipment, with 15 permanent employees and additional staff hired according to the workload.”

As each of the 550t vessels are practically identical, IHC SAS could continually optimise its assembly methodology, explains André: “For the first tensioner, all mechanical parts were assembled together into a complete tensioner assembly, then the outrigging was completed. For subsequent tensioners, we used building blocks, so the outrigging was done in modules. This was more efficient, as various teams could work on them at the same time.”

Weight issues

IHC SAS Senior System Engineer Marco Lock highlighted another unique aspect of the vessels for Brazil, which posed a potential issue to be resolved. “The machines are very heavy – 300t each – and are mounted in the tower structure. The actual product tension is measured by means of load pins mounted in the lower connection points between the tensioner and tower construction.

“Due to vessel movements and inertia of the tensioners, an extra load is introduced in the load pins, which affects the actual product tension. So we installed accelerometers on the tower. The measured acceleration values are used to filter out the forces created by vessel movement to gain a net product tension value.”

André adds: “During structural analysis, the mass is also a parameter we are required to lower by the customer. We face a weight penalty, so we’re not allowed to exceed a certain weight.”

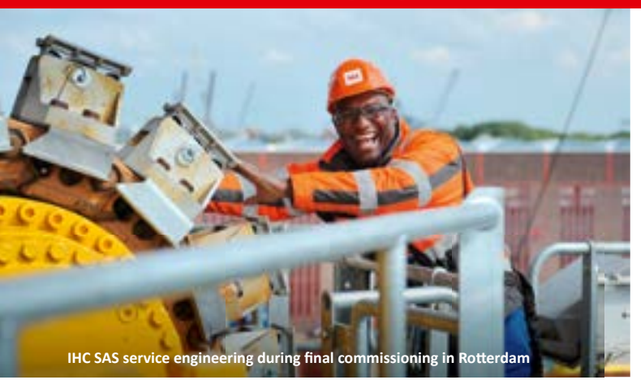
The weight of the storage and traction winches were considered in the vessel design. “The storage winches are single drum for 3,500m of steel wire rope. The challenge is when the total length of cable is on the winch, that’s a lot of mass and it has to be strong during vessel movement.”

The maintenance of the equipment in the towers was another focal point. “Maintenance must be carried out high up in the towers,” says André. “Access to all points for changing components, for example, is an important consideration. We put a strong emphasis on making maintenance safe and easy, with the design of access platforms and ladders. The tensioner has platforms all around it to access certain points.”

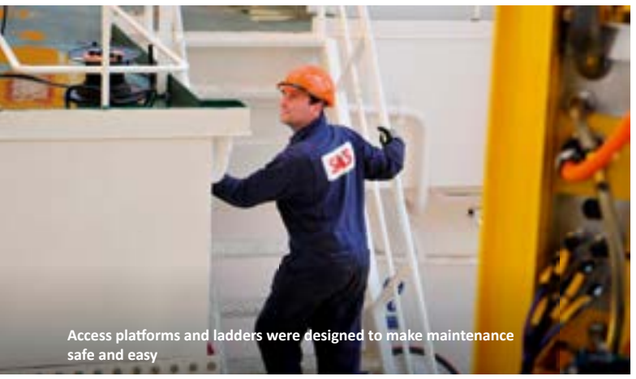
In addition to maintenance, IHC SAS recognised the time required to change the steel pads that grip the pipe as an important factor. “There are 350 pads per tensioner on the system designed for Sapura, each weighing 15 to 20 kilos,” says Erik.

“The customer wanted to limit the time needed to change the pads, depending on the diameter of the pipes, because it regards this as downtime. So we developed a system with a single retainer and pin to remove it, making it as quick and easy as possible.”

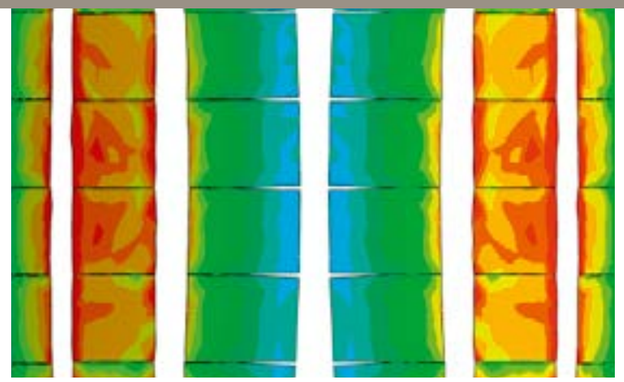
Advanced equipment

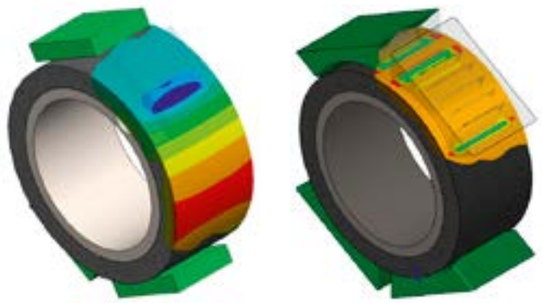


IHC SAS service engineering during final commissioning in Rotterdam



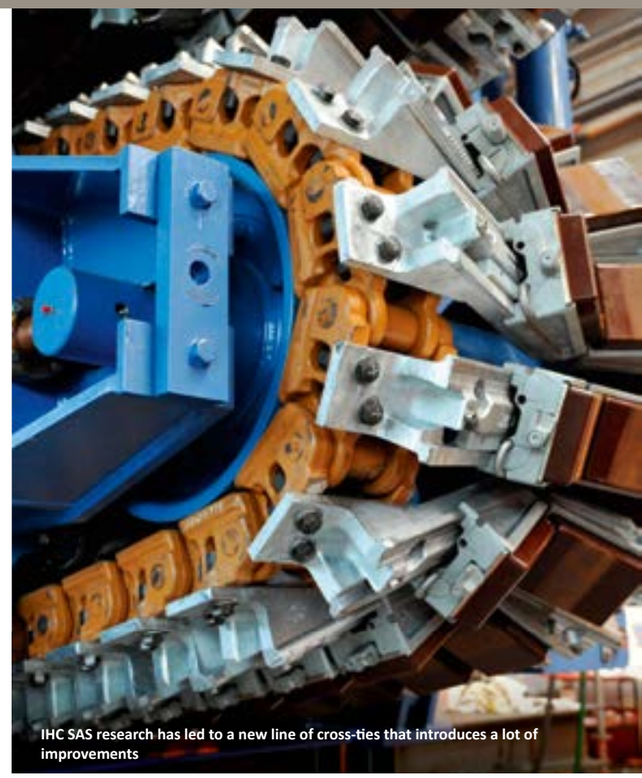
Access platforms and ladders were designed to make maintenance safe and easy





The R&D team has investigated the cause of concrete cracking during clamping and ways to mitigate this effect

Friction on different pipe materials was also a topic of analysis and experiment research at IHC SAS



IHC SAS research has led to a new line of cross-ties that introduces a lot of improvements

People behind the solutions

To meet the needs of customers such as Sapura Navegação Maritima, IHC SAS relies on a talented and dedicated workforce. This consists of 130 permanent employees in engineering (40), production (15), assembly (15) and other departments (60). During peak periods in assembly and testing, more than 70 additional workers were hired on a temporary basis to assure timely delivery.

The company's engineering department has many disciplines, including structural, mechanical, hydraulic, software and controls. In order to integrate all of these disciplines, IHC SAS appoints a system architect to act as a single point of technical contact internally. He/she works closely with the project manager, who is responsible for the budget and deadlines, and dealing with the customer.

In the production process, the manufacturing engineering department is responsible for ensuring equipment is manufactured correctly. Some components and construction work, such as tensioner and winch frames, drums and pads, are subcontracted to IHC SAS partners, whereas others, such as software and controls, are produced internally.

In the assembly department, "a huge amount of effort goes into producing IHC SAS systems effectively, and continually improving its processes," says Erik. "We aimed for a steep learning curve during these projects for Sapura Navegação Maritima."

For all vessels operating in Brazil, after-sales support is managed by the local IHC office, located in Rio de Janeiro. In addition to service support, the local team is also responsible for managing production and subcontracting activities of their own specific products (umbilical and hose reels), as well as other IHC products for the Brazilian market.

The customer also played an important role in the development of these particular vessels, says Erik. "Sapura Navegação Maritima has a lot of experienced people involved in flex-lay, and we listened to and learned from them throughout the process. The voice of the customer was considered in all the equipment we supplied."

Pad designs for flex-lay and S-lay

This pipelaying project in Brazil is indicative of a growing trend in the market for increasing water depths, which require higher tension capacities. Tensioners are therefore getting bigger to lay pipes in deep and ultra-deep water, and also at a high production rate.

In order to meet the changing market demands, the R&D team at IHC SAS develops new products and continuously improves existing ones. One of the areas it is currently focused on is the pipelaying of both S-lay and flex-lay, and the optimisation of clamping systems on concrete-coated and PP/PE/PU-coated pipe.

To avoid buoyancy of a subsea pipeline, concrete is clad on top of the pipes' protective coating. This depends on the pipe diameter, sea depth and wall thickness of the pipe. In some cases, the concrete can show minor cracks during the laying process due to the high squeeze forces.

IHC SAS investigated this topic for various pad arrangements, pipe diameters and clamping forces, using Finite Element Analysis. "The outcome of this study has provided valuable insights that are taken into account in the designs of our new-built machines and modifications," says André.

"Sometimes the pipe will sink on its own, so concrete is not required," he adds. In this case, a PE/PP/PU coating is used to prevent corrosion. These materials are very slick – even more so when wet – so there is much less friction than on concrete-coated pipes. Damage to the coating is not an option, therefore a soft material must be used for the interface between the tensioner track chain and the pipe.

Research on this interaction began at the start of 2014 and involved an in-house test rig, and the development of an accompanying test method and processing/interpretation algorithm. This allowed IHC SAS to compare many materials and features of tensioner pads. Finally this resulted in a design tool for dedicated pads that provide optimal holding capacity on the slickest of pipes.

The research has led to a new line of cross-ties being developed with an optimised pad angle suited for different pad forms, all optimised for specific pipes and conditions. All developments aim to improve performance of the equipment on the pipelay operations. This includes mitigating concrete cracking during clamping, allowing for quick and easy adjustment, and replacement of pads without tools, minimising run-in effects and maximising vertical clearance.

"The angle of the pads on the track gripping the pipe is important," says Marco. "The greater the angle, the more likely the pads will go to the top and bottom of the pipe when clamping, so it will become egg-shaped. We reduced the angle from 140 to 120 degrees for straight pads and even further beyond that for swivelling pads in combination with smaller pipe diameters. For the grip-critical smaller polymer pipes, the pad arrangement is now very close to the ideal of 90 degrees. We are trying to get as close as possible to that, and exceeding what's currently available in the market."

A logical step

Such innovations underline the technological know-how at the disposal of IHC SAS and its capabilities in the installation of subsea pipelines. Before its acquisition by IHC, it acted not just as a supplier, but as a partner, as Erik explains: "As an independent company, SAS Offshore also sat at the table with IHC and Sapura Navegação Maritima as part of the sales team. So the acquisition by IHC earlier this year was a logical step."

For more information on IHC SAS, please visit www.sasoffshore.com

A versatile solution

1. Semi-submersible vessel equipped with well intervention tower

Vuyk Rotterdam, an IHC company, has developed a conceptual design for a vessel that can be used not only as an offshore accommodation and support facility, but also as a standalone unit for independent operational activities in oil and gas such as well intervention. Find out how this multi-purpose semi-submersible design can increase an operation's efficiency, while providing an additional number of advanced and innovative services.

Since the Deepwater Horizon tragedy in 2010, the need for increased safety measures across the offshore gas and oil industries has risen dramatically. Specifically, in direct response to the disaster, there is an important requirement to separate the operational activities of the platform from the accommodation and support services. The necessity for an increase in safety measures was sadly proven once again on 1 April 2015 by the fire that broke out on the Abkatun Permanente oil platform, situated in the Gulf of Mexico.

In the past few years, the market has shown that oil and gas field activities are expanding further away from the mainland, while developing countries (such as Brazil and India) are increasing the complexity of their offshore operations. Therefore, the need for advanced, specialist support platforms and vessels has now become an urgent requirement worldwide.

The design and implementation of such dedicated vessels can help to minimise potential dangers to personnel. In addition, the benefits of lifting capabilities and storage facilities would provide significant reductions in transportation and operational costs.

Other gains include increased efficiency, by dedicating the main platform to its primary activities, and with companies such as Prosafe (the world's leading owner and operator of semi-submersible accommodation vessels) showing particular interest in the design, the attention from the market is clear. In order to assess the design and ensure it meets all safety and stability requirements, the concept has also been reviewed by Class and was found to be fully compliant with all regulations.

A history of innovation

Vuyk Rotterdam (Vuyk) has a history of providing design and engineering solutions to customers in the offshore, dredging, renewables and heavy lift market sectors. It aims to build long-term partnerships with these customers in order to share knowledge and expertise, and helps to solve complex problems effectively and reliably.

The integrated design packages contain not only the stability and strength of a vessel, but also the system design and arrangement, including the specifications needed for Class approval. Finally, workability based on motion analyses is considered. Therefore, Vuyk is ideally positioned to study the market's requirements and develop a suitable solution.

Testing the waters

The risk of casualties in the event of a catastrophic incident on board an oil rig or offshore vessel would dramatically

Innovative vessels

2. Semi-submersible accommodation vessel equipped with 2x 300t cranes

decrease if the number of staff present on the platform is reduced to the absolute minimum required for operation. After considering several options, it was concluded that the most effective solution to these issues would be a multi-purpose concept, based on a semi-submersible vessel design.

“Initially, we carried out several hydrodynamic studies, including motion analysis tests and workability comparisons, in order to decide what type of vessel would be best suited to this kind of work,” explains Senior Project Manager Sander Bot.

“A mono-hull design would result in a smaller vessel, which may be more cost effective. However, we found through studies and structural analyses that a semi-submersible design would create a more motion-friendly platform, increasing the operability, safety and efficiency of the vessel.”

With a mono-hull design, for example, options for additional functionality are limited. The addition of cranes would be difficult, due to the significant weight impact on a relatively light vessel, plus operational time windows would be reduced due to wave induced motions. The developed semi-submersible design is a concept that allows for greater stability and therefore increases the potential for a number of additional features and applications.

As a result of the vessel’s robust specification and deadweight tonnage, provisions and adjustments can be made to convert the vessel into a ship’s tender to assist with drilling operations. Also, as Sander explains: “We have included a moon pool in the design, which means the vessel can be used to perform oil and gas activities independently such as well intervention applications. It can sail to shore if required, further enhancing performance possibilities and operational scope.”

Stability is key

Due to the shape of column-stabilised units, and their behaviour when loaded under extreme weather conditions, regulations state that stability must be checked, taking into account the ‘most critical heeling axis’. In order to determine these axes, a set of righting arm curves is calculated for varying rotation of the heeling axis, and this set is converted into a surface plot. In figure 4, the critical path is shown as a red line. The plot presented here is for 15m draught.

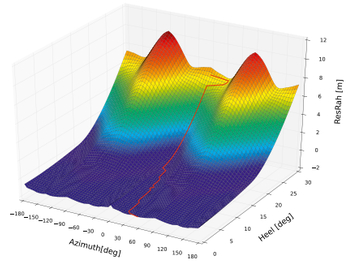
Safety first

The primary purpose of the vessel is to provide a hotel service to a nearby platform. With accommodation space for 400 people, a significant number of workers can be located at a reasonable distance from the platform’s operations, while the vessel incorporates all appropriate safety systems in the design.

“Safety measures include proper on-board emergency medical services, and the vessel is FiFi 2-certified with high-quality fire defence installations,” explains Sander. “Helicopter facilities are also available to transfer ill or injured personnel back to the shore, while transfer to and from the platform is made available by means of a telescopic gangway with an integrated swell compensation system.”

However, with the accommodation facilities located so close to the platform, it is logical to incorporate a number of additional capabilities in the design to assist with day-to-day operational requirements. These features can maximise the investment in the vessel and increase the efficiency of the activity.


3. Semi-submersible accommodation vessel equipped with 2x 300t cranes



4. Surface plot of righting arms

Versatile and dynamic

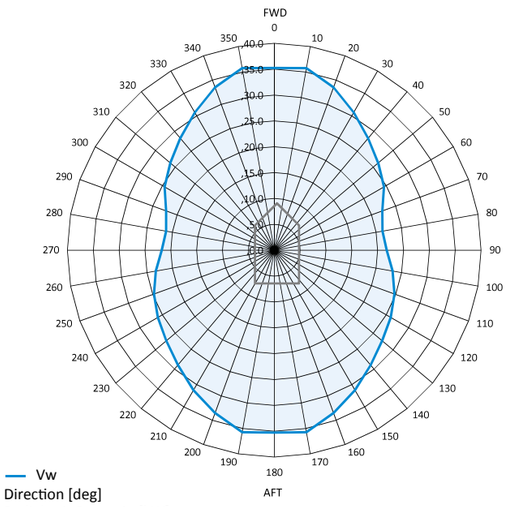
“In recent years, the need for extra hoisting capacity and lifting height has increased,” says Sander. “The semi-submersible vessel is able to handle such hoisting requirements and perform lifts in a number of different sea states.”

Throughout a project, specific equipment may be installed, spare parts may need exchanging and occasionally large machinery may need to be lifted on to the platform. To perform these tasks, the vessel can be equipped with two 300t capacity cranes, which are capable of executing single lifts, or tandem lifts up to 400t, to support the platform or carry out construction activities. In addition, a lightweight knuckle boom crane of 100t is installed for handling lighter equipment or moving storage materials.

In order to remain efficient and safe during heavy lifting operations, the vessel requires an effective dynamic positioning (DP) system. A semi-submersible design is more efficient in providing the required thruster capacity to cope with higher sea states, particularly beam seas. Motion behaviour is of particular importance to platform assistance operations, and was therefore another key factor in the decision to choose a semi-submersible design for this project.

The vessel’s integrated DP system conforms to the requirements of a DP3 class notation. With this specification, the vessel is able to provide assistance while in close proximity to the platform up to a significant wave height of 4.5m.

“The main dimensions of the vessel have been specifically tailored to allow for the hoisting requirements,” says Sander, “while at the same time carefully minimising the power necessary for the DP operation. The design also places a strong emphasis on the free deck area, which increases efficiency.”



5. DP Capability plot of a semi-submersible

More possibilities

With a free deck area of 3,000m^2, it is well within the vessel’s capacity to transport pieces of equipment or supplies directly from a tender vessel and hold them on board before they are lifted on to the platform. In addition, it offers the opportunity for increasing or adapting the vessel’s operational possibilities.

“Creating a large deck space makes the vessel more flexible during its lifetime,” says Sander. “Not only does it provide an intermediate space to handle equipment or spare parts, it may even be considered as a long-term storage solution for components that are not required on the platform. Ultimately, the operational profile and functional requirements will dictate the payload of the vessel.”

A shared commitment

With this concept, Vuyk has developed a versatile, multi-purpose design capable of being deployed across a number of applications. These range from offshore oil and gas support facilities, to standalone projects and activities.

This response to increasing concerns regarding the wellbeing of offshore personnel highlights the commitment IHC and Vuyk share towards providing the market with safe and secure solutions. It also demonstrates an ability to design and produce innovative, practical equipment for the evolving offshore market.

For more information on Vuyk Rotterdam, please visit: www.vuykrotterdam.com

Making upward progress in vertical transport

ROV working at a depth of 2,500m

In recent years, IHC has made a valuable contribution to the advancement of technology for deep-sea mining applications through continuous research and development activities. Progress requires important innovations, including a solution for the difficulties surrounding the vertical transportation of solid materials over large distances. This is the focus of an exciting IHC study, led by Senior Research Engineer Jort van Wijk. Here he outlines its challenges and potential implications.

Despite its untapped potential, deep-sea mining has yet to become a sustainable business proposition. With vast amounts of valuable raw material at the bottom of the ocean, including polymetallic and phosphorous nodules, sulfurous deposits and metallic muds, the opportunities are abundant. However, developments have been staggered and the technology is yet to be proven in a practical application.

Investigations into the feasibility of deep-sea mineral mining were first conducted in the 1970s, when the tools for attempting such activities became readily available. However, development was halted, due in part to advances in land-based mining techniques and increasing environmental concerns, as well as the inherent difficulties involved in transporting raw materials vertically from the deep-sea floor to the surface.

Following these early investigations, additional research and technological advancement are now required. With global demand for resources growing, and the EU identifying the supply of these materials as a major element in its economic strategy, IHC is committed to ensuring it has the required knowledge and technology ready to step into the industry when it is needed.

Investing in progress

Fluctuations in the prices of raw materials also greatly affect progress, and deep-sea mining is a much more expensive proposition than its terrestrial counterpart. When material prices rise, it will become more economically feasible, and when prices drop, the natural pace of development slows down and interest declines.

Although raw material prices are currently low, this is expected to change over the coming decade and, along with the exponential growth of technological development, interest will begin to increase. Therefore, IHC is making significant progress investigating the entire chain of technological development, from the excavation of deposits to the vertical transportation and post processing of materials.

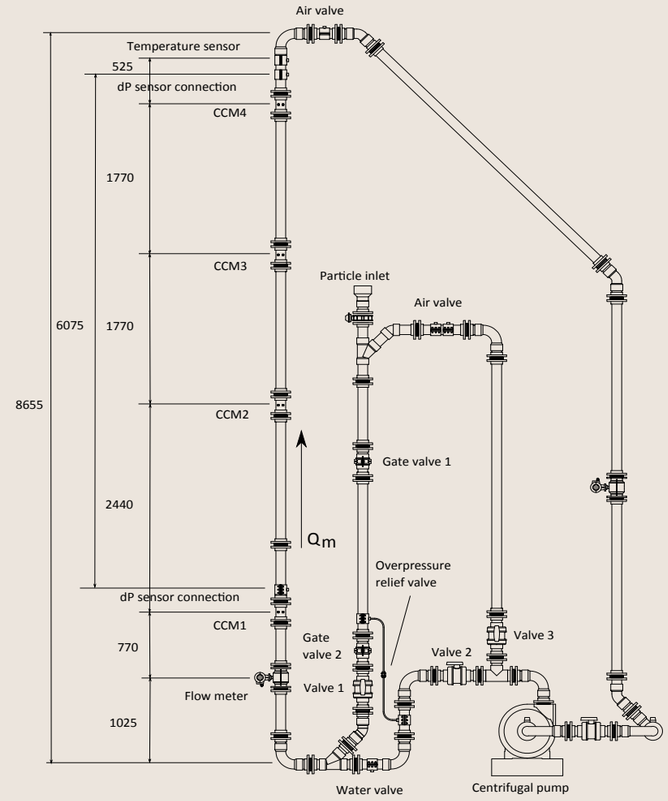
Bridging the gap

The deep-sea mining process involves the deployment of a mining support vessel (MSV), a vertical transport system (VTS) and a subsea mining tool (SMT). The materials collected or excavated from the sea floor by the SMT are pumped into the VTS, consisting of a riser through which the mixture of solids and seawater is vertically transported to the MSV.

Artist impression of the mining support vessel, vertical transport system and subsea mining tool

Outer and inner view of a manganese nodule

The flowloop that has been used for the riser blockage experiments



Schematic layout of the flowloop

From a commercial perspective, the market drivers may be predominantly materials-led, but from an academic point of view there is a huge gap in the knowledge of vertical hydraulic transportation for deep-sea mining applications. Jort van Wijk, Senior Research Engineer at MTI Holland, is close to finishing a PhD thesis on the subject at the Delft University of Technology in The Netherlands. He also spends two days a week working across IHC projects involving dredging technology.

“Dredging near-shore is a tried and tested process,” says Jort, “but the conditions and materials are very different when moving out to deep sea. There is no step in between, so an enormous knowledge gap between the two fields exists, and this is the biggest challenge in conducting research.”

Solving problems

In order to mine the deep sea, it is necessary for the materials to be transported vertically across huge depths. In theory, this simply involves scaling up current dredging technology into deeper waters, but there are a number of problems that must be solved given the longer transport distances.

“The main issue with vertical hydraulic transport at these depths involves the guarantee of an optimised internal upward flow,” explains Jort. “We can study density waves and the processes resulting in a blockage in the pipeline by laboratory scale experiments. While the vertical transport might be considered a trivial issue, riser blockage is actually a serious complication and requires many studies to overcome.”

For the system to function effectively, it must be designed for flow assurance – ensuring materials are transported vertically through the pipeline in a safe and efficient operation with no blockages. Not only does the issue impede the mining process, but also the environmental impact could be considerable if an emergency shutdown is enforced. This is difficult considering that there is no precedent for a project of this scale.

Advancing technology

As it is fundamental to the entire operation, the concept of flow assurance has been the focal point for Jort’s PhD work. By reducing the risk in vertical transportation, equipment can be designed to increase operational efficiency and uptime, with the additional benefit of reduced costs. Once the technology has advanced beyond this stage, implementing more energy-efficient systems would be the next step.

In order to make a design for flow assurance, it is first necessary to establish the various ways in which riser blockage can occur during the vertical transportation process. Given the potential depths of deep-sea mining operations, there is the risk of the pipeline becoming too heavy and difficult to handle. Therefore, a pipeline with a relatively narrow diameter (around 20-50cm) must be employed to make the process more manageable.

However, this means the solid materials extracted from the sea floor are relatively large when compared to the narrow pipeline. While particle size could be modified using crushers, the deployment of this equipment on the deep-sea floor would be cost prohibitive, and so optimising the process is a more attractive option.

During transportation, a second risk results from the fact that smaller particles are conveyed faster than large particles due to the natural effects of gravity. Such large variations in transport velocity can lead to a “merging zone” of different layers. This propagates the formation of large volumetric concentrations of solids, which can also cause plug formation and could result in a blockage in the pipeline.

The third risk is posed by the influence of particle shape. Long, flat particles tend to form clusters and adhere to the wall of the pipeline, which also leads to a blockage of materials. This is a risk regardless of the volume of water flowing through the pipeline.

“These risks were discovered through laboratory research,” Jort explains. “By identifying the potential problems inherent in deep-sea vertical transportation, we systematically examine them to test potential solutions. The second phase of the project was to use the knowledge from the research stage and experimental programme in order to create a mathematical framework to describe the entire transport process.”

A model approach

The mathematical model allows research engineers to study the overall vertical transportation process, and will eventually enable IHC to design a system that accounts for flow assurance. Separate, smaller models are generated based on research data to describe and simulate a number of individual processes, for example wall friction of solid plugs, the effect of turbulent mixing on particles, and the transportation velocities of solids.

Two illustrations of a booster station at a depth of 2,200m

These models are fed into the generic framework and a number of parameters are set, including: the specific length of the transport system; the location of the centrifugal pumps; and the amount of solid materials present at the inlet. The model is then able to calculate how the flow develops, where the solids will be at any time and if a plug will form or density waves occur. The model perfectly mimics the actual transport process, enabling researchers to examine what materials leave the riser after the simulation.

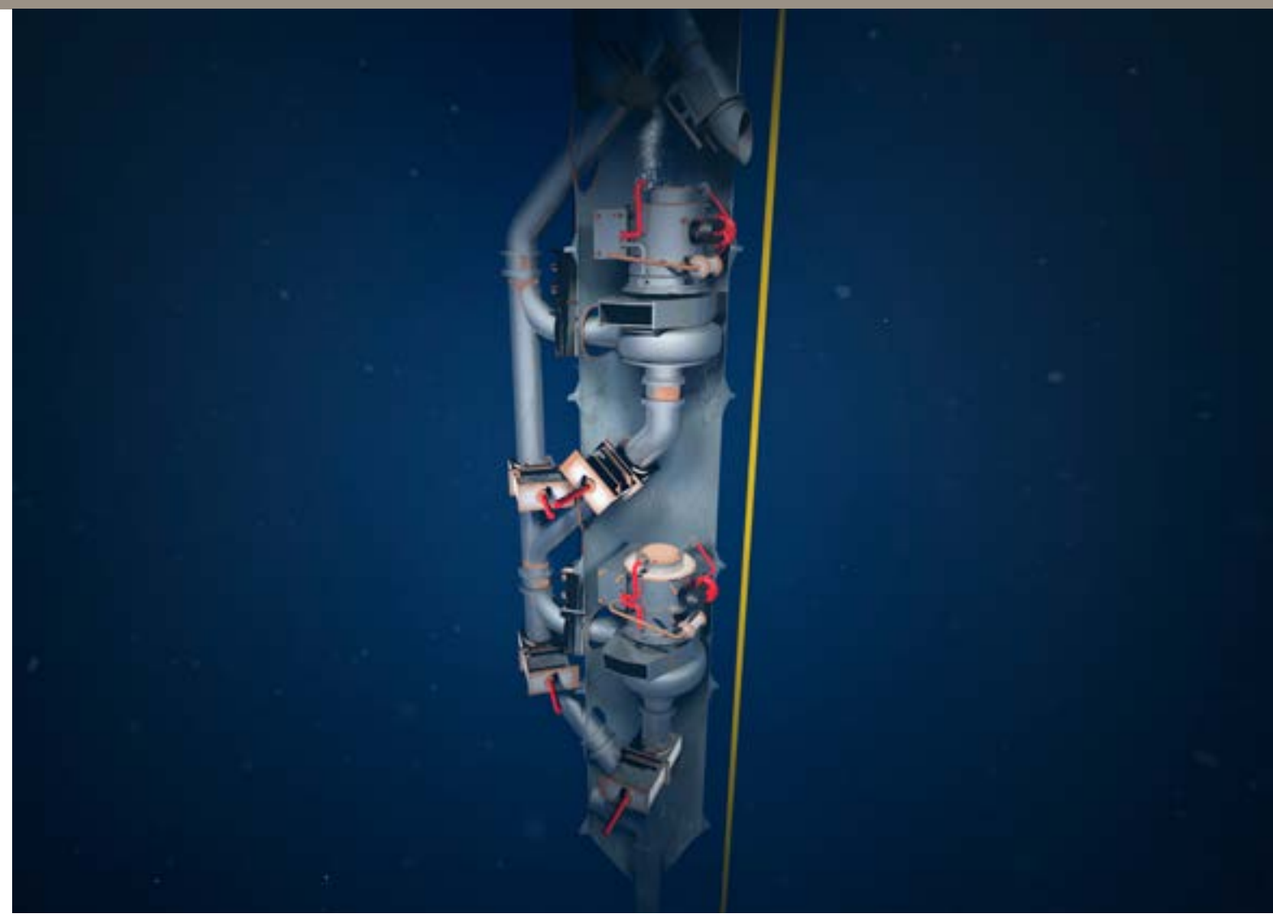
"It is a continuous process," Jort explains. "First you're looking at particles in a laboratory, and thinking about what's happening to them and how they're behaving. Then you're able to understand the situation better through specific mathematical modelling, and seeing other possibilities. Next, you return to the laboratory and see if the model predictions were correct, and each time you're getting closer to perfection!"

Driven by results

Jort initially started work with an idea of how an effective vertical transport system might work, but the technology hadn't been tested. Now, four years on, tests are being conducted into the individual processes of a workable system, and the mathematical models produced are able to accurately describe them.

"These results provide IHC with complete models to simulate the operation of a transport system, and predict how the technology will actually work," says Jort. "They also provide specifications that we are able to design from, in order to ensure the creation of an effective system with flow assurance."

Jort and his team, which has included several university students, have accomplished a successful experimental programme, which covers all the important aspects of the vertical hydraulic transport process. Jort is currently waiting for the results of a final set of simulations and the concept version of his PhD thesis, which was due to finish in spring. However, despite the completion of the research project, there is still much work to be done. The process of research, development and innovation will continue with the Blue Mining project, which aims to provide long-term solutions for a sustainable deep-sea mining value chain, including mineral extraction and processing in extreme environments.



Looking to the future

Funded by the EU, the Blue Mining project is a consortium of academic and industrial project partners, led by IHC. Currently, the project is investigating deep-sea mining technologies with a focus on manganese nodule mining – rock concretions found on the sea floor, formed of concentric layers of iron and manganese hydroxides, along with such metals as nickel and gold.
"Before deep-sea mining can become a reality, we must first conduct much larger experiments than what we've done so far," says Jort. "That's what we aim to achieve with the Blue Mining project."

When the EU announced its plans to advance the development of deep-sea mining strategies, it invited commercial parties, industries and academia to bid for their participation in the project. The IHC-led consortia won its bid, as the specifications presented included all the steps required from exploration to transportation, and so IHC's future participation in the field will continue through leading the Blue Mining project.

The long-term targets of the Blue Mining project are to increase technology readiness levels to industrial scales and develop environmentally friendly capabilities for accurate and cost-effective extraction of mineral deposits from water depths of up to 6,000m. Controlling the discovery, assessment and extraction of these resources is the key to decreasing EU dependency on imported materials and strengthening Europe's mining sector along with its technology providers.

Moving forward

Not only do the advancements made through the R&D of deep-sea mining technology ensure that IHC is prepared for the industry to move forward, but the results also have applications in the existing dredging and offshore markets. Possessing a greater knowledge and understanding of these physics, modelled mathematically, can be used to improve regular dredging systems, among other applications, and supports IHC's development of innovative technologies.

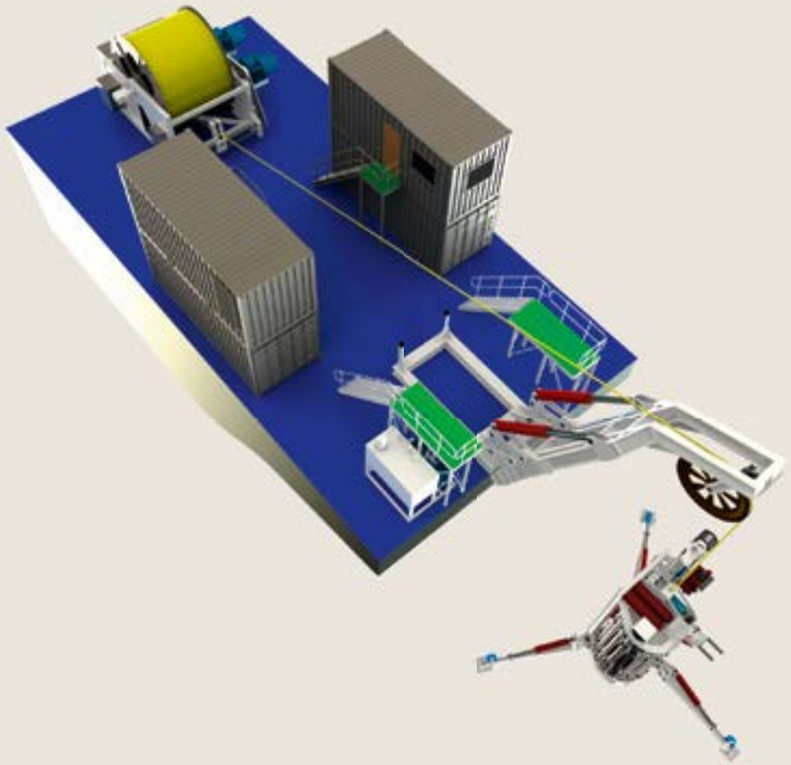
In partnership with the Blue Mining project, IHC is demonstrating its commitment to investing in people and advanced technologies. The researched solutions for effective vertical hydraulic transport for deep-sea mining applications reinforce IHC's position as a world leader in innovative solutions for this emerging sector.

For more information on the Blue Mining project, please visit: www.bluemining.eu

Breaking new ground

TI Geosciences' deep-push CPT system, capable of operating at 3,000m

The development of a subsea remote-controlled drill has enabled IHC to enter the market for oil and gas geotechnical survey and site investigation in deep and ultra-deep water. The IHC SWORD plays an essential role in the services provided by TI Geosciences, a new company co-owned by IHC. So, what is its part in the process, how does it work and what advantages does it have over what's currently available in the market?



Two illustrations of the IHC SWORD, the subsea remote-controlled drill developed by IHC

Working in the world's most remote environment, the ocean floor, poses many challenges to the deep-sea mining and offshore oil and gas industries. The cost of exploration and field development has soared, partly due to the increasing complexity of targeting deep-water reservoirs. However, these challenges present opportunities for companies to develop solutions and simplify processes, and ultimately drive these industries forward.

TI Geosciences, co-owned by IHC and Tompkins UK, is aiming to do just that. Based in Darlington, UK, it has been established to deliver integrated geotechnical site investigation services in deep and ultra-deep waters. Its services include offshore geotechnical data acquisition, geotechnical engineering services and a cloud-based data management and reporting system.

Director of Business Acquisition Emile Rupert explains: "TI Geosciences offers a complete service – we go offshore, collect data, interpret the data and deliver a report to the customer. Basically, we are taking tubes filled with soil, photographing and processing the information on the ship and sending this information straight to shore. The customer can see what we're doing – as we're doing it.

"Our aims are to measure and manage data that customers can use and access quickly, to be transparent, and deliver results faster and more cost-effectively than the competition."

The company's potential customers operate in three market segments: oil and gas (ultra-deep and frontier), and offshore mining. When working in deep and ultra-deep waters in the oil and gas industry, it is not possible to use jack-ups or gravity-based production platforms. The fields are developed with subsea wellheads, which are connected with pipelines and manifolds, and usually to an FPSO through a riser bundle. The entire subsea infrastructure and, for instance, the anchor points of the FPSO are placed on or in the seabed. Detailed information on the strength of the seabed is therefore crucial to the design of the field.

As the oil and gas industry pushes into deeper waters, it also pushes into harsher environments. This brings its own challenges in terms of health and safety, soil composition and remoteness.

Resource development for an offshore mine requires many shallow drill holes in deeper waters and remote locations. Depending on the type of deposit, the soil can be difficult to drill and/or result in bad sample recovery using conventional methods.

A new approach to deep-sea drilling

To collect the data from the seabed required by companies working in the above segments, IHC has developed its Sonic Wireline-Operated Remote Drill (SWORD) system. The IHC SWORD works directly from the seafloor by advancing a drill string and an outer casing into it. The hole is advanced by alternately drilling into the seafloor, casing the hole and retrieving the sample in a continuous cycle.

Each drill rod and casing section is stored in a storage carousel from which the various sections can be collected by a manipulator. The manipulator aligns the sections with the drill string in the seafloor, so that the drill head can engage with it and advance the drill string a step further.

Rodney Norman, IHC Deep Sea Mining Director, who was been involved in the development and build of the tool, says: "It uses high-frequency vibrations to push casing sections, drill rods and sampling tubes into the earth. The sampling tubes fill with soil, which can then be analysed to provide a geotechnical report for companies that are looking to build foundations for the construction of anchor or oil platforms on the seabed."

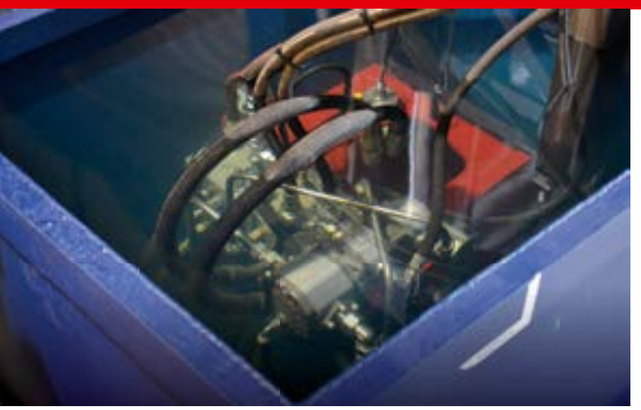
The use of sonic drilling equipment in deep-sea applications is a revolutionary development for the oil and gas and offshore mining industries, and brings numerous advantages. Able to operate in ultra-deep water, IHC SWORD offers an attractive alternative to drilling from a specialised vessel on the surface, which is the conventional method in today's market. Drill ships have depth limitations of 800m to 1,000m, but the IHC SWORD can be used in depths up to 3,000m and is highly accurate when drilling the depth of the hole.

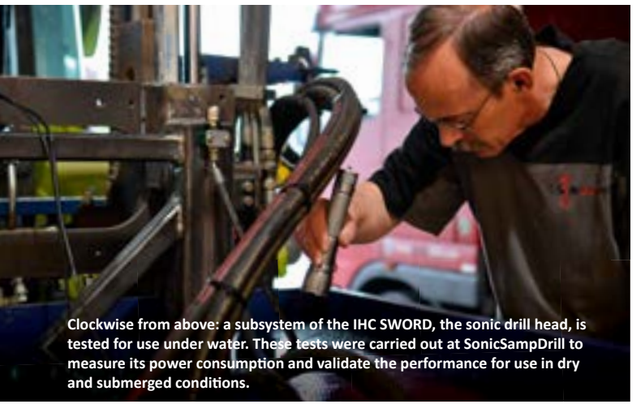
The IHC SWORD can be used to provide undisturbed high-quality samples for analysis and is suitable for use in all soil types. "In non-cohesive soils, such as sandy or very hard soils, the sonic high-frequency vibrations are used to push the rod into the earth," explains Rodney. "In cohesive soils, such as clay, piston and push samplers are then used."

Robust and efficient

Its robustness for working in the hostile ocean floor environment is demonstrated by the fact that the IHC SWORD is capable of drilling in complex seabeds, working through stones and gravel, and producing high core recovery rates. "When drilling into the earth using conventional drilling," says Rodney, "if you hit rock, then you have to stop, move the rig and start again. With sonic drilling, you can go right through hard rock – there is no need to stop."

The IHC SWORD has a drill depth of up to 80m, with 80m casing. With a large four-inch core diameter – compared to three-inch cores of competitors in the market – it is fitted with several downhole tools, such as a cone penetration test (CPT) and Shelby tube push/piston corers. Unlike in conventional rotary drilling, the IHC SWORD does not require drill muds.





Clockwise from above: a subsystem of the IHC SWORD, the sonic drill head, is tested for use under water. These tests were carried out at SonicSampDrill to measure its power consumption and validate the performance for use in dry and submerged conditions.

A land-based coring tool used for on-shore sonic drilling

Examples of the core after drilling

Reducing costs

This means drill muds do not need to be transported and stored on the vessel and subsea tool. “Using the IHC SWORD will result in a less complicated and faster drilling process, and a quicker campaign,” says Martijn Schouten, IHC Executive Sales Director. “The less time drilling, the less time spent at sea, which reduces costs.”

Costs are further reduced by the use of a small vessel of opportunity rather than a specialised drill ship. The IHC SWORD can be installed on medium to large offshore supply vessels with DP capability and 80m in length. Accommodation for crew and a flat aft deck is required for easy mobilisation of people and equipment. “These vessels are easily available and at a cheaper day rate than specialised vessels,” adds Martijn.

A vessel of opportunity can be chartered anywhere in the world. The IHC SWORD can be transported in containers and shipped to the nearest port, where it can then be installed on the ship within four days. Demobilisation also takes four days and requires a crew of six to eight people.

Technical and commercial breakthroughs

The development of this unique and innovative tool represents not only a technical but also a commercial endeavour for IHC, explains Martijn. “It was both the development of a product and a business model, which was developed thanks to our experience in offshore markets. Together with our partner, Tompkins UK, we identified the customer base we could initially focus on.”

During the development of IHC SWORD, IHC looked at the market in deep-sea mining and oil and gas industries, and questioned whether it should build and sell the product, or look at rental opportunities. “While we explored the rental market possibilities, we came across Charles Tompkins, the MD of Tompkins UK. After several discussions, we realised that we could join forces to offer this kind of equipment to the market.”

A strong partnership

The support and global reach of IHC’s international network of office, production and engineering facilities will be a huge benefit to TI Geosciences. In addition: “IHC brings its history in equipment design and manufacture, and its ability to deliver on time and budget to TI Geosciences,” says Martijn. “This is particularly important for a company in the development phase.

“We know what it takes to make companies successful and our relationship with Tompkins UK is very strong. We are aware of each other’s strengths, which are not in conflict with, but complement each other. We push and learn from each other. I’m enjoying the collaboration even more than I thought I would!”

In addition to the IHC SWORD, an extensive range of equipment is at the disposal of TI Geosciences. It includes a deep-push CPT system, capable of operating at 3,000m and with up to 40m single push continuous penetration. It also has access to other geotechnical tools commonly used in the industry through partners UTEC Geomarine and Modus Seabed Intervention: a Roson CPT, piston corer, geoROV CPT; ROV support; and AUV support and/or geophysics where required.

Vessels are supplied via an agreement with a specialist company, explains Emile: “TI Geosciences has guaranteed availability of vessels for fast global mobilisation to accommodate the overall project planning and help reduce mobilisation/demobilisation time and cost.” The modern and continuously expanding fleet of DP2 vessels has sufficient and modern accommodation and large open deck space – ideal for the IHC SWORD.

Looking ahead

The first in the range of IHC SWORD systems will be operational by the fourth quarter of 2015, deployed from a Swire Pacific Offshore vessel, following final testing at sea. It is a vital part of the equipment offering of TI Geosciences, which hopes to expand its fleet of subsea tools as the company and its customer base develops.

With operating bases in the UK, Singapore and South Africa, TI Geosciences can take advantage of market potential, particularly in the southern hemisphere. “There is a lot happening in Brazil, West and East Africa at the moment in terms of the construction of subsea platforms,” says Emile. “The East is also important, so Singapore is a significant location in the middle of the South East Asia market. As things gather pace, other markets will also develop, such as New Zealand.”

The IHC SWORD systems will remain within IHC’s research and development programme. This will enable the company to continually improve its design and performance, based on operating experience and new industry/technical requirements. Constantly raising the bar with each subsequent system is at the heart of IHC’s philosophy, and its reputation as the technology innovator.

“Developing a tool that is faster and different from the competition shows how IHC is always looking at new opportunities that require innovation to get us there,” says Martijn. “We create products with advantages over our competitors, and in doing so, create new markets for ourselves.”

For more information on the IHC SWORD or TI Geosciences, please visit www.ti-geo.com or email info@ti-geo.com

Providing integrated solutions

IHC IQIP is the new name for four integrated IHC business units: IHC Hydrohammer, IHC Handling Systems, IHC Sea Steel and IHC Fundex Equipment. The merger enables IHC to take the next step in offering a fully integrated solution for on- and offshore installation, foundation and decommissioning to customers in the rapidly developing oil and gas, offshore wind, and coastal and civil markets.

To maintain the profitability of their operations, companies in these markets are increasingly looking for ways to lower their costs, decrease risks and maximise project efficiency. This has led to a growing demand for integrated solutions.

IHC CEO Bram Roelse said: “Many of our customers are already working with one or more of the four IHC business units now integrated under the IHC IQIP umbrella. This merger was the next logical step in our desire to quickly respond to clients’ requirements. In this way we further strengthen this vital part of our activities and create room for further growth. IHC IQIP will continue to contribute substantially to IHC’s overall proposition for its onshore and offshore customers.”

IHC IQIP Executive Director Jan Albert Westerbeek added: “By combining all of our experience and expertise, as a market leader, we are able to offer an innovative and complete range of equipment and services. Approaching the market as one organisation means our customers will only have to deal with one point of contact, which benefits their project management and efficiency.”

A stronger foothold in Brazil

IHC has acquired a majority stake in Brazilian-based Brastec Technologies, which designs and builds value-added, tailor-made production lines for the production of umbilicals and flexible pipes.

Announced in January, this agreement fulfils two important elements of IHC business strategy: a foothold in the important Brazilian market; and the acquisition of Dutch-based SAS Offshore, which was fully owned by Brastec Technologies. Now known as IHC SAS, it specialises in the design and manufacture of deck equipment for the offshore oil and gas market.

Founded in 2002, Brastec Technologies has built an impressive customer base consisting of major suppliers to oil companies. These multinationals are mainly manufacturers of flexible pipes and umbilical cables. The value-added equipment manufactured by Brastec is considered as essential for the activities within the oil-and-gas exploration supply chain.

“These investments are a good fit for our strategy of internationalisation, and strengthening our position in the offshore market,” said IHC CEO Bram Roelse. “With a foothold in Brazil, we are able to meet the demand for local content and service our customers with better regional facilities.”

A pioneer in responsible deep-sea mining

A leader in responsible dredging and offshore mining activities, IHC Mining has expanded its scope as one of the pioneers in deep-sea mining by joining the World Ocean Council (WOC). The organisation is a growing global industry alliance for “corporate ocean responsibility”. Its members share the vision of a “healthy and productive global ocean and its sustainable use, development and stewardship by a responsible ocean business community”.

Using its extensive mining and ocean expertise, IHC Mining is working towards reaching deep-sea mineral deposits. This is being achieved with the support of a dedicated research and development programme, as well as through its position as a leader of the EU Blue Mining project. It is also demonstrating its commitment to understanding and addressing the environmental aspects of seabed mining through its participation in the EU Midas Project and other similar programmes.

IHC Mining Managing Director Henk van Muijen said, “IHC Mining is pleased to become a WOC member. With activities such as the recent Business Forum on Ocean Policy and Planning, it is creating valuable opportunities for ocean industry collaboration and leadership on issues critical to the future of seabed mining.”

Rodney Norman, IHC Deep Sea Mining Director, added, “The WOC provides a unique forum that enables IHC Mining to work with other ocean industries on key challenges and opportunities related to the responsible, science-based development of ocean resources.”

Rambiz 4000 on order

IHC has signed a contract with Normalux Maritime SA – a joint venture between DEME, Jan de Nul and Herbosch-Kire – for the design and build of Rambiz 4000. The heavy-lift self-propelled crane pontoon will be used to transport and install heavy foundations, jackets or substations for offshore wind farms. It can also be used for installation or decommissioning projects in deep water for the oil and gas market, and any type of heavy lifting work in challenging situations, such as the construction of bridge components and clearing shipwrecks.

With a length of 108m and a width of 48.8m, the vessel will be equipped with two Huisman cranes with a total capacity of 4,000t. These cranes can move by up to 25m over the deck area with a skidding system. This allows the deck to be used to transport cargo, then relocate it at a later stage.

The Rambiz 4000 has four main anchors, and four auxiliary anchors. It is capable of installation works without use of these anchors because of its four azimuth thrusters and the DP2 system. This guarantees flexibility and efficiency, and also means that work can be carried out in zones where pipelines and cables already lie on the seabed.

Vuyk Engineering created the integrated design of Rambiz 4000, which will be built in Qidong and finished in Xiamen, China. This is in cooperation with IHC’s partner yard, Nantong Rainbow Offshore & Engineering Equipments. The vessel’s delivery is planned for 2017. It will be operated by Antwerp-based Scaldis Salvage & Marine Contractors NV, which currently operates the Rambiz.

On order

Yard number	Name	Specifications	Country
TRAILING SUCTION HOPPER DREDGERS			
1274		Easydredge® 2700	For stock
1275	JUN YANG 1	21,000m³	China
1278		5,500m³	South Africa
1279	MAHURY	1,840m³	The Netherlands
STANDARD CUTTER SUCTION DREDGERS			
02806		IHC Beaver® 1200	India
02815		IHC Beaver® 50	Bangladesh
02816		IHC Beaver® 50	Ecuador
02817		IHC Beaver® 65 DDSP	Egypt
02819		IHC Beaver® 65 DDSP	Abu Dhabi
02833		IHC Beaver® 65 DDSP	Egypt
SELF-PROPELLED CUTTER SUCTION DREDGER			
CO1276		23,684kW	The Netherlands [1]
PIPELAYING VESSELS			
731	SEVEN RIO	550t pipelayer	UK
732	SAPURA JADE	550t pipelayer	Brazil
733	SEVEN SUN	550t pipelayer	UK
734	SAPURA RUBI	550t pipelayer	Brazil
735		550t pipelayer	UK
-	SAPURA ESMERALDA	300t pipelayer	Brazil

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Recently delivered

Yard number	Name	Specifications	Country
STANDARD CUTTER SUCTION DREDGERS			
02811		IHC Beaver® 300SE	Maldives
02795		IHC Beaver® 45	France
02820		IHC Beaver® 50	Tanzania
02782		IHC Beaver® 65DDSP	Saudi Arabia
02718		IHC Beaver® 65DDSP	Abu Dhabi
SELF-PROPELLED CUTTER SUCTION DREDGER			
02800	AL BAHAR	23,545kW	Saudi Arabia [2]
PIPELAYING VESSELS			
729	SAPURA TOPÁZIO	550t pipelayer	Brazil
730	SAPURA ÔNIX	550t pipelayer	Brazil [3]
WORK BOATS			
11053		DMC 1450	Tanzania
GRAB HOPPER DREDGER			
11010	ITALENI	750m³	South Africa [4]

4

Main features

- ✓ Close partnerships: customer experiences in Brazil
- ✓ IHC Connect: remote monitoring and support
- ✓ R&D update: fuel-saving vessel designs
- ✓ Foundations for the future: IHC SAS
- ✓ Versatile solutions: semi-submersible vessels
- ✓ Upward progress: vertical hydraulic transport for deep-sea mining
- ✓ Breaking new ground: IHC SWORD

IHC 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 innovative ships and supplies for offshore construction.

IHC has in-house expertise for engineering and manufacturing integrated standard and custom-built vessels, advanced equipment and also providing life-cycle support. This 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.

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