FACTS ABOUT
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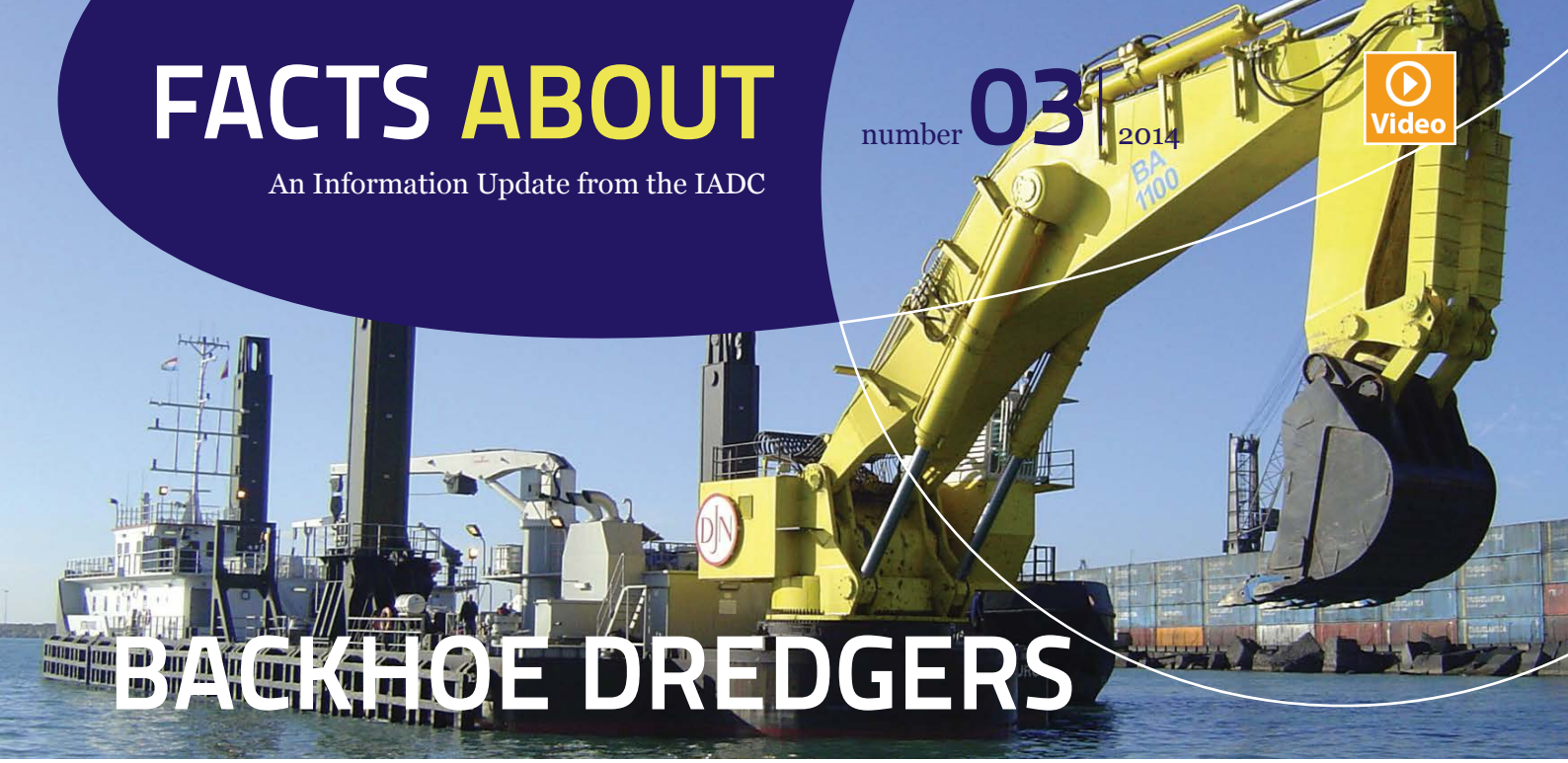


BACKHOE DREDGERS

WHAT IS A BACKHOE DREDGER?

A backhoe is a hydraulic excavator with a single digging bucket positioned on the end of a two-part articulated arm. Land-based backhoes are typically mounted on the back of a tractor or front loader that has an undercarriage with wheels or with tracks. A backhoe dredger (BHD) is water-based excavator that evolved from the land-based backhoe.

The water-based backhoe dredger is a stationary, hydraulic crane mounted on a dedicated dredging pontoon that often has a rotating table. The word "backhoe" does not refer to its location on the back of a vehicle or pontoon. It refers to the action of the shovel, which digs by drawing earth backwards, rather than scooping material with a forward motion like a steam shovel or a bulldozer or a dipper. In dredging operations both land-based and water-based backhoes may be used.

WHAT CHARACTERISES A BHD?

The backhoe excavator itself can be either an integral part of the dredging vessel with its own pontoon or a crane excavator mounted on an external pontoon. Excavators are produced by various manufacturers and have been adapted for maritime operations. In all cases, the excavator itself must be mounted securely on a pontoon that can absorb the shock of its digging activities. Older types of BHDs utilised a wire-operated integral excavator that was very heavily built to allow for dredging of hard materials such as old masonry and unblasted rock. But these types have been in general replaced by hydraulically operated backhoes

HOW POPULAR ARE BACKHOE DREDGERS?

Thirty years ago a custom-built backhoe was relatively rare. Backhoe dredgers were frequently used but rather small compared to other dredging vessels. But as dredging operations and projects have expanded, the need for larger backhoe excavators became obvious. This resulted in the modern, custom-designed BHDs. These made-to-order backhoes can dig at greater depths and have greater total installed power and therefore can be utilised more extensively and cost-effectively for larger projects. A quick review of vessel registers of the last few decades shows that the numbers of backhoe dredgers available is rising significantly and, in terms of the total fleet, the backhoe dredger continues to grow in popularity.

WHEN ARE BHDS SUITABLE?

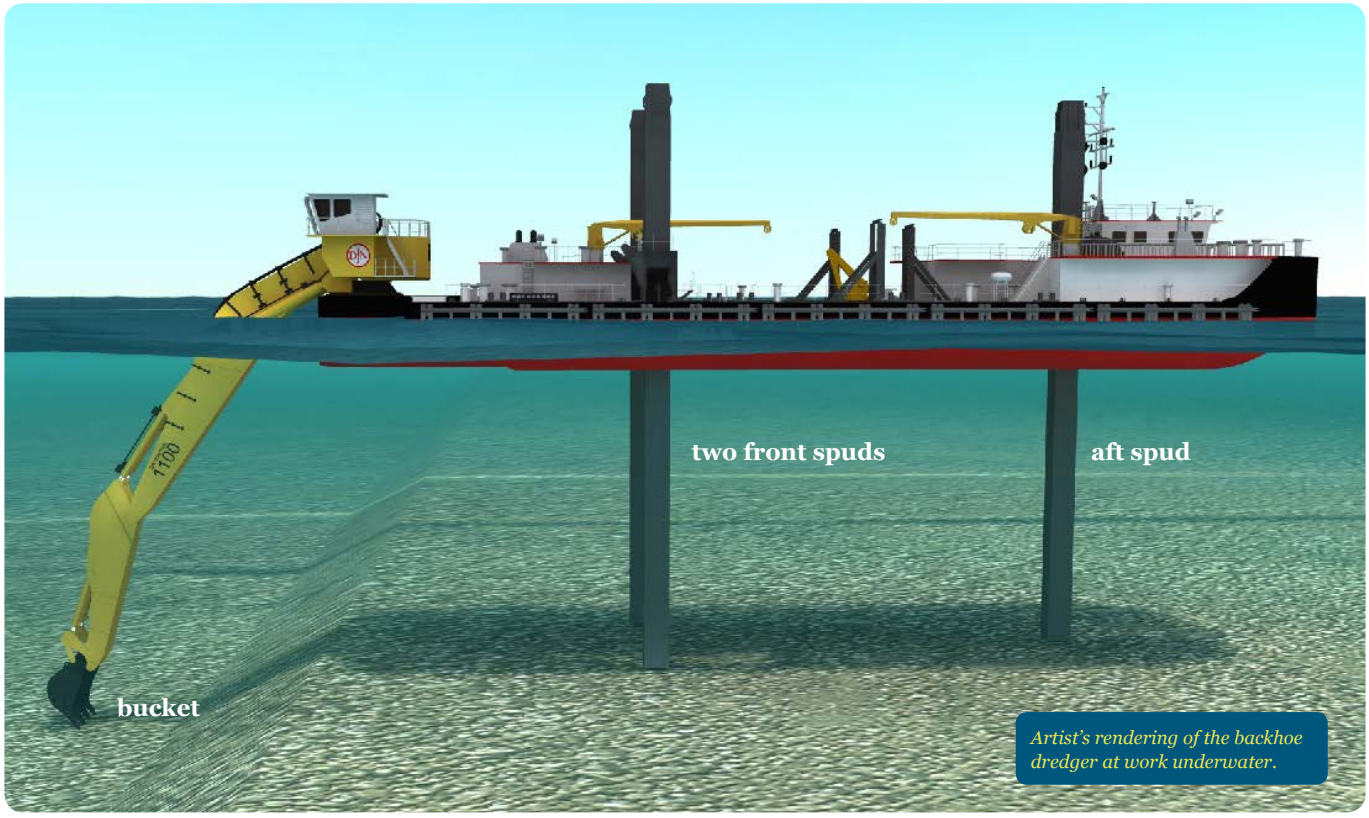
The modern BHD is now treated as one of the main classes of dredging vessel. It has emerged as a suitable workhorse for soils made of an unconsolidated, heterogeneous mixture of clay, sand, pebbles, cobbles, and boulders known often as glacial tills, and for dredging fragmented or softish, crumbly rock. Because backhoes can generate reasonable cutting force, they are suitable for a variety of non-rock types of soils that have stones: that is heavy clay, soft stone, blasted rock and soil thought to contain fractured rocks, boulders or rubble.

HOW DOES A BHD WORK?

To ensure stability and counter the large digging forces of the BHD at work, the pontoon is anchored and its position maintained by three spud poles. A spud is a large pole that can anchor a ship while allowing a rotating movement around the point of anchorage. On a BHD, two spuds are fixed to the front side of the pontoon near the excavator crane, with one movable spud at the aft side, that is, the opposite end of the pontoon. These heavy pile-like structures are dropped into the seabed by the dredger. During dredging, the rear spud is first raised and brought backwards to its new position. The front spuds are then raised until they have cleared the seabed. The dredger is then moved backwards by pulling on the rear spud carrier.

In the new position the front spuds are lowered firmly and planted in the seabed. Using wires running over the spud poles, the dredger then raises itself partially out of the water to further anchor the spuds. With the pontoon slightly lifted

Above: Backacter 1100, the world's largest backhoe dredger, is a floating hydraulic excavator fitted to a pontoon with a high-end positioning system for precision dredging.



Artist's rendering of the backhoe dredger at work underwater.

out of the water, a part of the weight of the dredger is now transferred via the spuds to the seabed, resulting in an increase in anchoring. This is sufficient to deliver the required resistance to the digging forces. Secure anchoring makes the BHD less sensitive to waves, currents or the wake of passing vessels.

HOW DOES THE BUCKET WORK?

The bucket is placed and filled by hydraulic cylinders on the boom and the bucket arm. The radius of the boom and arm is small and consequently the cut width limited to 10 to 20 metres. The effective dredging area depends on the swing angle and the forward step per pontoon position. A small step results in a large width and a large step in a small width; the total area is almost the same. The reach of the crane also determines the dredging depth and this is usually limited to about a maximum 25-30 metres for the very largest BHDs. Once a cut has been made by the bucket, and before moving the pontoon to the next area, the seabed should be checked for high spots and action taken to level any peaks. The newest, largest BHDs are equipped with accurate positioning systems and can deliver precise underwater profiles in almost any subsoil.


A land-based backhoe mounted on an under-carriage with track can work in shallow waters.

WHERE ARE BHDS USED?

BHDs are used, for instance, in foreshore protection operations. Small BHDs are often track mounted and then work from the banks of ditches especially when being used in harbours or other shallow waters. They can be used in access channels and harbours along quay walls that are difficult to reach. They may be used for dredging relatively small quantities of material that are at varying depths.

The new, much larger BHDs that have been delivered in the last few years are more able to dredge at greater depths. They are often used for bulk dredging of a variety of sediments. Some pontoons may be self-propelled which offers more mobility, but the majority of smaller BHDs must be towed or transported to the work site. The largest BHDs are transported by water and so the spuds are designed to be tilted out of the water.

HOW HAVE BHDS IMPROVED?

Although the basic excavator and its support platform have remained relatively the same, the power of the excavator has increased and the electronic controls are now centralised. Hi-tech automation applied to the positioning and control of the bucket have greatly improved the efficiency and accuracy of the bucket because of electronic positioning and bucket location systems. Land-based backhoes, used for dredging inland waterways, have been developed with improved, extended reaches. A number of low-ground pressure and amphibious versions are now available.

WHAT FACTORS INFLUENCE THE PRODUCTION RATE?

The production rate of a BHD is influenced by the work methods, working conditions and the materials to be dredged. For instance, the excavation force of the backhoe at large depths and the slope of the dredge site which will determine the bucket's positioning. Also to be considered is the degree of precision dredging required, for example, during operations in the vicinity of quay walls. Because the backhoe bucket is heavy and relatively rigid, extra care needs to be taken to avoid damage to the quay walls and canal linings.

The type of materials being dredged, hard soil, boulders, vegetation or debris removal and other obstructions as well as the in-situ strength of the material being dredged are also factors influencing production rate. And of course the location of the dredge site, the weather, the currents and waves and the presence of other vessels.

The size of the bucket is also crucial and production rates are clearly dependent upon bucket size and the average percentage of the bucket's filling, which is again influenced by the type of material being dredged. Choosing the correct-sized BHD and bucket is an integral element in ensuring a cost-effective operation. Backhoe excavators can be very efficient and with good vertical and horizontal control; carefully used, they can produce a smooth profile.

And lastly the capacity and type of barge is a factor, because time must be allocated for changing barges. The size of the barge and whether it is self-propelled or not are then in turn dependent on sea conditions, currents and the dredging site itself.

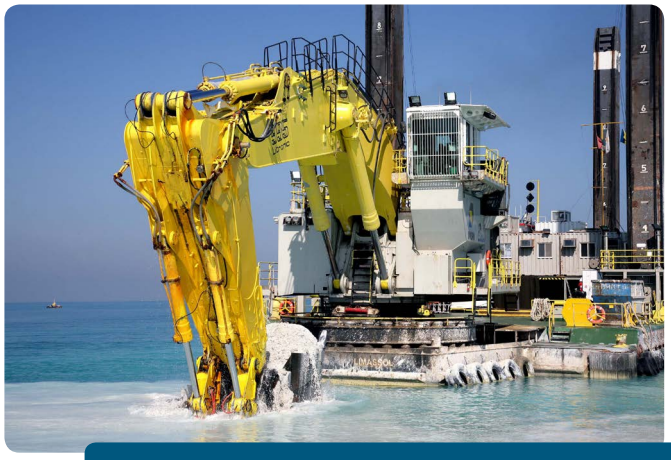
DO BHDS HAVE LIMITATIONS?

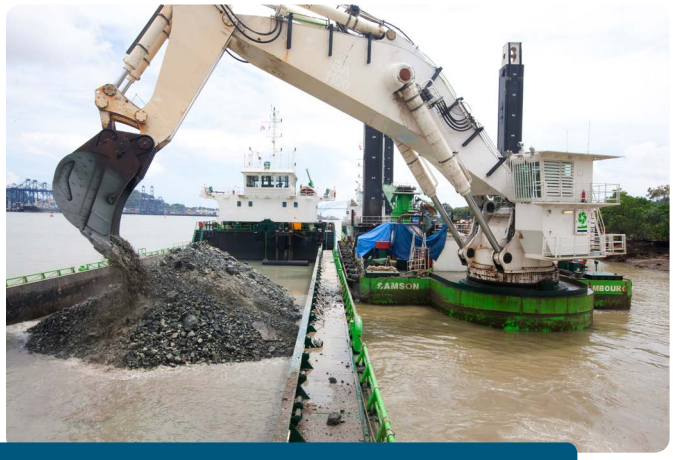
The limitations of a BHD depend partially on the size and particular characteristics of a specific vessel as well as the location of the operation. Is it close to shore? In an active harbour? What are the minimum and maximum water depths? What are the minimum and maximum widths of a cut? The dynamic forces on BHDs should also be considered because they can have significant impacts: A BHD is affected by the inertia of the loaded bucket as it breaks through the surface of the water and begins to swivel. The impact of the cutting process as well as the barges that are moored to the pontoon also have an effect on the BHD's spuds. As with all dredging works, the right equipment demands close attention to several factors, including climate conditions which influence the maximum wave and swell heights and cross-currents.

HOW DO BHDS DISCHARGE DREDGED MATERIAL?

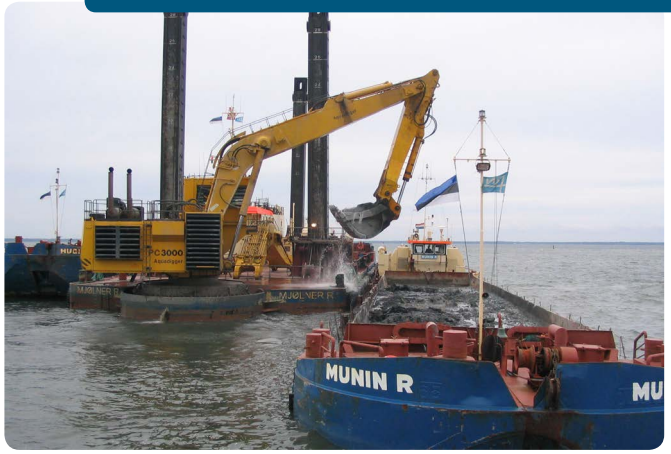
All BHDs regardless of size have a similar dredging cycle. The bucket is lowered into the water, the excavator bucket is filled by cutting and tilting and is then hoisted out of the water. The crane then swivels toward a nearby barge and the dredged materials are emptied into the barge. The BHD then swivels back and starts the process again. The barge maybe a standard, flat-bottomed vehicle that needs to be towed or a self-propelled, split-hopper barge.

Although in most cases the BHD discharges its load into a barge moored onto the pontoon, in some cases the excavated material will be placed onshore. When a BHD is being used for trench excavation the dredged material may be sidecast.





One advantage of a BHD is its ability to dredge a wide range of subsoils, clayey soils, stones, even materials containing boulders or debris.



However if the outreach of the excavator is limited, there is an inherent possibility that the dredged material will drift and re-enter the excavated area. Loading excavated material into barges for transport remains the most common means of disposal.

HOW BIG ARE BHDS?

BHDs come in a wide variety of sizes and are selected based on the particular task at hand. They are usually classified by their length, draught, potential dredging depth, bucket size and total installed power. The variety of BHDs available is greater than ever and each job will determine the most economically viable equipment to be deployed. BHDs are most commonly described as small, medium, large and mega.

The smallest BHDs vary from around 25 to 35 metres long, with medium ranging from 30 to 50 metres on average, large backhoes at about 45 to 60 metres and the mega BHDs topping out at 60 to over 70 metres in length. Length is not the only measurement to be considered however. The draught of BHD determines where it can be used. A small BHD will have a draught of around 1.5 metres, with medium/large ranging from 2 to less than 3 metres and the mega equipment usually ranging from 2.5 to 3.5 metres draught. Dredging depth is also a factor, varying from 10 to 20 metres for the smaller equipment and 20 to 35 metres for the megas. Bucket sizes also vary from a 1.5 to 2.5 cubic metres on the small and medium BHDs to up to 40 cubic metres on some of the newest mega vessels. Accordingly, installed power also varies. A small BHD may have between 200 to 500 kW installed power, a medium BHD from 500 to 950 kW, a large one from 1,000 to 2000 kW and a mega BHD with from 2000 to over 4000 kW.

WHAT SAFETY FACTORS SHOULD BE CONSIDERED?

Nowadays safety and sustainability are considered part and parcel of every dredging operation and onboard every seagoing vessel including BHDs. Because a BHD has a limited number of crew members the communication amongst the operators is more easily managed. One of the significant safety awareness principles is aimed at being aware of the swing area and keeping that area clear of personnel.

The weight of the loads and center of gravity and stability of the pontoon also require special attention. Fire, flooding and capsizing are real risks for which operators must be alert and well trained. In the newest BHDs, especially the electrically driven models, these risks have been reduced.

Communication amongst crew members is also of essential importance when unloading, moving the spuds and changing barges. Although the operator in the cab, as the person who is in charge of regulating this, bears a good portion of the burden of responsibility, being vigilant when working with heavy machinery is everyone's responsibility. New automation as well as BHD simulators have helped to train and assist operators and reduce risk factors.

WHAT ARE THE ADVANTAGES OF A BHD?

The primary advantage of a BHD is its ability to dredge a wide range of materials, even materials containing boulders or debris. The larger BHDs can dredge stiff clays and soft rock as long as they are in relatively shallow waters. Smaller BHDs are able to work in narrow, confined spaces close to shore. They can dredge with great precision and control of their positioning and depth. Compared to other types of dredgers, they have no anchors or associated wires that could interfere with shipping traffic. And in general they have a faster cycle time than a grab dredger of equivalent size.

Backhoes also do not require ancillary equipment aside from the hopper barge used to transport dredged material to a disposal area. Boosters, pipelines and other extra equipment is not necessary. Smaller BHDs are a less costly capital investment. They also require only a limited number of crew members, as the backhoe itself only requires one operator. On larger vessels another one or two crewmembers may be onboard for safety reasons and for manoeuvring the pontoon and for maintenance. And finally, because of the land-based origins of a BHD, they are rather well known, tried, tested and true in terms of production.

FOR FURTHER READING AND INFORMATION

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Facts About is presented by the International Association of Dredging Companies whose members offer the highest quality and professionalism in dredging and maritime construction. The information presented here is part of an on-going effort to support clients and others in understanding the fundamental principles of dredging and maritime construction.

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