

FACTS ABOUT

An Information Update from the IADC

DREDGING PLANT AND EQUIPMENT

HOW DID DREDGING START?

A simple question that leads to a complex answer. The origins of dredging go back to the need to determine nautical access as well as the need for flood control. Dredging has existed at least as far back as the Romans. It started with shovelling out a ditch to make it wider and moved on to digging out a meandering river with horse drawn bucket dredgers to make it more accessible to small boats as they transported goods from one town to another. Fast forward to the late 20th century, dredging has evolved and become even more complex, and more necessary as the backbone of economic growth. Dredging machines are involved in port development, urban expansion, beach replenishment, coastal protection, flood protection, energy exploration and production, mining, and environmental remediation and improvement. The magnitude of earth-moving activities – and the kinds of machinery demanded by these activities – have caused a surge in research and development, and resulted in highly specialised, innovative equipment dedicated to specific projects.

WHY IS DREDGING EQUIPMENT SO SPECIALISED?

Each dredging project has its own unique demands. The cost-efficiency of a project is determined by the matching of the site-specific conditions (hydrometeo, soil) with the characteristic of the dredger. A particular project is influenced by the quantity and type of soil or rock that is present, where it is located, and where it may have to be relocated or placed. Weather conditions and the accessibility of the site, such as its depth or width, and environmental issues such as marine habitats, their flora and fauna, and contamination must be considered. No single type of dredger is suited for every project. Two major breakthroughs in power technology allowed for the expansion and specialisation of dredgers: the invention of steam-powered engines in the 19th century and the post-World War II introduction of diesel engines in the maritime world.

Dredge equipment optimisations including evolutions in the worlds of electronics (positioning and process sensors, automation and visualisation), primary power supply and power distribution technology (dual fuel engines working on clean fuels such as LNG, scrubbers cleaning the exhaust of conventional heavy fuel engines, 'all electric' dredgers) and specific dredging technology (special dredge heads, optimised centrifugal pumps, green or anti-turbidity valves) allow for responding to actual environmental and sustainability challenges. As a result, up-to-date dredging equipment is very specific and high tech, requiring a large investment and highly-trained, well-experienced personnel.

WHAT ARE SOME TYPES OF DEDICATED DREDGING EQUIPMENT?

Dredging equipment can be classified into several broad categories based on the mode of excavation and how they operate. These include hydraulic dredgers, mechanical dredgers, hydraulic/mechanical combinations, hydrodynamic dredgers and environmental dredgers that have been developed or adapted from standard equipment into dedicated or purpose-built machines. Within all these classifications, a distinction can be made between self-propelled and stationary equipment. These latter ones are fixed to the seabed by means of anchors and/or spuds at one or more points.

WHAT ARE THE MOST COMMON TYPES OF DREDGERS USED TODAY?

Trailing Suction Hopper Dredgers (TSHDs), Cutter Suction Dredgers (CSDs) and Backhoe Dredgers (BHDs) are probably the most common workhorses of the industry. Recently assembled data from 2019 identifies a total of 1489 vessels as active internationally, comprising 601 TSHDs, 595 CSDs, and 293 BHDs. Since the early 1960s, dredging vessels have evolved to be more powerful with greater tonnage-carrying capacity and the ability to achieve greater dredging depths.

Above: Cutter Suction Dredger Khaleej Bay from Gulf Cobla on a project in the United Arab Emirates.

These developments are parallel to ever more environmentally friendly work methods. All this progress is not only a response to the increased demand of the projects and their economies, but is also a trigger for ever larger projects and ever more challenging projects with respect to soil, weather, and distance dredging-disposal area.

WHAT ARE HYDRAULIC/MECHANICAL DREDGERS?

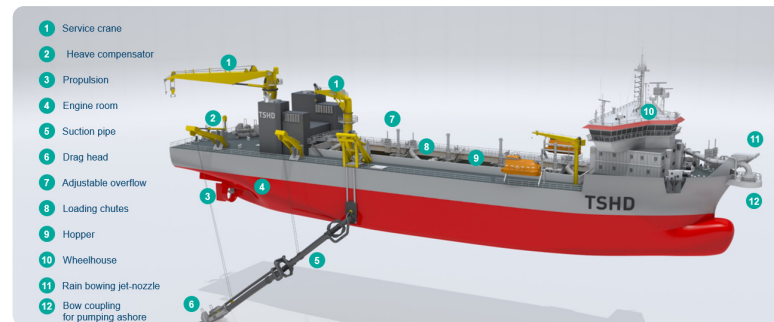
CSDs and TSHDs are the most common vessels in this category. CSDs have the ability to dredge nearly all kinds of soils – sand, clay and rock – but since they operate in stationary mode, they are particularly vulnerable when working in shipping channels, in wave conditions and in rough seas. Although the larger and most modern CSDs are generally self-propelled, they remain working in ‘stationary’ mode when dredging. Nevertheless, they can be mobilised on own keel over long distances to a project and are also readily relocated during the project. The working principle of the CSD is that it disintegrates or breaks the cohesion of the soil to be dredged mechanically by a rotating cutter head. When the material is loosened or pulverised, it is then sucked up and transported through a pipeline by centrifugal dredge pumps to the discharge area or onto barges moored alongside the CSD. The most recent CSDs have up to 12000 kW installed on the cutter head allowing it to dredge rocks – that had to be blasted before – in an economic way.



A CSD like this one from Jan De Nul is used for cutting sand, hard clay and rock.

TSHDs are free sailing and self-propelled, seagoing or inland waterway vessels which are stable and thus relatively insensitive to weather, waves, and rough seas. They are self-loading and self-unloading or – discharging, and thus are also suitable for work in shipping channels. Generally speaking, they dredge ‘non-rock type’ soils by either hydraulic means, mechanic means or a combination of both. The dredging cycle of a TSHD begins with loading at the dredging or borrow area (the so-called trailing phase), then sailing (loaded) to the unloading area, unloading via bottom opening doors or by pumping and then sailing (empty) back to the dredging area. The carrying capacity in the hopper is restricted either by volume (hopper is full) or by weight (maximum draught). Production may vary as a result of the soil characteristics and weather conditions; available

propulsion power, the size and weight of the drag head; the keel clearance when the ship is loaded; the dredging depth; and the pumping distance. TSHDs vary dramatically in size and the capacity of their hoppers: from under 1,000 m³ hopper / 1,150 ton deadweight to 30,000 m³ and above hopper / 8,500 ton deadweight. In ‘ideal’ circumstances, the larger TSHDs generate a production of 1 or more million m³ a week!!



Artist's rendering of a TSHD with an elongated drag arm. TSHDs come in a wide variety of sizes and are extremely flexible.

WHAT ARE HYDRAULIC DREDGERS?

The Plain Suction Dredger (PSD) and the Dustpan Dredger (DPD) are typical hydraulic dredgers. These dredgers use hydraulic centrifugal pumps to provide the excavating force and they use hydraulic transport to carry the solids or slurries from the digging site through pipelines to the discharge site. Hydraulic dredgers may also pump into barges for later transport to a placement site. As the excavation force is purely hydraulic, only free running material like sand can be dredged. Jet water is used for dislodging and fluidising material. No specific head is foreseen on the suction pipe of a PSD, necessitating relatively large layer thicknesses to generate economically viable productions. On the other hand, a DPD is foreseen with a wide suction head generating economically viable productions even with relatively small layer thicknesses. The barge unloading dredger is a specific hydraulic dredger used to empty a barge by hydraulic means and basically works as a plain suction dredger.



This Plain Suction Dredger (PSD) from Boskalis is a hydraulic dredger using hydraulic centrifugal pumps to provide the excavating force.

WHAT ARE MECHANICAL DREDGERS?

Mechanical dredgers are in essence similar to dry land excavators. They include Grab or Clamshell Dredgers, Backhoe Dredgers and Bucket Ladder Dredgers. They usually have no hoppers but discharge into barges which then bring the sediment to the appropriate disposal site. Occasionally a Grab Dredger will have its own hopper within the vessel hold and will have to travel to the placement site to discharge its cargo as does a TSHD.



A Backhoe, mounted on a pontoon, is loading soil onto a barge for transport to a disposal site.

WHAT ARE THE CHARACTERISTICS OF A GRAB DREDGER?

A Grab Dredger (GD) can be a common grab crane on a pontoon or a specially built pontoon (with spuds) with a fixed grab-crane on a rotating table. Small GDs are often used for areas that are difficult to access, in shallow waters as well as for construction works for shore and bank protection. Material dredged by a grab is loaded onto barges and transported to deposit sites. They are suitable for non-rock types of soil and for debris and vegetation but they are generally unsuitable for creating an even bed.

WHAT ARE THE FEATURES OF THE BACKHOE OR HYDRAULIC EXCAVATOR?

A Backhoe Dredger (BHD) can be a common hydraulic excavator located on a flat-top pontoon or – for larger sizes – a specially-built pontoon (with spuds) with a fixed hydraulic excavator founded on a rotating table. A reasonable cutting force can be generated making the BHD suitable for 'non-rock' type soils with stones, blasted rock and for precision dredging. The dredged material is then loaded onto barges for transport to a disposal site. It is also possible to fit different types of Buckets, Sticks and Booms on the arm of a BHD in order to increase production as function of depth and soil

strength. The advantages of the BHD is that while it is less suitable for strong rocks, it is suited to precision dredging along quay walls, slope dredging, and the removal of debris or vegetation. Moreover, it only occupies a small area allowing its deployment in shipping lanes. The larger up-to-date BHDs with a bucket of 40 m³ can realise productions up to 200,000 m³ a week in 'ideal' circumstances.

WHAT ARE SOME OTHER TYPES OF MECHANICAL DREDGING EQUIPMENT?

There are a few other types of mechanical dredgers that are used less frequently: The Bucket Ladder Dredger (BLD), the dipper dredger and the rock breaker. The Bucket Ladder Dredger was once the mainstay of the dredging fleet but has long been outpaced by newer TSHDs and CSDs. Still, the BLD is reasonably economical for mixed materials. It works by a revolving chain of buckets, and swings



as a Cutter Suction Dredger, with no spuds but rather position-fixed by wires. At the highest point of the chain, the buckets turn upside down to discharge the dredged material onto barges. The dipper dredger is rather like a powered shovel and is mounted on a barge. The shovel empties through the bottom as it discharges into a barge. Dippers come in all sizes. They are particularly suited for dredging boulders and stiff clays. Rock breakers use hydraulic power to crack rock and can assist other dredgers in removing extremely hard spots. The broken rock is then removed by the other dredger.

WHAT IS A HYDRODYNAMIC DREDGER?

Water Injection Dredger (WID) and Ploughs are two examples of hydrodynamic dredgers: they mobilise the material underwater and transport it without bringing it to the water surface. Water Injection Dredgers (WID) use water pressure to fluidise the bottom material to be removed, creating a dense fluid slurry. The slurry is then transported from the excavation site by currents either induced by the density gradient between the slurry and the water or by naturally occurring currents such as from tides or the bed slopes. The WID has been used successfully for maintenance dredging. This is a relatively low-cost technique whose use is limited to silts, unconsolidated clays and fine sands. It is less suited for environmentally sensitive areas as one has no real control over the deposit location. Ploughs or bottom levellers assist the TSHD with the removal of ridges and high spots, and of soft material from small harbours. It is an inexpensive, low production method as they are not self-propelled but towed by a tugboat.



Van Oord's Water Injection Dredger Jetsed along the coast of Lisbon, Portugal.

WHAT ARE ENVIRONMENTAL DREDGERS?

Environmental improvements to dredging techniques have become increasingly important over the last 25 years. For instance, new or modified dredging techniques try to minimise turbulence and turbidity to cause less disturbance to marine flora and fauna. One example of this is the 'green valve' system developed for TSHDs which reduces turbidity caused by overflow during the dredging process. Environmental dredging tries to optimise the precision with which operations are done, for instance, to remove accurate thin layers so that there is less dredged material to be disposed of, especially if the dredged material is contaminated. For this purpose, special Environmental Dredgers have been developed which are primarily modifications of CSDs, BHDs, and GDs.



The Scheldt River, a TSHD of DEME. Named after a 350-kilometre-long river that flows through the north of France, western Belgium and the south-western part of the Netherlands with its mouth at the North Sea.

WHAT OTHER TYPES OF DREDGING EQUIPMENT ARE IN USE?

Large dredging vessels are also supported by a variety of water-based equipment such as previously mentioned barges, work boats and launches, anchor pontoons, floating pipeline pontoons, rubber floating pipelines, and booster pumping stations. Other equipment includes multicats and survey launches, and conveyor belts for transport as well some land-based equipment.

HOW DO YOU MATCH THE PROPER DREDGING EQUIPMENT TO THE JOB?

The choice of equipment depends on the type of soil conditions, the transport options, the configuration of the dredging area, including pre- and post-dredge water depths and placement requirements with respect to environmental and other considerations. Because of the wide variety of tools – due to diverse vessel types and sizes, diesel engine power and hopper capacity, pumping power, and other specific dredging equipment – clients, often assisted by expert consultants, can best seek the advice from the dredging companies themselves to help find reasonable, economical solutions within the framework of competitive bidding processes.

FOR FURTHER READING AND INFORMATION

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Clarksons Research Dredger Register 2019 documents more than 2,000 vessels in the fleet and on order:

<https://www.crsi.com/acatalog/the-dredger-register.html>

The IADC Knowledge Centre:

www.iadc-dredging.com/en/knowledge-base



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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