Environmental Dredging for An Efficient Removal of Contaminated Sediments

Use of the term "environmental" or "remediation" dredging has evolved in recent years to describe dredging performed specifically for the removal of sediment contaminated at levels that can endanger marine life and human life. Environmental dredging techniques aim to achieve a high concentration of dredged sediment with the lowest possible turbidity. They try to optimize the precision with which operations are done. To do this, special 'environmental dredgers' have been developed. These are often modifications of cutter suction hoppers, backhoes and grabs. Other adaptations are the so-called "green valve" system developed for trailing suction hoppers, which reduces turbidity caused by overflow during the dredging process.

Two dredgers cleaning the fjords in Sweden and both them are at work within a silt screen

What characterizes environmental dredging?

Environmental dredging projects are generally smaller in scale than navigational or capital dredging, but because of their long-lasting environmental implications, environmental dredging projects are of special importance. A capital dredging project may have an environmental component, but more often environmental dredging projects are specific initiatives designed to remove contaminated sediments with the goal of improving water quality and restoring the health of aquatic ecosystems. Cleaning water bodies where industrial wastes deposited in a pre-environmentally conscious era or other contamination occurs directly aims to protect human health and ensure significant sustainable development.

Key components in dredging contaminated sediments

Removal of contaminated sediments from the waterbed is complex and demanding. Some of the key components to be evaluated when considering dredging as a clean-up method include sediment removal, transport, staging, treatment (pretreatment, treatment of water and sediment, if necessary), and disposal (liquids and solids). More complex projects may include most or all of these components. Efficient coordination of each component typically is very important for a cost-effective cleanup. In general, fewer sediment re-handling steps lead to lower implementation risks and lower costs. To do this requires dedicated equipment which can dredge in a way that recognizes the added hazard of working with contaminated sediments. To that end, shipbuilders and the major dredging companies have invested in research to adapt regular dredging vessels. They have also created dedicated technologies to address these hazards.

What is precision dredging?

Environmental dredgers have optimized their precision so that they can accurately dredge thin layers. Environmental dredging aims to remove accurate thin layers so that there is less dredged material to be disposed of, especially if the dredged material is contaminated. Special environmental dredgers, such as augers and scoop heads, are equipped with advanced technological positioning and monitoring systems. These increase the ability to dredge with a high degree of precision. This precision however means that the production level is often lower than with a normal dredging process because the goal is to work with high accuracy and to minimize turbidity. On the other hand, the increase in dredging accuracy permits a decrease of overdredging. This is an essential development as less overdredging means less material to be dredged and treated. From an environmental perspective this means a decrease of suspended sediments. From a financial perspective it results in lower costs, which can lead to reduced tender prices.

"Environmental dredgers have optimized their precision so that they can accurately dredge thin layers"

What are low-impact environmental dredgers?

This new range of equipment increases precision, i.e., by reducing overdredging and minimizing the suspension of bed material and thus has a lower impact than traditional dredgers. In some cases existing dredger types have been modified; in other cases completely new dredgers have been designed. These new or modified dredgers and technologies ensure that contaminants are not re-mobilized and/or released into the water column where they may detrimentally affect aquatic life. They are built to minimize turbulence and turbidity so as to cause fewer disturbances to marine flora and fauna.

In many cases the dredged materials are brought via a closed system to a barge or to disposal areas. Examples include: encapsulated bucket lines for bucket chain dredgers; closed buckets

An environmental clamshell seals after closure minimizing the resuspension of contaminants

for backhoes; closed clamshells for grab dredgers; auger dredgers, disc cutter, scoop dredger and sweep dredger, all of which are modifications of standard cutter dredgers. These dredgers also contain sophisticated automation and the ability to maximize the concentration of the sediments – which means controlling the excavation level as well as the layer thickness.

The 'green valve'

The 'green valve' system was developed for trailing suction hopper dredgers to help reduce turbidity caused by overflow during the dredging process. One of the first technological advances in the reduction of turbidity was the design of an overflow valve which discharged sediment under the vessel instead of at the water's surface. However, water overflow consists of not only water, sediments and fines, but also air. And air rises. So, although the larger sediments were discharged to the sea/riverbed, as the air rose from the underwater outlet to the water surface, it carried fines with it, spreading over a large area causing increased turbidity. With the invention of the 'green valve' a major breakthrough took place. The Green Valve reduces the air entrainment and therefore sediments and fines sink to the sea- or riverbed and reduce the turbidity. Less turbidity means less environmental impact.

"The Green Valve reduces the air entrainment and therefore sediments and fines sink to the sea"

When is environmental dredging the solution?

The need for the remediation of contaminated sediment is recognized throughout the world despite its costs. Stakeholders realize that for a truly sustainable world the contamination caused by residual chemicals and industrialization must be addressed and that often remedial dredging is the only sufficient answer.
Cleaning up toxic chemicals in ports and harbors and rivers is a specific skill. Technologies including capping, monitored natural recovery, and dredging have advanced and continue to develop. In this way contaminated sediment management has differentiated itself from mainstream dredging. However, from a sustainability perspective, and despite the capacity of the dredging community to remediate contaminated sediments, the long-term solution and ultimate goal should always be given to control contamination at source. This basic premise is an environmental rule: Prevention is always worth a pound of cure.

Pros & cons

Environmental dredging can result in efficient and accurate removal of contaminated sediments. One given however is that operational and production rates for environmental dredging are lower than for navigational dredging. Another is that re-suspension, release and residual sediments are controllable, but these issues must be addressed in the planning stages. Typically, as with other dredging equipment, the impact of noise, fuel emissions and exhaust must be considered. In general, sustained production rates for environmental dredging are low, but their precision allows the removal of contaminated sediments without removing clean material. This precision is ultimately cost-efficient. Environmental dredgers serve a unique purpose in the stride towards sustainability. They provide the opportunity to clean up waterways – ports, access channels, lakes and rivers – that are crucial to long-term global well-being, both economically and socially. ■

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تطوَّر استعمال مصطلح التجريف "البيئي" أو تجريف "المعالجة" في السنوات الأخيرة لوصف التجريف المعتمد بشكل خاص في إزالة الرواسب الملوثة بمعدلات تهدِّد الحياة البحرية والبشرية. وتهدف تقنيات التجريف البيئي إلى جرف نسبة عالية من الرواسب المجروفة بأقل نسبة ممكنة من العكورة. وتعمل هذه التقنيات على تعزيز الدقة التي تتمّ بواسطتها العمليات. ولتحقيق هذا الأمر تمَّ تطوير كراءات بيئية خاصة تكون غالباً تعديلات في قواديس الشفط القاطعة والجرافات والقلابات. أما التعديلات الأخرى فهي ما تسمى بنظام "الصمام الأخضر" الذي تمّ تطويره لجرّ قواديس الشفط، الأمر الذي يؤدي إلى خفض نسبة العكورة التي يسببها الفيض خلال عملية التجريف. بشكل عام، تعتبر مشاريع التجريف البيئي أصغر حجماً من التجريف الملاحي أو التجريف الأساسي، ولكن ونظراً لآثارها البيئية الطويلة الأمد، تُعتبر مشاريع التجريف البيئية ذات أهمية خاصة. وقد يُشكل مشروع تجريف أساسي عنصراً بيئيا، ولكن تعتبر مشاريع التجريف البيئية في أغلب الأحيان مبادرات محدّدة تهدف إلى إزالة الرواسب الملوثة من أجل تحسين نوعية المياه وإعادة تأمين سلامة النظم الإيكولوجية المائية. ويهدف تنظيف المسطحات المائية حيث أودعت النفايات الصناعية التي ترسبت في عصر واع مسبقا للبيئة أو أي تلويث آخر ناتج إلى حماية صحة الإنسان وضمان تحقيق التنمية المستدامة بشكل ملحوظ.