

## **ENVIRONMENTAL DREDGING AT HIGH DEPTH DAM CLEANING DREDGING**

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### **ABSTRACT**

Environmental dredging and High Depth dredging are emerging trends in the dredging market. Dragflow has developed a full line of hydraulic and electric pumps and cutters for high depth applications that our customers have been using for Environmental dredging. A perfect example of this is a dam cleaning dredging project close to the city of Udine (Italy). In this dam cleaning project, our Environmental High Deep System is operating at depths of over 50 meters. The beauty of the system is that the dam is in full service during the dredging operation. Our High Depth Systems, powered by hydraulic power packs or electric generators, can operate as deep as 300 meters and include hydraulic or electric pumps, hydraulic or electric cutters, high-pressure water jets and Anti-turbidity bells. The design of our High Depth System prevents contamination. The action of both, the strong suction of the impeller and the effect of the double blade agitator (that sends a high-pressure flow of water towards the settled material), put the solids in suspension, creating a high-density slurry. This slurry is conveyed to the eye of the impeller at high velocity, containing the turbidity in a cone shaped zone adjacent to the pump. As a safety factor, the Anti-Turbidity Bell covers the perimeter where the pump and cutters are operating, keeping all disturbances within. The Dragflow system handles high concentration of solids with smaller pumps, less power and reduced discharge pipe diameters; achieving better productions than larger conventional cutter-suction dredges at a much lower operating cost.

**Keywords:** Dredging, high depth, dam cleaning, contaminated sediment, anti-turbidity bell.

### **INTRODUCTION**

Dredging is becoming a crucial activity for the development of our society. Create new land or develop and maintain efficient harbors network, as well as restore dams' capacity and productivity or open safe and efficient water-ways are basic activities to sustain economic growth in most countries. But more and more new challenges demand not only efficient and reliable dredging solutions, but also solutions that assure environment protection.

Many dredging projects, such as dam cleaning or maritime port causes a high and complex environmental impact. Parallel to the challenge of extraction of materials by means of dredging, it is acquiring greater importance the need of protecting the underwater ecosystem during the excavation process.

Sea sediments, for example, can be polluted by metals, hydrocarbons, bacteria, chemical substances, etc. which in most cases are toxic, resilient and accumulate as debris. A digging operation without taking care of controlling turbidity in surrounding waters, could cause serious damage to the marine flora and fauna.

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**Figure 1 and 2. Dam cleaning project.**

Environmental dredging is distinctly different from large-scale dredging because of the approach. Dredging can possibly cause turbidity and contamination, but with Dragflow advanced environmental dredging techniques we achieve the necessary high concentration of solids being pumped causing minimum turbidity during dredging operations.

Dragflow has been involved in the production of submersible dredge systems for more than 25 years. A business that begun in the early 80's specifically for coastal protection along the Italian and European coasts, thanks to the passion of the people and engineers working in the company, has rapidly evolve into an international recognized partner for the most challenging high depth dredging projects.

### **WHY APPROACHING HIGH DEPTH DREDGING PROJECTS WITH SUBMERSIBLE PUMPS?**

#### **Efficiency factor**

Dredging and solids reclamation are energy intensive operations. The main challenge for manufacturers of dredging equipment is to develop efficient machines that can reduce the use of energy to minimize projects operating costs and reduced fuel emissions.

From the beginning, Dragflow has been fully concentrated on submersible dredge pump technology. The effect of a double blade agitator, directly in contact with the material, and strategically located, works together with the pump suction, enabling Dragflow pumps to pick up sedimented material in a slurry containing up to 70% solids by weight.



**Figure 3. Agitator's effect.**



**Figure 4. Double cutting system.**

Higher solid concentration means focusing the energy to move solids instead of water. It means the possibility to work with smaller diesel engines and reduced discharge pipe diameters. This results in a lower environmental impact and considerably reduced operating costs and fuel consumption per cubic meter produced. With smaller submersible agitator pumps productivity is similar if not greater than much bigger size suction pumps.

### **Versatility**

The submersible pump due to its own heavy weight can be positioned in the water with the use of a crane and a steel cable. This solution allows working at any depth without limitations using pressure compensators. Dragflow has also introduced an innovative double cutting system which cutter heads turn in opposite direction, eliminating torsion as the pump is suspended from a single cable.



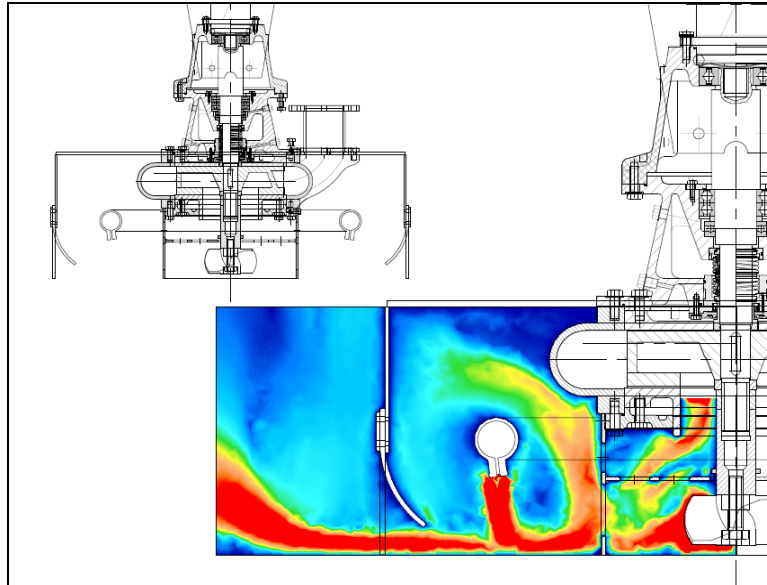
**Figure 5 and 6. High depth dredging system.**

## **ENVIRONMENTAL DAM CLEANING**

### **Anti-Turbidity Bell**

The water turbidity in the zones adjacent to the dredging areas is a problem that has always existed, but only recently is gaining a particular importance. The possible damages caused to the present flora and fauna in this working zone are considerable and its consequences are seen on the long period.

In hydropower Dam Dredging projects, water turbidity and suspended fine solids can cause serious damage to hydroelectric turbines. In potable water Dam Dredging projects, the process can cause serious water contamination with public health consequences. Our environmental dredging system offers the tremendous advantage of minimizing these effects while the dredging process is taking place. The Dragflow System allows keeping the dams in full service during the dredging operation.



**Figure 7. Anti-turbidity bell operating principle.**

The combination of the strong suction of the impeller and the effect of the agitator that puts the solids in suspension, create high-density slurry current with the turbidity adjacent to the pump in the shape of a cone that is conveyed at high velocity to the eye of the impeller.

In order to further contain the water turbidity during dredging, an anti-turbidity bell could be retrofit on the dredging unit. This bell, without altering the performances of the pump, allows limiting the turbidity deriving from the dredging operation to a circumscribed area around the pump.

The dredging unit can be equipped with a double cutting system or with a high pressure water jet-ring system or both. The steel bell covers not only the pump but the entire system. The disturbance of the aquatic environment is therefore kept to an absolute minimum.

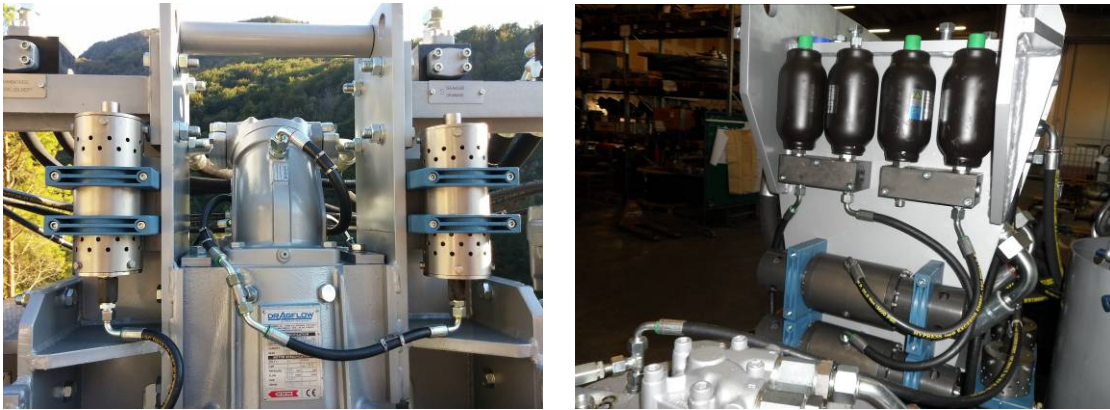


**Figure 8 and 9. Anti-turbidity bells.**

## **OTHER COMPONENTS OF DRAGFLOW HIGH DEPTH SYSTEM**

### **High Depth Pump and Cutters**

The core of any dredging system is the pumping unit. Dragflow has developed a line of hydraulic and electric pumps for high depth applications. High depth pumps and cutters are equipped with a pressure compensation system that allows compensating the external water pressure with the oil pressure inside the pump.



**Figures 10 and 11. Compensation systems for hydraulic pumps and cutters.**

Pump and cutters compensators are calculated for the maximum dredging depth and carefully mounted to guarantee equivalent internal and external pressure of the dredging system. Furthermore, a specific hydraulic system mounted on the pump and cutter motors avoids abrupt interruptions of oil flow thus protecting the motors and pump's internal components. This is possible thanks to a bypass connecting oil delivery and return allowing a gradual reduction of RPMs

### **High Depth Jet-Ring System**

As previously illustrated, the dredging system can be combined with a compensated double cutting system; this allows installation of cutter heads also in high depth project without risks of the pump spinning around. Additional cutting power can be installed with a compensated high pressure jet-ring system. This latter is composed of a Dragflow compensated high head hydraulic pump and a standard jet ring frame.



**Figures 12 and 13. High depth Jet Ring System.**

### **Oil Hoses Reels and Umbilical Line**

In high depth projects it becomes crucial to have an efficient and flexible system to bring hydraulic power to the dredging system. A traditional oil line, for projects with working depth higher than 30m, could be too vulnerable and get damaged but is also very complicated to handle. Damages to the Oil lines cause oil leakage, environmental contamination and maintenance down time to replace hoses plus any costs for long term environmental remediation

Umbilical systems are ideal to combine environmental safety and usability. They consist of a set of oil hoses twisted around a core non stretchable rope, which absorbs all the strains and shocks, and is covered by a protective canvas.



**Figure 14. Umbilical line.**



**Figure 15. Hydraulic reel.**

To properly handle the umbilical line, Dragflow has developed a line of custom made hydraulic reels that can be controlled from the main power pack (also via wireless controls) and that are equipped with an automatic brake for descending operation and automatic recovery for ascending operations. Hydraulic reels are provided of rotating junctions and rotating base frame for trouble free automatic recovery of the umbilical line. These reels could be installed also on existing barges.

### **Hydraulic Power Packs**

High depth hydraulic dredging system requires efficient and reliable Power Packs. Power Packs specifically built for high depth are:

- designed to have separate oil circuit for pump and cutters in order to permit high flexibility during operations. There is no need to stop the pump in case cutters jam due to presence of big solids.
- equipped with assisted descent of the pump and cutter that enters into action when "automatic" mode is selected at the power-pack
- oil boosters and oil compensators to avoid cavitation during fast start-up of hydraulic oil pumps
- equipped with a Sound Proof Canopy "all weather" resistant and built into container style enclosures
- available with wireless remote control to improve usability and operator's safety or with 3G wireless connection to send and store operational parameters into remote servers. This allows managers in remote offices to have a real time and historical view of how the system is performing.



**Figure 16 and 17. Power Pack diesel or electric driven.**

## HIGH DEPTH REFERENCES

### Sicily, Italy 2006 - Dirillo Dam reservoir dredging 50/60m working depth

*Project Description:* Removing alluvial sediments accumulated in the lake near the dam bottom spillway.

*Dragflow Product:* Diesel driven dredge with Hydraulic Pump HY300B and Hydraulic Cutters EXHY35, everything compensated for maximum working depth of 60 mts.

*Average Production:* 300 m<sup>3</sup>/h of solid material at 1.000 m of discharge distance.



Figure 18. DHR300E23 Dredge



Figure 19. Discharge at 1 km distance

### Azerbaijan 2007 - Off shore project 120m working depth

*Project Description:* Removing sand and silt around the jacket of an off shore platform for petroleum extraction from the bottom of the sea.

*Dragflow Product:* Hydraulic Pump HY50B plus cutters EXHY20 with Hydraulic Spooler, Umbilical and protective off-shore frame.

*Average Production:* 60 m<sup>3</sup>/h of solid material at 200m of discharge distance at sea bed level.



Figure 20. Off-Shore protective frame



Figure 21. Spooler and Power-Pack

### Colombia 2013 - Dam dredging 60m working depth

*Project Description:* Hydroelectric Dam de-silting. Dragflow equipment has been used onto a working vessel equipped with cranes and propellers.

*Dragflow Product:* Hydraulic Pump HY85/160B with cutters EXHY20S with Hydraulic Spooler and Umbilical.

*Average Production:* 120 m<sup>3</sup>/h of solid material at 500m of discharge distance.



Figure 22. Dredging vessel



Figure 23. Hydraulic reel on rotating junctions

### Russia 2012 - Off Shore Dredging - 270m working depth

*Project Description:* Trench dredging in Deep Ocean. Dragflow equipment has been used onto a vessel equipped with dynamic positioning and ROV system able to detect real time position of the pump. During the initial phase of the project the pump has been successfully tested at 300m of working depth into clay, sand and gravel.

*Dragflow Product:* Dredge HY85B with cutters EXHY20S with Hydraulic Spooler, Umbilical and protective off-shore frame.

*Average Production:* 100 m<sup>3</sup>/h of solid material at 270m working depth.



Figure 24. Hydraulic Reel with guide



Figure 25. HY85 with Cutters for High Depth

### Russia 2014 - Dredge for 50m working depth

*Project Description:* Sand and Gravel extraction.

*Dragflow Product:* Dredge DRH400E23-14" with Umbilical line and Hydraulic Spooler installed on a frontal additional floater.

*Average Production:* 300 m<sup>3</sup>/h of solid material at 500m of discharge distance.



Figure 26. Pump HY400 with cutters and jet-ring



Figure 27. Dredge Overview

### Norway 2014 - Off-Shore dredging 100m working depth

*Project Description:* Underwater excavating for concrete foundation at approximately 100 mts of working depth.

*Dragflow Product:* N.2 high depth dredging system composed by Dragflow HY85B with 2 cutters EXHY20 and High Depth Jet-Ring System. Dredging unit equipped with n.2 underwater cameras with lights for perfect monitoring of the position of the pump.

*Average Production:* 100 m<sup>3</sup>/h of solid material at sea bed layer.

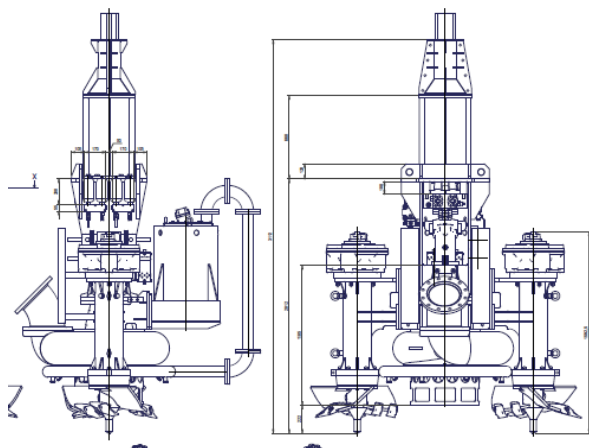


Figure 28 and 29. HY85B with Cutters and High Depth Jet-Ring System

### Central Africa 2015- Dredging river for mineral extraction

*Project Description:* Dredging operation at 50 meter depth for mineral extraction. The discharge goes into a washing plant for separating minerals from other sediments.

*Dragflow Product:* New model Dredge DRH85/160E22DFHD with automatic hydraulic reel between operator cabin and power pack for optimal view. Dredging unit composed by Hydraulic Pump (HY85/160B) and two Excavators (EXHY20).

*Average Production:* sand and lime 125 m<sup>3</sup>/h at 600 m distance



Figure 30. Hydraulic pump



Figure 31. Dragflow Dredge with hydraulic spooler

### Caspian Sea, Kazakhstan 2015 - Off shore pipeline maintenance

*Project Description:* Special dredging system allowing sand removing along submerged pipeline.

*Dragflow Product:* Two Dragflow HY85/180HC High capacity with cutters EXHY20 attached to a steel frame with a protective shield.

*Average Production:* sand 400 m<sup>3</sup>/h at 200 m distance from the pipeline.



**Figure 32 and 33. Dredging tool for submerged pipeline maintenance**

**CITATION**

Benassuti, M., Ranaldi, A. and Freivokh, M. "Environmental dredging at high depth dam cleaning dredging," *Proceedings of the Western Dredging Association and Texas A&M University Center for Dredging Studies' "Dredging Summit and Expo 2015"*, Houston, Texas, USA, June 22-25, 2015.