Volume 2, Issue 9, September - 2024
ISSN (E): 2938-3781

Web of Agriculture: Journal of Agriculture and Biological Sciences
webofjournals.com/index.php/8

DREDGERS: TECHNOLOGIES FOR REMOVING UNDERWATER SEDIMENTS

Abduraxmanov Umirzok Mamatmurotovich
"PhD Student at the Research Institute of Irrigation and Water Problems"

Abstract

A dredger is a type of pump that removes a water-slurry mixture from a central intake. It differs from ordinary water pumps in that it has a more robust casing and fewer paddles on the impeller. The pump usually has 3-6 paddles, which allow sediments and other materials (such as small stones, metal, glass, and various plant roots) to pass through. If these materials get clogged inside the pump, an opening is made in the pump casing for cleaning, and it is then sealed with a special cover and bolted shut.

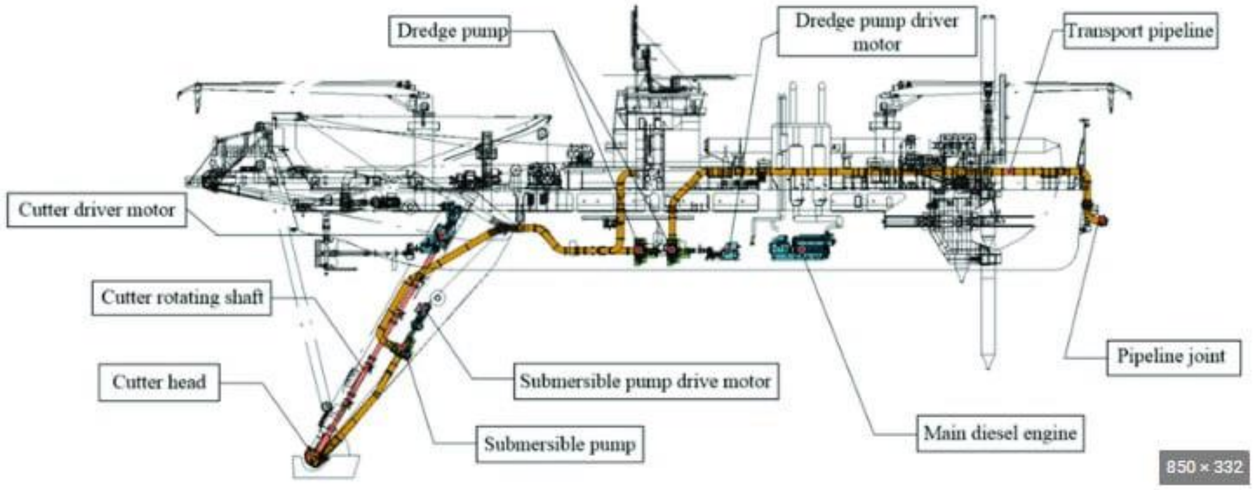
A floating machine equipped with dredging equipment is called a "dredger" (zemsnaryad). It is used to suction underwater sediments (softening hard sediments if necessary) along with water and transport them. The overall design of the dredger includes a diesel-electric engine, a dredge, a winch, a pile driver, and other related equipment. The electrical energy produced by a generator connected to the power unit (IYOD) is supplied to the dredger, the dredge, and the electric motors that power the sediment softening and winching systems.

This article provides a detailed analysis of the operating principles, structure, and technical specifications of dredgers and dredge pumps.

Keywords: dredger, mixture, pump, water, sediment.

Introduction

To ensure efficient operation of a dredge pump in harsh conditions, such as when water contains sediment, stones, metal, and other debris, its casing and impeller must be made from durable, abrasion-resistant metal. The suction pipe of the pump is connected parallel to the wheel axle, while the discharge pipe is connected perpendicular to it. Special sinking devices are used to keep the discharge pipe above the water. The process of raising and lowering the suction equipment is carried out using steel ropes and a winch. The dredger uses a special pile to stay in the water. The pile is installed in the sediment at the bottom of the water using a pile-driving device, which helps to keep the machine in place and allows it to rotate around the pile. The ability to rotate the dredger to the right and left around the pile extends the range of underwater sediment coverage. The dredge's impeller consists of two parallel disks and blades positioned between them, fixed to a shaft. The openings formed between the disks allow the mixture to enter the pump. The pump casing, designed with an outlet port, discharges the mixture through the openings. When debris accumulates inside the pump, an access cover is opened for cleaning.



Before starting the pump, the suction pipe is closed and the pump is filled with water. Then, the pump is started using the electric motor, and the suction pipe is opened. The dredger is brought to the center of the water body and anchored to the sediment at the bottom using a pile. Piles are driven into the opposite banks of the basin, and loops are installed to hold them in place. During these processes, the cutter head is driven by a special electric motor, gearbox, and cardan shaft. After the cutter is immersed in the sediment, the dredge is started, and the suction process begins. Cleaning the sediment is accomplished by moving the cutter in an arc-shaped motion along a horizontal plane.

Archimedes' principle plays a crucial role in the operation of the dredge. The following condition must be met for the pump to float:

$$F_{og'} > \rho_s \cdot V_b \cdot g, \qquad [N]$$

Here, the condition is; $F_{og'}$ – The weight of the vessel must be equal to the buoyant force, *N*; ρ_s – density of water, *kg/m³*; V_b – The diameters of the suction and discharge pipes of the pump are determined using the following formula, which is based on the volume of the submerged part of the vessel, *m³*; g- acceleration due to free fall, *m/s³*.

Web of Agriculture: Journal of Agriculture and Biological Sciences
webofjournals.com/index.php/8

The diameters of the suction and discharge pipes of the pump are determined using the following formula:

$$D = 2\sqrt{\frac{Q}{3600 \cdot \pi \cdot \vartheta}} \qquad [m]$$

Here, the condition is; Q – flow rate of the water pump, m^3/soat; $\vartheta -$ velocity of water in the pipe, *m/s*; ($\vartheta = 2{,}5 \ldots 3{,}5\,\frac{m}{s}$)

length of the suction pipe $l_{sq} -$ it can be determined using the following formula:

$$l_{sq} = \frac{h + h_1}{\sin \alpha}, \quad [m]$$

Here, the condition is; *h* – distance from the water surface to the bottom of the channel, *m*; h_1– distance from the water surface to the pump shaft, *m*; $\alpha -$ angle of inclination of the suction pipe relative to the vertical axis, degrees, ($\alpha = 50^0 \ldots.55^0$).

Dimensions of the cutter head: diameter of the cutter

$$D_f = (3{,}0 \ldots.3{,}5) \cdot D\ [m]\ .$$

Length of the cutter $l_f = 0{,}85D_f \quad [m]$; number of blades on the cutter $z = 5 \ldots 6$ pieces; length of the cutter blade $l_k = (1{,}25 \ldots 1{,}30) \cdot D_f \quad [m]$; effective length of the cutter blade $l_{kf} = (0{,}9 \ldots 1{,}0) \cdot D_f \quad [m]$.

The distance the sediment is pushed by the blade is determined using the following formula:

$$l_{sur} = \frac{\vartheta_{ar}}{z \cdot n_f}, \quad [m]$$

Here, the condition is; $\vartheta_{ar} -$ sediment mixing speed m/min; $n_f -$ number of revolutions of the cutter, ayl/min.

$$F_{yu} = (k_1 + k_2)\frac{z l_{kf} l_{sur}(1 + \mu^2)\sin \alpha_k \sin \gamma}{2} + m_{gr} g \cdot \mu, \quad [N]$$

Here, the condition is; k_1 - relative shear resistance of hard soil, N/m^2, (16000...20000 N/m^2); k_2 - relative shear resistance of loosened soil, N/m^2, (3000 N/m^2); μ - friction coefficient, (μ = 0,7); $\alpha_k -$ angle of inclination of the blade relative to the cutter axis, degrees; γ- shear angle, degrees; $m_{gr} -$ mass of the soil, kg.

The power required for loosening the soil is determined using the following formula:

$$N_{yu} = \frac{3F_{yu} D_f n_f}{1000 \cdot 60 \cdot \eta_f}, \quad [kVt]$$

Here, the condition is; $D_f -$ diameter of the cutter, m; $n_f -$ number of revolutions of the cutter, ayl/min; $\eta_f -$ cutter's specific energy consumption., ($\eta_f = 0{,}75 \ldots.0{,}80$).

The power of the pump that sucks the mixture is determined using the following formula:

$$N_{nas} = \frac{\gamma_{ar} \cdot Q \cdot H}{\eta}, \quad [kVt]$$

Here, the condition is; $\gamma_{ar} -$ bulk density of the mixture, kN/m^3 $Q -$ flow rate of the water pump, m^3/s; $H -$ water head, m; $\eta -$ specific energy consumption of the pump, ($\eta = 0{,}50 \ldots 0{,}65$).

In general, to ensure that the operation of the dredger is perfect and efficient, it is essential to correctly calculate the above formulas and parameters. This approach ensures not only the proper functioning of the pump but also the successful removal of sediment.

References

1. Mathematical Model for Optimal Control of Dredger Movement in the Canal Supplying Water to the Amu Darya and a Pump Station. Муродов Н., PhD; Жовлиев У., PhD; Абдурахмонов У., PhD student at the Research Institute of Irrigation and Water Problems.
2.Cutter suction dredger construction and management. LIU SHOU JIN ZHU
Published by China Water Power Press, 1991.
3. Construction and Land Reclamation Machinery. S.T.VAFOYEV, N.K.DAULETOV.

Web of Agriculture: Journal of Agriculture and Biological Sciences
webofjournals.com/index.php/8