



Design and Manufacture of Machine for Removing Ceratophyllum Demersum and Other Plankton in Rivers

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Abstract

Ceratophyllum plant covers most waterways, including lined channels and trenches. This plant causes a loss in the amount of runoff, velocity of water in the channels, and reduces the drainage rates. This research aims to design and manufacture a machine to clean the water intake outlet for the filtering station of Karbala drinking water by removing plankton, Ceratophyllum plant and algae, and throw these impurities out by means of adding catchers to the machine. As a result of gathering of these floating plants during runoff, it around water surrounding channels intake that were went to suction pumps, so that the channels are blocked. That is why, the workers would be frequently getting down to the river for cleaning after shutdown of the pumps. After studying the topic and coming up with an idea, according to which the design and technology drawings of the machine and determining the location where the device will be tested after implementation at different speeds (30, 60, and 100 m/min.). Three types of catchers (holders) of Ceratophyllum Plant and other Plankton were used. It was obtained that the cross-sectional area of the flow of the machine is greater than that of the suction pipe of the water purification station. The best linear speed for this machine was 30 m/min, which removes impurities by 2.2m³.

1. Introduction

Water is one of the basic substances of life and its availability is essential for life on earth [1-3]. Ceratophyllum demersum which locally (Iraq) called Shinblan, is distributed in large areas in Europe, Asia, and North Africa [4, 5]. Ceratophyllum plant is a plant of the submerged aquatic weeds group, a dark green plant ranging from (20-100 cm) tall with forked leaves between 1cm and 2.5 cm long [6, 7]. They gather intensely at the end of the plant's branches to give it a tail-like appearance, which is a long-lived plant with many, newly formed side branches. It is adapted to aquatic environment and it has no roots, stomata and wood. [8]. It can cause problems for waterways and blockages at hydroelectric power stations [9]. It can spread rapidly and grow in a large range of aquatic habitats. In Iraq, Ceratophyllum demersum is commonly available and grows in rivers, lakes, marshlands, and manmade ponds [9]. Its flowers start blooming at the beginning of spring [10]. In a previous study [11]. The mechanical method applied to remove the Ceratophyllum plant from the water in three ways: labor, hydraulic excavator, and wire with weight. The financial cost per kilometer for each type was calculated. Three models of Babylon Province Rivers, such as Al Kifl, Babylon and Nile rivers, were taken as a model for this study. When

comparing the three methods, the removal of Ceratophyllum plant in wire with weight manner is the best, the cheapest, the fastest and the most suitable for irrigation work in Babylon province. A series of experiments were conducted in the laboratory of the College of Agriculture at the University of Kufa to reveal the effects of chemical, physical and biological control methods on the growth of the Ceratophyllum plant. The results showed that chemical treatments have a significant impact on the growth of that plant. Although this plant is considered harmful to aquatic wealth, there are many studies showing the extent of its utilization [12]. Applying a phytoremediation system to treat sewage with local alternatives and using it on the agricultural side. The plant treatment system was used to observe the efficiency of the Ceratophyllum plant in reducing the values of floated pollution indicators and improving water quality. In [13], they studied the usage of the barbine plant with the Ceratophyllum plant to identify some trace elements in the water of the Nile River where a change was found in the rate of concentrations of these elements based on human and industrial influences at the study sites. C. Demersum L. was used in [14] to enhance the quality of wastewater collected from the secondary sedimentation tank of Hamdan sewage water treatment plant, Basrah, Iraq, using phytoremediation in the laboratory experiment. In this study, a specialized machine was designed and manufactured to lift Ceratophyllum plant and other waste from rivers water, or creeks, which is floating and run with water towards this machine, so it works to raise it outward, and thus ensuring that the water entry gates are cleaned to the water treatment plant and not being clogged with these impurities to ensure continuous operating of the pumps.

2. Experimental Procedure

Design drawings and technological documents have been prepared for the manufacturing of the mechanical removal machine of the floated Pollutants and the Ceratophyllum plant in the rivers. The machine is made from a steel structure frame and stainless-steel conveyor belt, installed on gears, rollers, and bearings, which are installed on the steel structure and driven by an electric motor.

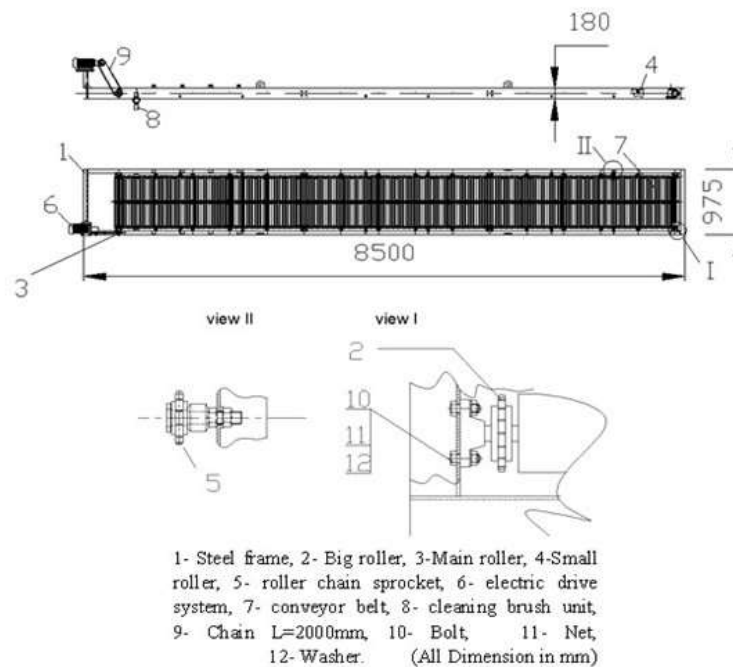


Figure (1). Illustrate Shinblan removal machine.

Materials involved in the manufacture of parts and accessories have been selected in proportion to the nature of the water-diving system where they are resistant to rust, salts, and other water-diving conditions. Consideration has been given to the maintenance of the device in the event of a malfunction, consisting of a set of parts that are easily disassembled and very easy to maintain.

Electric Drive System

Specifications of the electric motor are: (3 Phase Y, Δ , 50 Hz, 6.4 Amper, 1.5 Kilowatt, 1430 Rev./ min.). It was selected according to the standard specifications of electric motors to carry the extracted impurities with a load of 1 ton on the conveyor belt out of the river. Gearbox with a speed regulator was attached with electric motor to control the linear movement of the conveyor belt. In this work, weeds and floated pollutants and plankton are moved out the water pond by using three speeds (30,60, and 100) m/min. Controlling the speed of this device from (30-100) m/min has been conducted by using speed regulator (AC DRIVE).

Catchers of Ceratophyllum Plant and Other Plankton

Three types of catchers (holders) of Ceratophyllum Plant and other Plankton were used strips (820x10x3mm), notched-perforated plate (735x80x3mm,diameter 30mm) and, notched plate (735x30x3mm) to show which one is the best in removing these weeds and other pollutants out of the streamed river. Figure (2) shows catchers used in this work.

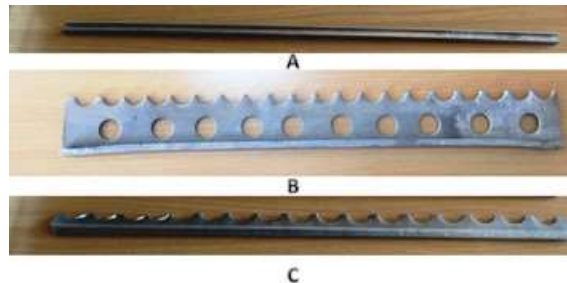


Figure (2). Three types of catchers. A: strips, B: notched-perforated plate, C: notched plate.

Machine Operation

The experimental operation of the machine was performed after assembly within the workshop and without loading, where the principle of action was confirmed for the movement of rotational parts of the conveyor belt and the sprocket, rolls, coupling wheels, electric motor and gear box. An experiment was conducted inside an aquarium containing plants and aquatic plankton similar to Ceratophyllum plant, where the experiment was carried out using three speeds and three catcher's types of impurity- holding equipment. The machine was moved to an experimental site at the entrance to a water treatment plant (Al-Hussein water station) in Karbala governorate., as shown in Figure (3).

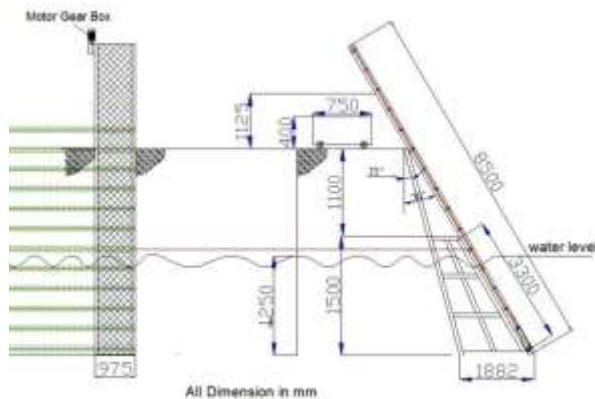


Figure (3). Shows an installation of the device at the entrance of a filter station.

3. Results and Discussion

In view of the high percentage of plant and floating pollutants in the main and secondary rivers and the intakes of electric power stations and drinking water filter station, it was necessary to develop an idea to manufacture a machine to get rid of these pollutants and mitigate their effects in river waters. The test results of this machine demonstrate that used of the notched plate as holders for plankton and impurities is better than the rest of the other types due to removing a large amount of these impurities as elucidated in table1. The operation of the device at 30 m/min is very suitable with the amount of Ceratophyllum plant and plankton carried on the conveyor belt of the

device, compared to the other speeds 60, 100 m/min as in figure 4. Because of coefficient of friction decreases with the increase of speed [15], adhesion of impurities to the conveyor belt decreases as speed increases. where the higher the speed the lower the amount of Ceratophyllum plant extracted from the river. The amount of impurities extracted from this machine is 2.2m³ (loading capacity), this agree with [16].

Table (1). The relationship of the device's speed with the type of catcher.

Catcher type	Notched plate			Notched-perforated plate			Stripes		
	30	60	100	30	60	100	30	60	100
Device Speed (m/min)	30	60	100	30	60	100	30	60	100
Collected Impurities (m ³)	2.2	1.7	1.4	2	1.6	1.3	1.6	1.4	1

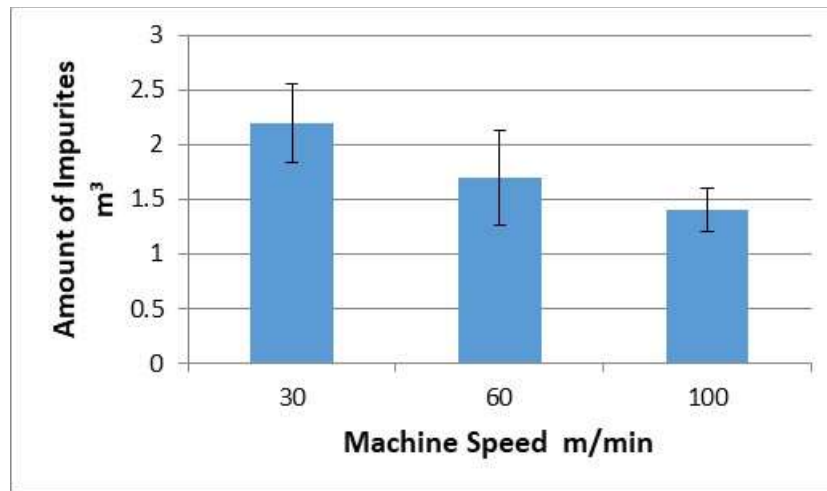


Figure (4). The relationship between device speed and volume of removed impurities for notched plate.

After studying and reviewing the work of the Karbala governorate filtering station, the required discharge through the entrances to the station is 8000 m³ / hour. In the breeding season of the Ceratophyllum plant, the rate of flow or discharge decreases to less than half of this amount, in addition to stopping the suction pumps due to the entry of these plants into the water intake holes leading to the pumps.

- ❖ The diameter of the intake pipe for each inlet = 90 cm
- ❖ The number of entrances to the station = 4
- ❖ Area of flow cross-section = (radius)² × constant ratio = 0.4502 × 3.14 = 0.636 m²
- ❖ Total cross-sectional area of four entrances = 0.636 × 4 = 2.544 m²
- ❖ The area of flow section of the manufactured machine = The cross-section area of the conveyor belt that removed impurities × Number of conveyor belt sections = (0.756 × 0.05) × 32 = 0.0378 × 32 = 1.2 m²

It is clear that the area of the flow section of the manufactured machine is greater than the area of the flow section of the single pipe of the filter station, and accordingly, the manufactured machine meets the required discharge for the station, by putting one machine at each entrance.

The machine was tested for a period of about a month and for continuous working hours throughout the day and night also in bad weather conditions. The movable and electrical parts, such as the gearbox, the electric motor and the electrical control devices, were not affected throughout the continuous operation, nor were the metal parts with coated surfaces affected by water throughout the experiment.

4. Conclusions

The machine succeeded in cleaning river water from the shinblan plant, floating plastic bottles, and all kinds of textile, metal waste, algae, reed sticks and other unknown plants, in addition to removing the carcasses of dead animals. It was found during the experiment that the device is easy to install, operate, and maintenance and meets the safety and security requirement. The device was not negatively affected by the high speed of the water current and was not affected by the low and high water level in the river. This machine is successful to work in drinking water purification and filtering plants and for all lined and unlined river sites, also the device used succeeded in ensuring the flow of water quantities required to ensure the work of the station, amounting to 8000 m³ / hour.

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