FABRICATION OF PEDAL OPERATED LAKE GARBAGE COLLECTOR

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ABSTRACT

Municipal and industrial garbage dumped into water bodies pollutes them and reduces waterfront property values, and inhibits waterfront activities. Existing methods of garbage removal are expensive. This article describes an inexpensive lake garbage collector designed to clean lake water. An efficient pedal-operated garbage collector (POLGC) was fabricated with a conveyor attachment in the front to collect floating waste. Accessories used include dredging rakes, water filters, sludge handling chains, weed rippers, weed catchers, etc. It was found that POLGC collects an average of 85 kg garbage per day. 46% increase in the garbage collection was observed with POLGC when compared with weed rake at Pushkar ghat.

KEYWORDS: Pedal Operated garbage Collector, Conveyor, Lake Pollution, Rake

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1. INTRODUCTION

Municipal solid waste is being dumped into water bodies. As the inhabitants grow, the size of the municipalities and townships also grows. This increases the quantity of household waste which is indiscriminately thrown into waterways [1]. As waste is dumped into rivers and lakes, water becomes contaminated and generates foul odour [2]. This contaminated water affects human life if it is used for drinking, degrades the water quality, reduces recreation and aesthetics sense of water bodies [3]. Consumers suffer from epidermal, gastrointestinal, neurological and heart diseases. The garbage thrown in the water obstructs the natural flow.

The Indian government has taken a number of measures to clean rivers and spent enormous funds in many river cleaning projects like “Namami Gange” and many major projects in different cities like Ahmadabad, Varanasi, etc. Manual removal of lake garbage involves a threat to worker safety (Figure 1a). Sometimes workers collect the trash sitting in boats using rakes (Figure 1b). Active and passive skimmers are used for Macrophyte fragment collection [4]. Tahoe Keys Property Owners Association, South Lake Tahoe, California evaluated active and passive skimmers for Macrophyte Fragment Collection. These machines were originally designed for trash and debris collection. Several companies offer equipment to remove trash from canals and lakes [5-9]. They will pick up floating trash. Some use special equipment like skimmers for garbage collection. This is certainly a worthy technique for pond cleaning. Some companies have built larger garbage trucks for the sea and the ocean. In this vessel, the operator collects the wastes floating in the pond and in turn loads them in a tray located on the deck. With the help of a conveyor, garbage can be collected (Figure 2).

Figure1: Traditional Weed Removal Processes

The Buddy Catamaran is a garbage recovery and river upkeep boat for docks, harbours and canals. The Water Witch work boat can be compared to a floating excavator and has a robust front loader that can handle up to one ton and stretch 3.65 m below the waterline. Available accessories include dredging buckets, hooks, brush cutters, access platforms, cranes, etc.

For cleaning fresh or salt water bodies, different marina cleaners are available and have a vertical arm which discharges waste to the front collection conveyor. Cross cleats are incorporated in the chain conveyor to avoid roll back. Medium and small objects are easily collected.

Figure 2: Mechanized Weed Removal Methods

Ponds or lakes have catamaran boats that tourists pedal quietly in the pool. These are not very useful for cleaning. Regular paddle boats can run with pedal power. They are useful in places where diesel engines or electric motors are not permitted due to pollution or noise. The power of the pedal is noiseless. In addition, it is also very well-regulated at low speeds. By stopping pedalling action, the user can halt the garbage collector quickly. In addition, the worker can carry a good distance by pedalling, while still using his hands for other functions. Kannan et al. proposed the use of Radio Frequency (RF) controlled garbage collector [10].

Mark Knapp invented a cycling boat which has a flexible shaft to run a propeller. With a flexible shaft, the operator seat can be located further down in the container, which increases steadiness. Small and energy efficient devices

are not available in the market to collect garbage from canals and lakes [1]. Large garbage collectors, which are commercially available in Western countries, are often not suitable for small shallow ponds and canals. The escalation of labour costs is making the maintenance of the pond profitless. Most of the maintenance staff find work on selected days in a year. The development of an improvised garbage collector will allow them to dispose of garbage and other wastes in the early stages and transport them to the land. Maintenance staff can do this job on their own and save labour charges. These garbage collectors help to transform waterways in an ecological manner. The main intention of this work is to develop an economical garbage collector which cleans the lakes and reduces the environmental pollution.

2. FABRICATION AND TESTING

2.1. Fabrication of Garbage Collector

The garbage collector is a pontoon-mounted pedal operated system. Figures 3 & 4 show CAD and fabricated models. It floats on water and can be run 24/7 with little effort. Some hand tools were ergonomically designed and manufactured to help the operator manually to collect trash.

Pontoon: A pontoon was made with PVC drums. It is the watertight body of garbage collector. Superstructure or deck is mounted on the pontoon. The garbage collector chassis was made of pipe (size: Ø25 mm, thickness: 2 mm). Waterline is the level where the pontoon meets the water surface.

Conveyor: A chain conveyor was placed at the front of the garbage collector. A light chain conveyor made of several links was designed. The links were made of stainless steel. System was designed to tilt the conveyor up or down. The conveyor points down while picking up the trash and points up while unloading the trash onto the bank.

Propeller: The propeller fixed at the bottom of the pontoon works by pedalling action. The propeller transfers power by converting the rotary movement into thrust. The propeller pushes the water backwards. This push back will be balanced by an opposite force that acts forward and in turn runs the garbage collector [11].

Rudder: A rudder was placed at the rear to direct the garbage collector. The rudder is operated by the handle through mechanical cables. The rudder of the garbage collector is placed outboard. The external rudder is accommodated in the space between the barrels to make it more resistant to damage. The detachable rudder in the garbage collector provides faster handling feature.

Seat: An adjustable seat was provided over the propeller. The operator can pedal the propeller, and drive the garbage collector while sitting comfortably in the ergonomically designed seat.

Deck: The deck is esthetically designed to give a decent look and safe feeling.

Pedals: The garbage collector is pedaled by the operator. The cycling movement is transmitted to the conveyor through a chain mechanism. Conventional cycle pedals were used.

Casing: The casing acts as a protective cover for the propeller located at the rear end of the garbage collector. It prevents water from splashing towards the operator in the garbage collector. The casing is necessary to ensure a dry environment on board. A good casing also increases the lifespan of the garbage collector. In this model, the housing has a length of 125 cm and a curve with a radius of 50 cm.

2. 2. Working

The garbage collector uses a pedalling mechanism. Chain transmission is used to transmit power to the propeller and

conveyor. A chain joins the large sprocket wheel, fixed on the axis of the pedal and the small sprocket wheel on the conveyor system. A spur gear train is used for the backward movement of the conveyor belt to collect the garbage. A reverse gear is used to run the conveyor in the forward direction during the discharge of garbage onto the bank. The second chain links the other large sprocket wheel to the small sprocket wheel attached to the propeller shaft for forward travel of the garbage collector. To steer the garbage collector, a rudder connected to the handle is used.

When the garbage collector moves forward, the conveyor runs backwards and collects the floating debris ahead of it. When the tray is filled, the operator can raise the conveyor and move the garbage collector to the bank, and unload all the waste collected. In this way, floating garbage present in canals or ponds can be collected and removed without using any type of fuel.

Figure 3: Pedal Operated Garbage Collector

2.3. Testing

Some people pollute the water bodies by offering flowers, leaves, coconuts, etc. and tourists throw wastage and plastic pet

bottles in to the lakes [12]. The garbage collector was tested in the Krishna river, Vijayawada in four places over the course of two days at each location for studying its effectiveness. The study was conducted in four locations viz., Punnami ghat, Pushakar ghat, Kankadurga ghat and the Prakasam barrage. The weight of gabage collected was weighed on hourly basis. The results are shown in Table 1 and plotted in Figure 5.

Figure 4: Fabricated Garbage Collector

3. RESULTS AND DISCUSSIONS

The following points were observed from the Table 1. Weight of garbage collected at Prakasham barrage is reducing from 9AM to 1 PM and an increasing trend is observed from 2PM to 6 PM. The major portion of garbage was plant fragments. The average garbage collected with pedal operated lake garbage collector (POLGC) is 10 kg/hr, a minimum of 7.75 kg/hr and a maximum of 12.25 kg/hr at Prakasham barrage. Whereas a weed rake garbage collector collects an average of 7.8 kg/hr, a minimum of 6 kg/hr and maximum of 9.5 kg/hr at the same place i.e., Prakasham barrage. Nearly 14% increase in the garbage collection is noticed with use of POLGC. POLGC collects an average of 10.25 kg/hr garbage, a minimum of 8 kg/hr and a maximum of 12 kg/hr at Punnami ghat. But weed rake collects an average of 7.55 kg/hr, minimum of 6.25 kg/hr and maximum of 9 kg/hr of garbage at the same place. Nearly 33% increase in the garbage collection is noticed with use of POLGC. During 10-12 PM maximum collection is observed with POLGC. Almost same rate of garbage is collected with weed rake. The majority of garbage was plastic waste disposed by tourists. At Pushkar ghat maximum of 16 kg of garbage was collected with POLGC and 14 kg with weed rake during 11-12 AM. The average garbage collected with pedal operated lake garbage collector is 10.5 kg/hr, a minimum of 7.5 kg/hr and a maximum of 15 kg/hr at Pushkar ghat. It is due to more number of people visiting ghat and offering flowers, coconuts, etc., more garbage was noticed at that place. Whereas a weed rake garbage collector collects an average of 8.25 kg/hr, a minimum of 6 kg/hr and maximum of 10.25 kg/hr at the same place i.e., Puahkar ghat. Nearly 46% increase in the garbage collection is noticed with use of POLGC. The same trend i.e., initially increasing and finally decreasing, observed at the Prakasham barrage with POLGC in rate of garbage collection is noticed at Durga ghat also. The average garbage collected with pedal operated lake garbage collector is 11 kg/hr, a minimum of 8 kg/hr and a maximum of 13.5 kg/hr at Durga ghat. Whereas a weed rake garbage collector collects an average of 8.6 kg/hr, a minimum of 6.5 kg/hr and maximum of 12 kg/hr at the same place i.e., Durga ghat. Nearly 12% increase in the garbage collection is noticed with use of POLGC.

Garbage collector was able to successfully collect garbage that freely floats in lakes. But removal of thick mats of garbage was found to be a difficult task. Omofunmi *et al.* incorporated a mower and pickup reel in their water hyacinth harvester to facilitate forced loading of garbage on to loading conveyor [3]. A study was conducted to evaluate the effectiveness of the garbage cleaner on the Krishna River. It was considered to be successful due to the amount of waste collected, as well as the observable improvement in water quality.

The manual garbage collector is suitable for both small ponds and irrigation canals in underdeveloped and developing countries for mechanical cleaning of lake litter. The owners of the lakeside houses and the waterway maintenance operators will be the potential users. Low initial cost, lightness, ease of operation, operator safety, compactness, manoeuvrability, greater payload and balance, ease of launch, stability, robustness and durability, trouble-free operation (prevents debris from sticking between the parts of the conveyor) are the significant features of this garbage collector.

The strategic location of these garbage collectors could greatly improve the collection of debris in highly polluted areas. It has also been observed that the garbage collector oxygenates the water column through the agitation action created due to the propeller-driven aeration which helps the water living inhabitants or aquatic species. The oil filter, an optional addition to the garbage collector, could filter oil residues, floating debris and algae from the surface of the water column. In shrimp intensive ponds, the black sludge accumulated at the bottom of the pond leads to reductive conditions and negative redox values. The chains attached at the rear of the garbage collector (Figure 6) are dragged along the pond for sludge handling [13].

Table 1: Details of garbage collected during the experiment

Location	Instrument	Day	9-10 AM	10-11 AM	11-12 AM	12-1 PM	2-3 PM	3-4 PM	4-5 PM	5-6 PM	Avg	Min	Max
Prakasham Bararage	POLG Collector	Day 1	12.5	11.0	10.5	10.0	7.5	8.5	9.0	10.0	9.9	7.5	12.5
		Day 2	12.0	10.0	9.5	10.0	8.0	8.5	9.5	10.5	9.8	8	12.0
	Weed Rake	Day 1	9.0	8.5	7.5	8.5	6.0	7.0	8.0	7.5	7.8	6	9.0
		Day 2	9.0	8.5	7.0	7.5	6.0	7.0	8.0	10.0	7.9	6	10.0
Punnami Ghat	POLG Collector	Day 1	11.0	12.0	12.0	10.0	11.0	8.0	9.0	11.0	10.5	8	12.0
		Day 2	10.0	10.5	9.5	11.0	12.0	9.0	8.0	10.0	10.0	8	12.0
	Weed Rake	Day 1	8.0	7.0	8.0	9.0	6.5	7.0	8.5	7.5	7.7	6.5	9.0
		Day 2	6.0	8.0	9.0	6.0	7.0	9.0	6.0	8.0	7.4	6	9.0
Pushkar Ghat	POLG Collector	Day 1	12.0	12.0	16.0	10.0	8.0	7.0	9.0	10.0	10.5	7	16.0
		Day 2	13.0	12.0	14.0	10.0	8.0	8.0	9.0	10.	10.5	8	14.0
	Weed Rake	Day 1	9.5	7.0	7.5	9.0	8.0	6.0	8.5	7.5	7.9	6	9.5
		Day 2	11.0	10.0	11.0	9.0	8.0	7.5	6.0	6.5	8.6	6	11.0
Durga Ghat	POLG Collector	Day 1	14.0	13.0	12.0	12.0	10.0	8.0	9.0	9.0	10.9	8	14.0
		Day 2	13.0	12.0	13.0	10.0	12.0	8.0	9.0	11.0	11.0	8	13.0
	Weed Rake	Day 1	13.0	7.0	7.8	8.5	6.5	6.0	9.0	7.5	8.2	6	13.0
		Day 2	10.0	10.5	11.0	9.0	8.0	7.0	7.5	9.0	9.0	7	11.0

POLG Collector: Pedal Operated Lake Garbage Collector

Leo designed and tested control rakes (Figure 7) that were dragged along the bottom of a pond and then twisted to

scoop up the plant [14]. The garbage collection efficiency can be increased further by attaching two flaps in front of the conveyor (Figure 8). Transport of this unit, as well as its installation and removal from a pond, is easy, due to its smaller size. Unloading the garbage is also a simple process. In addition, smaller size and smaller storage capacity require frequent unloading (as they fill up). While the garbage collector has a relatively simple design, its larger size and cylindrical barrels could affect its use in shallow water and ponds with ramp bunds. Multiple garbage collection systems would be required to successfully collect garbage from an area, where there is a high distribution of docks that affect water flow.

This garbage collector can be useful in places where electric or IC engines are banned or where such types of propulsion are too noisy. Due to non-usage of fuel, the operating cost of this device is less and there are no harmful exhaust emissions and it is useful for maintaining the environment cleaner [15]. Pedal power is noiseless. In addition, it is also highly manoeuvrable at low speeds. Maintenance of the garbage collector is required daily or every other day. The chains must be greased and the garbage collected must be disposed off. It is necessary to remove the garbage collector before summer to avoid damage to the unit.

Figure 5: Garbage Collected in Different Locations (kg)

Figure 6: Sludge Chains

Figure 7: Weed Rake

Figure 8: Two Flaps Attached in Front of the Collector Help converging the Garbage on to the Conveyor

4. CONCLUSIONS

Lake garbage collector is a successful initiative due to the amount of debris collected as well as the observable improvement in water quality. It can be designed for any water body with a relatively quiet environment (including marinas, yacht clubs and harbours) where waves or water movement will not affect the way of collecting debris. Collection of garbage floating in the canals itself will prevent its passage in to the lake. Finally, improving the collection and control of garbage within waterways will help to restore aesthetic and recreational values. Waste such as polyethylene, food material and waste that occurs during religious ceremonies can be collected. The fabricated POLGC shows better performance than the weed rake at all the four places i.e., Prakasham barrage, Punnami ghat, Pushkar ghat and Durga ghat. The POLGC collected, maximum of 16 kg/hr of garbage at Pushkar ghat. Nearly 33 and 46% increase in the garbage collection was noticed at Punnami ghat and Pushkar ghat with use of POLGC. Garbage collection using POLGC is safer and faster procedure compared with weed rake collection method.

FUTURE SCOPE

The lake garbage collector can be mechanized (both the propulsion system and the garbage conveyor) through the use of power drives. The makeshift pontoon made with recycled plastic drums can be replaced by a pontoon hull with a modern flush deck design. A trailer can be designed to facilitate the transfer of the garbage collector from one place to another. A solar panel can be used to provide power to the garbage collector instead of the pedal operation.

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