

A design of a multistage recycling device for Marine plastic waste

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Abstract. Based on the research of Marine plastic garbage recovery method, the discussion of the recovery device and the understanding of the types of ships, this paper designs a multi-stage recovery device for Marine plastic garbage. This device according to the types of the existing Marine plastic garbage and recycling requirements, effective implementation for big (more than 50 cm diameter or width), medium (diameter and width are between 5 mm ~ 50 cm) and micro (diameter or width under 5 mm) type size grade plastic debris automatic classification recycling, determined the primary barb type crawler collection device, second level network intercept type garbage collection device and the third level based on the sponge and activated carbon micro plastic collection device. Recycling and storage of Marine plastic waste to effectively address Marine plastic pollution is consistent with the MARPOL convention on the protection of the Marine environment.

1 Introduction

PM2.5 in the ocean is "tiny" but changing the world! According to the study, 4.8 million to 12.7 million tons of plastic waste entered the ocean in 2010 alone due to poor management, and on current trends, if the waste management infrastructure is not improved, the cumulative amount of plastic waste entering the ocean is expected to increase by an order of magnitude by 2025. In 2014, 2016 and 2017, the United Nations environment programme (unep) paid special attention to the pollution of floating plastic wastes in the ocean at the UN environment conference. So how to recycle and dispose of Marine plastic waste efficiently has become an urgent problem. The society urgently needs an effective Marine garbage sorting and recycling platform and Marine garbage recycling devices including microplastics to solve the serious problem of Marine garbage pollution^[1].

At present, the Korean institute of oceanography has developed a new type of garbage salvage vessel that relies on "multi-joint" grasping spades, the "ocean garbage can" developed by the United States, and the floating salvage vessel developed by the Shanghai municipal waste disposal company^[2]. Although there is a certain research foundation for the salvage of surface garbage, it is not able to do the classification of garbage recovery and removal of microplastics in the ocean; Although it can clear away the small micro garbage. The multi-stage recycling device we designed for Marine plastic waste has the following advantages :

(1) A three-stage garbage recycling device is designed, which can effectively realize the classification and recycling of large, medium and micro plastic waste step by step.

(2) The collection efficiency is high and the collection range is wide.

(3) The device is small in size and easy to install. It can collect micro-plastic particles to reduce pollution to Marine ecology.

(4) The third-level microplastic collection part of the device is mainly realized by the multi-functional board, in which the natural fiber net is mainly responsible for the collection of microplastic, to avoid the fish swallowed and into the biological chain to endanger human safety.

2 Overall structure design and working principle of the system

2.1. System architecture

The multi-stage recovery device for Marine plastic waste consists of three stages: the first stage of barb crawler collection device, the second stage of net interception garbage collection device and the third stage of microplastic collection device based on sponge and activated carbon. Its overall structure diagram is shown in figure 1.

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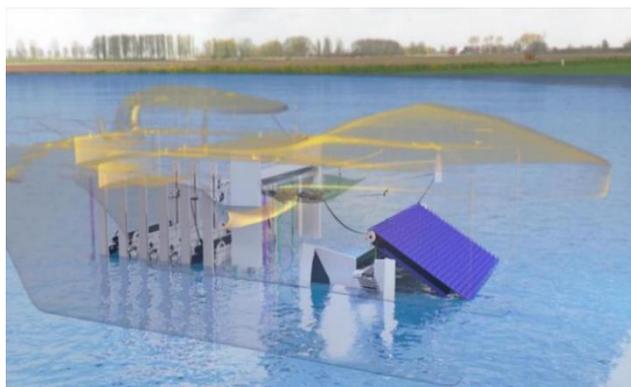


Figure 1. Schematic diagram of the whole structure of the recovery ship

2.2. Operating principle of the system

This design can collect more plastic floating garbage, and in the collection of large and medium-sized Marine garbage, but also for the small, micro plastic particles recycling this problem proposed a solution. Firstly, the small and medium-sized plastic garbage is collected and sent to the deck by conveyor belt through the barb-type crawler collection device distributed in front of the ship, and the plastic particles adsorbed on the larger garbage and Marine life are removed by the water flow. For the large garbage and plastic particles that cannot be collected in the first stage, they are collected by the second stage net interception collection device. Finally, it provides an excellent environment for the third stage micro-plastic collection device^[3].

3 Study on parameter calculation and selection of garbage classification and recovery device

3.1 First stage barbed crawler recovery device

The barb crawler collecting device is located at the front of the three-stage collecting device, and it is the first-stage recovery device, which is composed of a transmission crawler, a transmission roller and a barb. The main needle in the floating near the sea surface of plastic bottles, plastic bags and other medium-sized garbage collection.

The conveyor belt of this class device is 4m long and 2m wide. The transmission segment of the lower end of the device and about 0.2m above is below the sea level, and the whole is at a 30° Angle with the sea level. A conveyor belt with barbs passes through an opening in the deck so that rubbish can be carried to the deck. Transmission crawler set on sloping direction and in the same direction of barb, among them, the barb of specific size is: 0.1 m high, the horizontal spacing of 0.15 m, 0.2 m longitudinal spacing, with an odd number of rows barb and adjacent odd barb in the longitudinal are arranged corresponding format, even row barb and one-to-one correspondence to the adjacent even barb longitudinal distribution of the adjacent two even row barb and one odd row barb can form an isosceles triangle,

the odd rows barb and even barbed insert slot and cross design. Through the design of the barb, the cylindrical medium plastic bottle has a good anti-roll and fixation effect, which can effectively prevent the cylindrical beverage bottle with a capacity of about 2.5L from rolling down.^[4] For soft plastics such as plastic bags, the barb can pierce them, so as to play a good role in fixation. When the plastic garbage rises to the top of the conveyor belt, it is fixed by the conveyor belt due to gravity and transported to the garbage tank on the ship for centralized collection. In addition, in order to avoid the situation that plastic waste cannot fall into the garbage collection box after being fixed, a row of garbage scraper with the same width as the conveyor belt is set directly below the conveyor belt. Barb crawler collection is shown in figure 2 and 3.

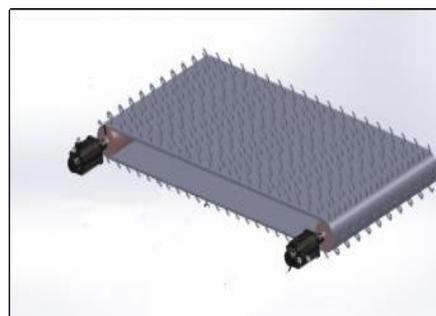


Figure 2. Barb crawler collection



Figure 3. Local enlargement

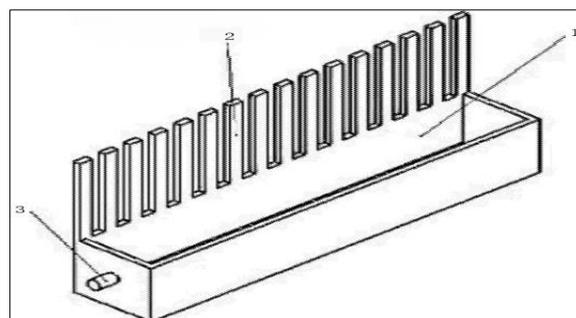


Figure 4. Barb crawler collection

Three identical devices should be connected to the device to prevent the accumulation of garbage when there is too much garbage in medium size and the garbage cannot be fully collected to the next collection device. In addition, when the garbage into the collection device at the corresponding level, large plastic because cannot be collected at the corresponding level device, the effect that can follow the flow of the sink and sink below the surface,

because of the catamaran is located in the hollow part of the hull is a good block on both sides, forming a collection of relatively closed environment, sank below the surface of the plastic particle in the large garbage and current basic not happen diffusion, through the corresponding device into the secondary recovery unit were collected for recycling.^[5] Barb crawler collection is shown in figure 4.

3.2 Two stage network interception recovery device

The net interceptor garbage collection device is located behind the barb crawler collection device, and it is the second stage recovery device, which is composed of the interceptor net, the bunching rope, the fixed rope and the mechanical sensor. Ultra high molecular weight polyethylene (UHMWPE) is a linear polyethylene without branched chain, and its average molecular weight is more than 1.5 million.

According to the relevant information, the sustainable development strategy of fisheries stipulated in the international convention on the ocean: "the mesh size of fishing nets shall not be less than 50*50mm", so the size of interception nets shall be set at 60*60 mm. On the other hand, this size maximizes the likelihood of intercepting large pieces of garbage, preparing for the later collection of small pieces of plastic. The interceptor net is erected and fixed on the ship. Two-thirds of the length of the interceptor net is below sea level, and this depth ensures that the lowest end of the net is below the first-stage conveyor belt to prevent garbage from escaping the interceptor net. The four corners are respectively fixed by four ropes on the rope reamer, which is connected to the Marine motor to realize the traction rope contraction interception net^[6]. Four Keyence high-precision mechanical sensors are installed on the top of the four ropes, which can collect the tension in real time.

The working process of this stage device is as follows: firstly, the interceptor will be thrown into the sea by the launching device, and the interceptor will be deployed by using the inertia of the ship to travel forward.

4 Automatic processing unit

Based on sponge and activated carbon, the small and micro particle multistage collection device is the third stage recovery device. The main body is composed of multi-functional rectangular plate, automatic processing device and corresponding automatic lifting device (guide rail, pulley, control system). The main collection is small and tiny plastic particles floating near the surface of the sea.

When the interception net reaches the set critical force, the mechanical sensor converts the mechanical signal into an electrical signal and sends a signal to the control device of the motor to make the motor work to drive the hoist. Then, raise the interception net by raising the rope end of the interception net to make the interception net quickly reach the horizontal state. Finally, the hoist continued to raise the lower end of the interception net and placed the garbage in the interception net in the cabin.^[7] When the

first interception net reaches the level, the integrated system will automatically release the second fishing net stored in the placement device, and restart the interception work to form a cycle.

5 Conclusion

This design is based on the current status of marine garbage in China, and a crusher specially designed to treat marine garbage. During the design process, through the analysis of the characteristics of the ship's garbage, we conducted a preliminary design. Firstly we determine the overall plan, analyze its advantages, determine the main components, and perform various checks on it. According to the structural characteristics of the ship's garbage, determine the conveying mechanism, select the conveyor belt, motor model, calculate the tension, strength and sag of the conveyor belt, and perform a check to select the speed and width of the conveyor belt. Second, we designed the auxiliary mechanism, determined the main parameters of the belt drive, choosed gears, designed the feeding mechanism, and choosed the frame so that the machine can run normally and smoothly, and reduce costs as much as possible. Then we carried out the design of the crushing mechanism, carefully selected the cutter, and did a simple analysis. In the end, we made a lot of calculations and made a brief introduction to the entire machine, and completed the design.

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