

Design and Application of Bubble Barrier to Prevent the Pollutant in Water Bodies

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Abstract— Around the world the awareness is growing for the increasing of the plastic waste in our ocean and it is highly dangerous for our ecosystem and for the health of our own. The total majority of the plastic in the ocean i.e., (80%-90%) of waste comes from the Land, via rivers and canals. The plastic waste is thrown into the water and transported directly straight to sea without any barrier to stop it from mixing in sea. Currently barrier system that are available usually not only block the plastic but also, they block ships and aquatic life, therefore they are not so good to fix the waste problem. In Amsterdam, Netherland group of engineers found the solution to not only stop the waste but also oxygenate the water and without having the ship traffic to occur, this project is called “The Great Bubble Barrier”. It uses a bubble barrier: a bubble made barrier of compress air. The bubble acts as barrier and stop the waste to flow through it before reaching into the oceans. The bubble produce does not harm any marine life it is easy to go through it for them and also the ship traffic due to bubble barrier is none. Due to air bubble it’s also reduce the CO₂ contain in the water which makes the ecosystem and aquatic life was water bodies great. It also recovers a valuable resource and brings it back into the plastic value chain, reducing the need for virgin plastic materials in the future.

Keywords: Bubble Barriers, Pollutant, Aquatic Life, Plastic

I. INTRODUCTION

Water is a basic necessity of humans and for all living beings. There is a plenty of water on earth but that is not suitable for human use. Clean water is more important and is used for some purpose [1]. The impurities present in water can cause hazardous diseases for all form of life. The Bubble Barrier are used to clean wastes from water like polythene, bottles etc. present in water. This can be used to overcome the problem of filtration of wastes from water and it save the time and cost that spend on cleaning the drainage. As the industry setup increase in the environment the water coming from industries are full of wastes like polythene, bottles, and other materials and that water mix with the other water that are used by people and we know that that water is not good for the health of living being and marine life. So, to overcome from these problems we can use bubble barrier it blocks the water waste and collect it at side of water bodies and also it improves the water oxygen level by oxygenating it [3]. In this project we use DC or AC motor to run the system when power supply is available& the Equipment, we used to be motor, socket gear pipes and etc. we block plastics from moving forward and make clever use of the current of the river to direct the waste to the banks. We create a bubble barrier by pumping air through a pipes or tubes with holes, placed on the bottom of the river at certain angle. We found an elegant solution that blocks waste in the river, but also allows the

passage of fish to go through a barrier of bubbles. By placing two bubble barriers diagonally in the waterway. The upward current that the bubbles generate brings the waste to the surface, and the turbulence stops the waste from flowing downstream. The waste gathers on the side of the river, where it can easily be collected by catchment system for example a conveyor belt, garbage separation system and etc [4]. The Bubble Barrier is a simple solution that blocks waste in the river, but also allows the passage of fish and ships. The fish slalom allows fish to pass the barrier unobstructed. The system also brings aeration to the water, increasing oxygen levels and improving the health of the ecosystem. With these features, the Bubble Barrier meets all the important conditions: it doesn't hinder ship traffic, fish movement or the natural workings of a waterway. The Bubble Barrier offers a solution for different problem owners: it can help governments meet changing regulation on waste management in waterways, but also help cities fight plastic problems in their waters, and help waterboards to save on their cleanups after high water [6].

II. DESIGN OF BUBBLE BARRIER

The Bubble Barrier comprises of the three main components i.e.: the bubble curtain, the compressor, and the catchment system. The three components are designed to work together to create an optimal solution at each location as shown in (Fig 1) [6]. The components outlined:

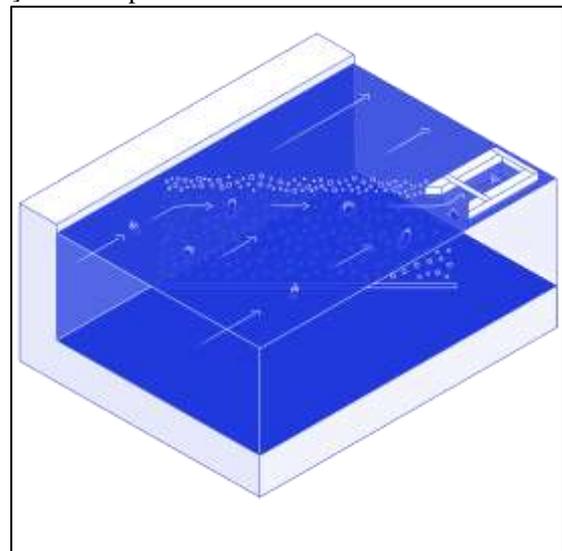


Fig. 1: Concept of Bubble Barrier

A. Bubble Curtain

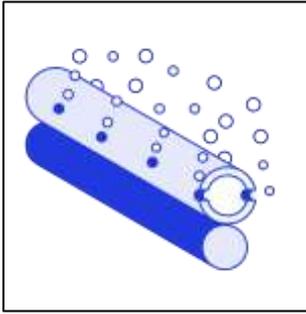


Fig. 2: Bubble Curtain through Pipe

The angle of water bodies and required airflow of our bubble curtain are designed according to the location's flow dynamics. The Bubble Tubing is made out of flexible 100% PVC as it has variety of sizes as per required and is optimally suited to be applied in a wide range of locations. The experimental air bubble barrier simulation system consisted of a horizontal manifold taxed at the bottom of the wave flume, connected to a compressor supplying air, and an airflow regulator with a flow gauge to control the air discharge rate. The manifold was made of a cylindrical stainless-steel pipe 0.5915 m long. Both ends of the pipe were sealed, and 30 perforations were made along the top. The perforations were 1.5 mm in diameter, and spaced at 20 mm center-to-center intervals. The manifold was installed across the channel 32 mm above the bottom, forming an air bubble barrier [6].

Air Supply

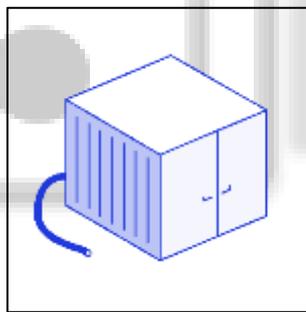


Fig. 3: Air Supply by Compressor

The bubble curtain is produced by using compressed ambient air. We use electric compressors that are tailored to the bubble curtain's requirements, continuous operation, and location-specific characteristics. For Ex. Bogey air compressor supplied air to the manifold through a 16 mm valve which was installed on the base plate of the wave flume. The compressor had a storage tank of 50 l capacities and was powered by a 1 HP motor. The motor was automatically switched on and oil by a pressure control switch which enabled the pressure inside the storage tank to be maintained between 4 to 10 bars [6].

B. Catchment System

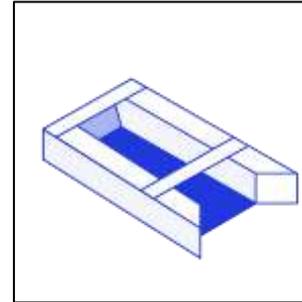


Fig. 4: Catchment System

The bubble curtain will be matched with the best suitable catchment system. We can developed our own catchment system which can be adapted to the location's infrastructure, such as to accommodate the method of emptying by local authorities [6].

III. BUBBLE BARRIER WORKING PRINCIPLE

The bubble barrier is created by pumping air through a tube with holes which is placed at the bottom of the river. With the help of a compressor device which is located on the bank of the river the compressed air is pumped through tube. The rising bubbles create a barrier of bubbles as these bubbles move up it results in an upwards current which brings the waste to the surface. In order to stop the waste at the surface to flow downstream the tube is placed diagonally on the bottom of river and make clever use of the current of the river to direct the waste to the banks [4]. By using this we can remove out the submerged and floating plastic and paper waste from flowing water bodies. By varying the pressure of air flowing through tube, size of the tube and size of the holes we can use this in kinds of water bodies of different depth, flow rate and width. The waste accumulates on the side of the river where it can easily be collected with a catchment system like conveyor system. Fish can pass through the bubbles, underneath the bubble tubing or through the fish pass. Besides the capture of debris, the Bubble Barrier has other positive side effects [5].

Oxygen levels within the water increase by a Bubble Barrier, which stimulates the ecosystem and stops the growth of toxic blue algae. As bubble screens absorb sounds and waves, fish and shores experience less harm from the ship traffic. By using conveyor waste is screened and carried out of the water body using the mesh buckets to the waste collecting pit. ¼ of the conveyor is submerged in the water where waste is accumulated so that the complete waste is removed out. The conveyor is chain driven and a DC motor is used to drive the conveyor. This motor is made to operate automatically according to the conditions like flow rate and density of waste in river. Automation is done using an electronic system which is fade with programming [4].

IV. DIFFERENT TYPE OF BUBBLE FORM INSIDE WATER

The bubble formation depends on many factors such as pressure input, rate of flow of air, the size of hole at the manifold of the pipe, the distances from the water bodies bed to the surface and the velocity of the liquid and the type of flow of current. There is total four types of bubble they are

Macro bubble, Microbubble, Ultrafine bubble and Nanobubble [5].

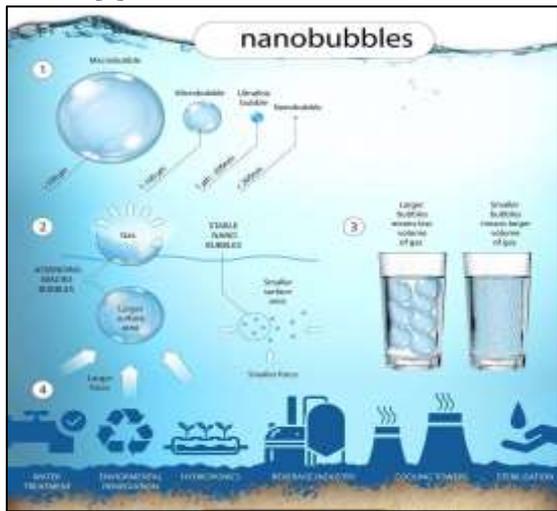


Fig. 5: Types of Bubble

Due to different types of bubble their properties and nature of behaviour also differs. Here we have explained the behaviour of different types of bubble in the following image [4].



Fig. 6: Bubble Behaviour of Different Types of Bubble

A. Different ways to make bubble enter in water

The process which forces air through a surface into a water volume is called entrainment; the process of bubble escape from the surface is called detrainment. Many flow situations result in entrainment. The supply of air may be – unlimited (air supply from the atmosphere); or – limited as from an air chamber, which may or may not be connected to the atmosphere by an air duct. In this case an interaction occurs among air flow, water flow and air pressure in the system [4].

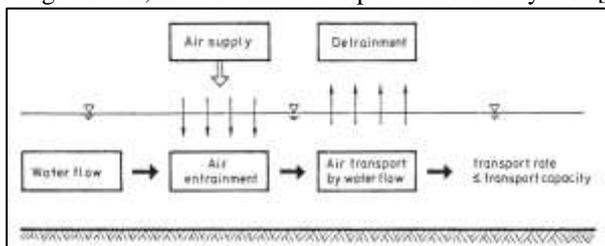


Fig. 7: Different Ways to make Bubble in Water

V. DISCUSSION

The Bubble Barrier will be highly use for the pollutant control of water bodies. It's only been five year since the discovery of Bubble Barrier, in 2016 they won the Plastic Free River Makathon competition, organised by the Dutch national

water authority Rijkswaterstaat. The price enabled the path to test it internationally, in less than a year they implemented the first full scale Bubble Barrier of 200 meters in the Dutch river IJssel, a major tributary of the river Rhine. During the four weeks of testing, the Bubble Barrier was confronted with wind, heavy rains, hail and rapid changes in the water level. Despite these challenging conditions, our Bubble Barrier did not disappoint us: 82-89% of the organic test material was caught. Besides that, actual pieces of plastic debris up to 1 meter big were caught as well. After the success in IJssel river, they started their research in wervershoof in April 2019 on Microplastic, in order to define whether the Bubble Barrier has an effect on microplastics of 0.02 to 0.5 millimetres [6]. This was quite a successful research but then there were some microplastic passed through the Barrier. To prevent it the upcoming research are going on to fully prevent the microplastic passed through the Bubble Barrier and also to collect the microplastic from the water and dispose it properly without harming the Aquatic Life. In the fall of 2019, the first Bubble Barrier was implemented and which will remain in place for a long period of time in the capital of the Netherlands: Amsterdam [6]. This Bubble Barrier was installed by The Great Bubble Barrier at one of the outlets from the canals into the IJ. With this the Bubble Barrier it will prevent the plastic from flowing into the North Sea of Netherland. This is a global first in the fight against plastic pollution. This project in Westerdok Amsterdam, give positive attitude to the future upcoming international project as it is greatly working till today.

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