Utilization of a Solar Aerator to Increase Dissolved Oxygen Level

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Abstract:

Dissolved Oxygen (DO) is one of the prime indicators of water quality. For proper growth and survival of marine life, DO play a very important role. Out of these, aeration by diffusion has been found to be the most efficient method for the introduction of Oxygen and water. According to research carried out on different aerators, diffused aerators have been found to as the best and most efficient medium for aeration. Thus, by combining the benefits of diffused aeration and solar energy, solar diffused aerators can be designed which will efficiently enhance the DO level of water and will also promote green energy. Solar aerators even though beneficial are less popular in India. Thus, there is ample scope for the development of a diffused solar aerator which will enhance the DO of water and in turn will help marine life flourish.

Keywords: Diffused Aeration, Solar energy, Solar Aeration, Biochemical Oxygen demand, Dissolved Oxygen, Self-Purification, Green energy

1.0 INTRODUCTION:

The Problem of pollution is increasing day by day, and the impact of the pollution produced by mankind is directly or indirectly imposed on the Flora and Fauna of the planet.

All the polluted water from the industries and Domestic and municipal waste ends up in the lakes, reservoirs or streams of the city. This increases water pollution and reduces the Dissolved oxygen of the water body which has aquatic life in it. The Dissolved oxygen which had to be used by the aquatic life for their survival is used by the micro-organism (bacteria) present in the water body. Aeration is the process in which water and air are brought in close contact to remove dissolved gasses and oxidize dissolved metals, including iron, hydrogen sulphide and volatile organic matter. This process is typically the first major process at the drinking water treatment plant and occurs in the secondary treatment process of activated sludge treatment in wastewater treatment plants. An evenly distributed oxygen supply in an aeration system is essential to effective wastewater treatment for fostering microbial growth.

By using the aeration process, we can ensure sufficient dissolved oxygen to the aquatic life of polluted water bodies. For the survival of the Aquatic animals, a minimum of 4mg/l or 4ppm is recommended. If the DO reduces below 4ppm the aquatic life struggles to survive. Hence, we can make use of the aeration process to make the water body from DO deficit to DO enriched.

The green revolution is taking momentum throughout the world. Thus, Promoting and using green energy is the need of the hour.

2.0 IMPORTANCE OF WORK:

As the world is approaching the green energy revolution, it becomes necessary to replace the age-old expensive machines with new and practical ones. As the lakes and ponds are the places which receive uninterrupted sunlight throughout the day because of their open surface nature, the use of green energy will prove to be very efficient and effective. There is a need to change diesel aerators to a better and cheaper alternative so that marginalized fish farmers can benefit in a better way economically. The beauty of a lake gets tampered with all the turbidity and hyacinth in the lake, aerator is a machine which will prevent the growth of unwanted weeds and algae in the lake or reservoir. Aeration is a simple process with an easy-to-manage machine, it can be easily understood by the fish farmers and the non-technical lake maintenance team. Solar Aerators can combine the benefits of Green Energy as well as aeration technology. Solar aerators have been popular in foreign countries. In India, solar aerators have been used in a few states but the technology is not yet fully developed or there is ample scope for further development. The most popular solar aerator in India is the 'paddle type surface aerator'. But according to research carried out by various researchers, diffused aeration is the most efficient type of aeration. If the diffuse aerator is combined with solar energy, the benefits can be multiplied. Thus, there is ample scope for the development of diffused solar aerators. Subsequently, after exhaustive research in solar aerators and aeration of water, it has been found that important work can be carried out on this topic.

2.1 Objective:

- To study the concept of Dissolved Oxygen and its importance to marine life.

- To study the concept of aeration and working of different types of aerators.

- To study green energy and its importance to our environment.

- To study and design a solar aerator.

3.0 METHODOLOGY:

3.1 Study of the area of sampling:

The sample for testing is taken from khandeshwar lake, which is located near the khandeshwar railway station of the Mumbai local harbour line. The water in this lake is generally used by the residents living in small settlements around the lake. The water is polluted by visual observation and the BOD of the water comes out to be 139.6 ppm when tested.

3.2 Calculation for air required for aeration:

The capacity of the water body: 0.5 m3

BOD of the water: 139.6 mg/l

Total BOD to be removed: 0.0698 kg

Oxygen % in atmospheric air: 23.2%

Standard O2 transfer efficiency for diffuser aerator: 20%

Hence O2 Required: 0.1396/ (0.2*0.23) = 0.349 Kg

Assuming the ratio of SOTE in clean water to effluent ratio = 0.8

Assuming factor for fouling of diffusers: 0.8

Therefore, Oxygen requirement = 0.698/0.8*0.8 = 0.54

Specific gravity of air = 0.8kg/m3

Air requirement = 1.09/0.232*0.8 = 2.938 m3/day.

Air requirement = 0.244m3/hr.

Electricity required in HP = CFM*PSI/229*Eff. Of blower = 0.0049

3.3 Solar Power system design:

The solar power system required for efficient working of aerator is a '12-volt system'.

Components required in the system:

- 12 V Battery
- 12 V Charge Controller
- 12 V Solar Panel

Required capacity of Battery: Power / Voltage = 60 / 15= 5 Amp hours.

For additional back up make an extra allowance of 2 Amp hours. Therefore, select a battery of capacity '8 Ah'.

Select Charge Controller of 12 Volts and 10 A Rating.

Watt Peak of Solar panel (Wp): It is the maximum electrical capacity that a solar cell can yield under ideal conditions are solar panels directed towards the sun in a cloudless sky.

Wp = V x I = 12 x 7

   = 84 Wp.

Battery + Charge Controller Loss: 15% approximately.

Therefore, make an extra allowance of 15%.

Hence, Wp = 84 + 15 = 99 Wp i.e. approximately 100 Wp.

Nozzle plays an important role in the entire aerator setup. The outlet of the air compressor is attached with a nozzle of approximately 6-7 cm. The main outlet of the nozzle is blocked and sealed using a sealing agent. Fine holes have been made on the nozzle at regular intervals. The finer the holes in the nozzle, the finer the air bubbles are formed resulting in effective aeration. As per various studies and research, the efficiency of the aerator nozzle with minute openings is much higher as compared to other means of aeration.

3.4 Frequency and Time of Aeration:

The time of aeration and frequency of aeration is very important concepts. They depend on various factors. Over aeration is always a problem. Over aeration can negatively affect the entire process and can also prove to be costly.

As per the research carried out by various researchers, it is found that any aeration system need not work for 24 hours and 7 days a week. Dissolved Oxygen does not deplete easily as soon as the air supply is cut off. It depends on factors like time of the day, organic loading, temperature, etc.

In our aeration system, we have calculated the value of DO to be achieved per day i.e. 24 hours, it is not necessary that aeration should be done for 24 hours continuously in a day. To achieve the target set, we can operate the aerator in a number of phases every day until we achieve the desired outcome.
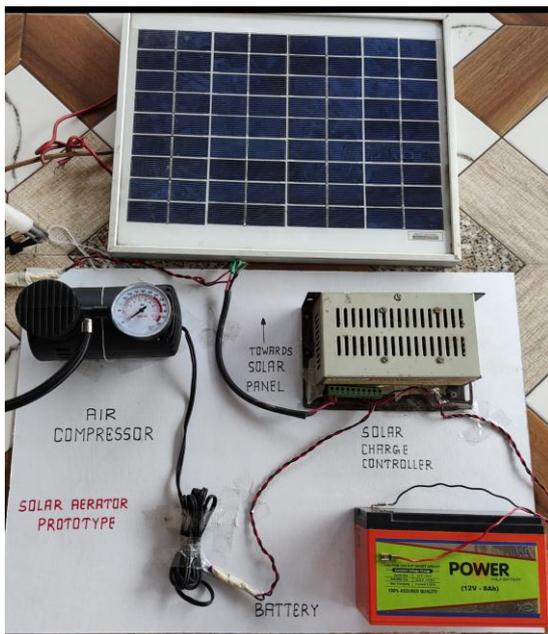
Fig no. 1: Solar Aerator Model Setup

4.0 RESULT:
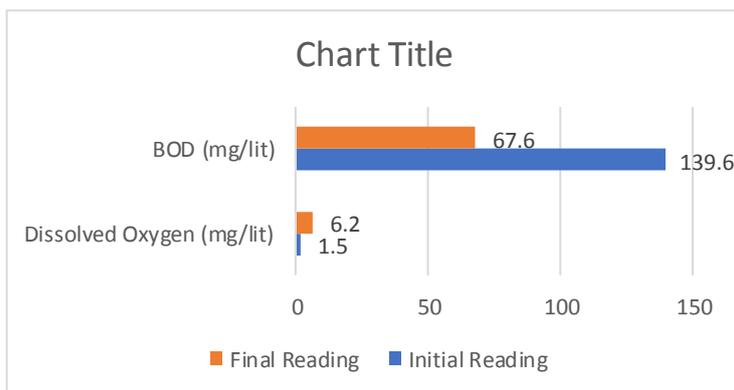
Chart No. 1: Display of test results.

Tests were done by the lab before and after the aeration process and the results were noticeable.

After the supply of oxygen from the air compressor, the oxygen is absorbed by the water and the DO increases from 1.5mg/l to 6.2 mg/l. As the oxygen was supplied the BOD was decreased by 139.6 mg/l to 67.6 mg/l. Choosing fine bubble aeration was also an important factor for the

results as the efficiency of the oxygen transfer increased more than that of coarse bubble aeration. (M.M. Harfadli)

Table No. 1: Test Results

SR NO.	TEST	UNIT	INITIAL READING	FINAL READING
01	Dissolved Oxygen	mg/lit	1.5	6.2
02	Biochemical Oxygen Demand	mg/lit	139.6	67.6

5.0 CONCLUSION:

From the studies and experiments carried out for this project, the following conclusions have been derived:

The Dissolved Oxygen of water depends on various factors like temperature, algal growth, sunlight, and the extent of pollution.

Solar aeration is an effective method to enhance the dissolved oxygen concentration of water.

Solar aeration can reduce the biochemical oxygen demand of water samples which indeed proves the enhancement of dissolved oxygen. Diffused aeration is one of the most efficient forms of aeration.

Green energy is one of the most powerful tools in today's world and with proper planning and management, it can be highly beneficial in the coming future.

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