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Effect of Aeration on Seafood Processing Wastewater

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ABSTRACT
The main environmental problems of fish industries are high water consumption and high organic matter, oil and grease, ammonia, nitrogen and salt contents in the waste water. Aeration helps in the oxidation of these minerals. This paper consequently focuses on how the various constituents of waste water vary with aeration. Diffused fine bubble aeration was done in a circular tank at various flow rates (3 l/minute,6.2 l/minute.6.4l/minute) at a constant time period of 20 hours using air stones and the percentage reduction in ammonia, total Kjeldahl nitrogen , BOD,COD and salts were found out . It was found that as flow rate of aeration increase the percentage removal of above constituents also increased. Optimum removal was possible at a flow rate of 6.4l/min. BOD, COD, Ammoniacal nitrogen, Kjeldahl nitrogen, were found to be removed by 91.2%, 82.79%,57.76%, 90.6% respectively . Aeration had no effect on salts and lipids .
Keywords: aspirators, CAD, EPDM, Kjeldahl nitrogen, reactors

I. Introduction

Fish industries play an important role in the social as well as economical development of our nation. The main environmental problems of fish industries are high water consumption and high organic matter, oil and grease, ammonia ,nitrogen and salt contents un their waste water

Aeration is the intimate exposure of water and air. It is a way of thoroughly mixing the air and water so that various reactions can occur between the components of the air and the components of the water.

As per the work of Ancheng Luo et al (2002), aeration can be an effective method in treating animal manure for removal of nutrients and odor problems without causing environmental problems. A laboratory experiment was conducted on pig manure to study the effect of continuous and intermittent aeration at an airflow rate of 1l/minute.

It was found that total Kjeldahl nitrogen was removed by 24% and organic carbon was removed by 26.55% under continuous aeration process, although the efficiency is not as high as aeration under high aeration rate adopted by past researchers. Intermittent aeration at two hour interval shows a lower efficiency of carbon & TKN removal than continuous aeration. Ammonia nitrogen was removed by 32.3% . This reduction is attributed to the ammonia volatization and microbial assimilation indicated by gain in nitrogen.

As per a study conducted by Elif Sekman et al (2002) on effect of aeration rate on leachate characteristics of landfill. The effect of aeration rate was investigated by means of leachate quality (chemical oxygen demand, biological oxygen demand, total Kjeldahl and ammonia nitrogen) at four different aeration rates of 0.1, 0.3, 0.6 and 1.0 L/min . After 75 days of operation, COD reduction was greater than 80% in all of the aerobic reactors reaching more than 85% at the end of the experiment. BOD5 removal efficiencies of reactors were determined to be greater than 95%.

As per the work of TS Jamieson et al (2003), the introduction of aeration to a pilot scale constructed wetland model improved the mean NH3-N removal efficiency from 50.5 to 93.3%.

This paper consequently focuses on how the various constituents of waste water vary with aeration. Aeration was done in various flow rates at a time period of 20 hours and the percentage reduction in ammonia, total Kjeldahl nitrogen, BOD, COD and salts were found out.

II. Aeration

Aeration removes or modifies the constituents of water using two methods - scrubbing action and oxidation. **Scrubbing action** is caused by turbulence which results when the water and air mix together. The scrubbing action physically removes gases from solution in the water, allowing them to escape into the surrounding air. Carbon dioxide and hydrogen sulphide are shown being removed by scrubbing action. Scrubbing action will remove tastes and odours from water if the problem is caused by relatively volatile gases & organic compounds. Oxidation is the other process through which aeration purifies water. **Oxidation** is the addition of oxygen, the removal of hydrogen, or the removal of electrons from an element or compound. When air. is mixed with water, some impurities in the water, such as iron and manganese, become oxidized.

III. Types of aerator

The goal of an aerator is to increase the surface area of water coming in contact with air so that more air can react with the water. As air or water is broken up into smaller drops/bubbles or into thin sheets, the same volume of either substance has a larger surface area. Two most common methods of aeration system used in wastewater treatment plants involve the use of either **Submerged diffusers (bottom diffused aeration)** by introducing oxygen or air into the wastewater or another approach is by **mechanical agitation (surface aeration)** which agitates the waste water by various means (eg., propellers, blades, or brushes) to introduce air from the atmosphere .There are several criteria to consider when selecting the right aeration technolgy. Energy efficiency is one of the most important, followed by the system's mixing abilities, with significant differences between mechanical aerators compared to diffuser aerators. Generally said, surface-aerated basins do not achieve the same performance level as bottom aeration. In bottom diffused aeration oxygen transfer is through submerged diffusers or other aerator devices. Oxygen transfer is controlled by varying the alr supply rate. Diffusers are connected to a piping system which is supplied with pressurized air by a blower. Diffusers break up the air by the displacement of air by the dispersement of bubbles throughout the aeration tank. For good performance, the rate of supply of dissolved oxygen should be equal to the rate of oxygen consumption exerted by the liquid under any given set of circumstance. While a number of equipment and operational parameters interact to influence the efficiency and rate of oxygen transfer for a given volume of water being aerated, aeration devices are evaluated on the basis of the quantity of oxygen transferred per unit of air introduced to the water for equivalent conditions. Automated software is available on the web to assist with drafting of aeration systems in CAD, as well as calculation softwares help to determine diffuser requirements for a given waste water.

3.1Coarse bubble (non porous) diffusers

The most common types of non porous diffusers are fixed orifices (perforated piping, sprayers, and slotted tubes); valve orifices; and static tubes. The bubble size of these diffusers is larger than the porous diffusers thus lowering the oxygen transfer efficiency. Coarse bubble diffusers with a check valve design can be the best choice when the goal is an aeration system that is simple to design and easy to fabricate and install in a vertical format. Coarse bubble diffusers with their rubber diaphragm cap and check valve system has been used for decades in waste water treatment plants and municipal facilities. Since the diffusers are plastic with molded EPDM rubber check valve diaphragms they are inexpensive and readily available. The simplicity of diffuser check valve design minimizes the back flow of wastewater and debris carried with it into the piping, which can cause potential long term operational problems. Also since they are vertical format diffusers, they lend themselves well to installations using inexpensive Sch. 80 PVC pipe for aeration headers.

3.2 Fine bubble diffusers

Fine pore diffusion is a subsurface form of aeration in which air is introduced in the form of very small bubbles. They are mounted or screwed into the diffuser geared pipe (air manifold) that may run along the length or width of the tank or on a short manifold mounted on a movable pipe (lift pipe).These diffusers come in various sizes and shapes such as discs, tubes, domes and plates .Fine pore diffusers (discs, tubes, domes and plates) are usually made from ceramics, plastics, or flexible perforated membranes. Although many materials can be used to make fine pore diffusers, only these few are being used due to cost consideration, specific characteristics, market size and other factors. These materials are resistant to the chemicals used in waste water treatment.

3.3 Other diffusion devices:

These include jet aerators which discharge a mixture of air and liquid through a nozzle near the tank bottom, aspirators mounted at the basin surface to supply a mixture of air and water and U tubes where compressed air is discharged into the down leg of a deep-vertical-shaft.

IV. Method of aeration adopted

4.1Fine bubble diffusion

Fine bubble diffusers have more oxygen transfer efficiency than coarse bubble diffusers. Coarse bubble diffuser are more economical and requires less maintenance, but have a lower oxygen transfer efficiency. Air stones were used as diffusers. They were preferred because,

- Dust and dirt particles up to 30micron can pass through it
- No air filters are needed.
- Produce uniform fine bubble.

4.2 Aeration tank

Circuar tank was used for aeration. It was found that the circular tanks are the most energy efficient. As per Achanta Ramakrishna Rao et al circular tanks produce maximum energy efficiency for a given input energy, followed by square tanks, rectangular tanks of L/W equal to 1.5 and rectangular tank of L/W equal to 2. This suggests that the circular tanks perform the most better as far as power requirements are concerned and hence provide better economy. Although the square tanks were the best for quick aeration, they consumed more energy than the circular tanks.

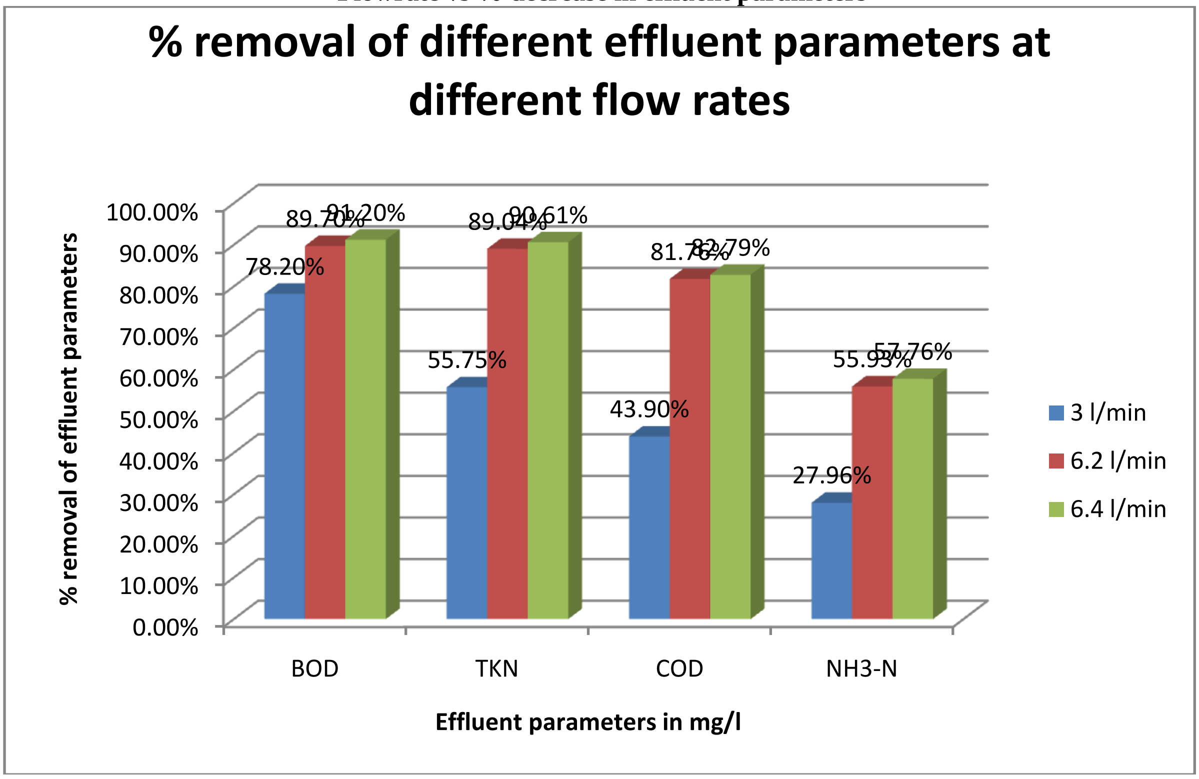
V. Results & discussions

It was found that as flow rate of aeration increase the percentage removal of BOD, COD , Ammoniacal nitrogen, Kjeldahl nitrogen also increased. Optimum removal was possible at a flow rate of 6.4l/min. BOD, COD, Ammoniacal nitrogen, Kjeldahl nitrogen, were found to be removed by 91.2%, 82.79%, 57.76%, 90.6% respectively . Aeration had no effect on salts and lipids.

TABLE 1
Percentage decrease of various constituents at different flow rates

Effluent	3(l/min)	6.2(l/min)	6.4(l/min)
NH_3-N	27.96%	55.93%	57.76%
Kjeldhal nitrogen	55.75%	89.04%	90.61%
Lipids	-	-	-
Salts	-	-	-
BOD	78.20%	89.70%	91.2%
COD	43.90%	81.76%	82.79%

CHART 1
Flowrate vs % decrease in effluent parameters



VI. CONCLUSION

It was found that as flow rate of aeration increase the percentage removal of BOD, COD, Ammoniacal nitrogen, Kjeldahl nitrogen also increased. Optimum removal was possible at a flow rate of 6.4l/min. BOD, COD, Ammoniacal nitrogen, Kjeldahl nitrogen, were found to be removed by 91.2%, 82.79%, 57.76%, 90.6% respectively. Aeration had no effect on salts and lipids .It can be expected that for a higher air flow rate above 6.4 l/min, more removal of these parameters can be obtained.

References

[1] **Achanta Ramakrishna Rao, Bimlesh Kumar and Ajay Kumar Patel ,** *Relative performance of different shaped surface aeration tanks, 34-40, 2007*

[2] **Hourard S Peavy, Donald R Roul, George tchobanoglous**,*' Environmental Engineering'.*

[3] **S K Garg**, '*Environmental engineering'*, volume 1 & 2, 1999, Khanna Publications, New Delhi.

[4] **DA C Turoet, F M Laur**,*'Water supply Engineering'.*

[5] **Dr.B.C.Punmia**,*'Water supply Engineering'* volume 2, 1999, Arihant Publications, 4 th edition.

[6] **Metcalf & Eddy**, Waste water Engineering, McGraw Hill International Editions.

[7] '*Standard Methods for the Examination of water and waste water'*, American Public Health Association.

[8] **IS: 10500-1991**,*'Indian Standard code for drinking water'*,Bureau of Indian standards, New Delhi.