# Effect of Barriers Height at Inclined Cascade Aerator

**Mahuwa Ghosh, Sayyad Abdul, Avinash Kumar**

***Abstract*: World generate a large amount of water loss due development of carbon dioxide, hydrogen sulphide, methane and various volatile organic compounds responsible for bad taste and odour water causes the large amount of marine animals' death. Aeration is used to increase to oxygen content of the water. Stepped cascade is one of that aerators one of that aeration which is applied. In this present study were analysed the performance of the Standard oxygen transfer rate (SOTR) and Standard oxygen efficiency (SAE) in water. In each case comparison of the performance of the SOTR at the barrier height 10cm shows different from the barrier height at 6cm. Same as comparison of the performance of the SAE at the barrier height 10cm shows different from the barrier height at 6cm. By varying the cascade height 0.5, 1, 1.5, 2 m and 0, 1, 3, 7 number of barriers at two different barrier height 10cm, 6cm. Found that performance increase with the increase in no of barriers, with the height of barriers and the height of cascade.***

***Keywords*: Barrier, Cascade, Organic Compound, Performance, Standard Oxygen Transfer Rate, Standard Oxygen Efficiency.***

## I. INTRODUCTION

Stepped cascade aerator is one of the know aeration used for the long time for the purpose of energy dissipation. As water content different types of volatile component so aeration is one of the best methods particularly in case of dam spillway to remove unwanted compound. Steeped cascade of consists of number of steps thorough which water will flow under the gravity. During the water fall, water bubble gets rise up and dragged the air. Results in mixing of air with water increases the oxygen diffusion into the water. Stepped cascade system was continued to be one of simplest method if natural slope was available in the stream and in the water and treatment of wastewater process. Stepped cascades are considered as a very effective means of aeration because of its strong turbulent mixing characteristic, making the large residence time and the substantial air bubble entrainment. The performance of such a system depends on the selected geometry of cascade system for hydraulic loading. The aeration potential was an important characteristic of stepped cascades aerator.

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### A. IMPORTANCE OF AERATION SYSTEM

Fish, like all Marine animals for respiration must get oxygen from the environment. Oxygen was available abundantly in air- breathers but it is less for aquatic organisms, and the less dissolved oxygen content of water may confine the activities of fish. In most natural waters, the supply of oxygen to water by two process diffusion of oxygen from the atmosphere and production from underwater photosynthesis also exceeds the amount of oxygen-consuming processes. The variation of rate of respiration, photosynthesis and diffusion process during different periods of the day change the dissolved oxygen level. To maintain the level of oxygen in the water, aeration process was needed. The cultural system having low dissolved oxygen does not cause mortality directly to the fish but leads to the deterioration of water quality which impart stresses in fish body and in turn causes mortality. The effect of dissolve oxygen concentration on growth and related activities of fish.

### B. OXYGEN TRANSFER PROCESS

There are several methods have been used to transfer the oxygen from atmosphere to water bodies. Oxygen transfer varies based on location of tank, depth of water and size of the water bodies. Generally, at the water surface theatre of oxygen transfer was very rapid and rate of variation of oxygen transfer also depends on the placement of aeration systems. Efficiency of aeration system depends on consuming of energy and energy consumption was major part of the total cost of water treatment. Aeration was often the first major process at the treatment plant (Fandriks, 2011) Aeration was a treatment process, here the water brought into contact with the air for the purpose of increase the amount oxygen and decrease the amount of carbon dioxide. Removal of the other volatile organic compound which are responsible for the bad taste and odor. Many research works have been conducted on cascade aeration and stepped cascade aeration system, which are mainly concerned about dam spillway. To date, no literature exists on the development of an inclined cascade system. Previous work has been done on the undulation sloped cascade and stepped cascade and plane slope cascade. But no such study has been done till now on inclined plane slope cascade with numbers of barriers, it is based on empirical techniques and act as a gravity aeration system where water flows downward.

Comparison of Standard oxygen transfer rate between different barrier heights, barrier numbers and at different cascade height to see the effect on its performance of inclined cascade aerator.

## II. MATERIALS AND METHODS

### A. STANDARD OXYGEN TRANSFER EFFICIENCY

For evaluating the performance first have to find out the value of SOTR and SAE at different slope height , at different numbers of barriers so that by keeping the constant slope height and then changing the numbers of barriers can compare the performance of inclined cascade aeration system without the presence of barriers and with the other aerators also. The oxygen transfer efficiency of aerators was evaluated from pilot-scale experiments in a cement pond under controlled conditions. The water tank initially oxygen level was dropped down to zero by adding 10 mg/L sodium sulphite. After that, the aerator was operated, and the oxygen level was detected by using a DO meter. The DO deficit was computed for each time that DO was measured during re-aeration based on the mathematical equations. Next the oxygen transfer rate was assessed by computing the Standard Oxygen Transfer Rate (SOTR). Finally, the efficiency of oxygen transfer into water was calculated by Standard Aeration Efficiency (SAE).

### B. Standard Oxygen Transfer Rate (SOTR):

An aerating device the conventional oxygen transfer rate SOTR of was defined as number of oxygens could be introduced into the human body of water per unit time at standard conditions of 20°C water temperature, 0 mg/L initial DO concentration, one atmospheric pressure by a device. In project SOTR determines the performance of cascade aerator (APHA 1980).

$$SOTR_i = (C^* - C_0) \times K_L a_{20} \times V \quad = K_L a_{20} \times V \times 10^{-3} \times 9.07$$

$$SOTR_m = (C^* - C_0) \times K_L a_{20} \times V \quad = K_L a_{20} \times V \times 10^{-3} \times 9.07$$

$$SOTR_n = (C^* - C_0) \times K_L a_{20} \times V \quad = K_L a_{20} \times V \times 10^{-3} \times 9.07$$

$$SOTR_o = (C^* - C_0) \times K_L a_{20} \times V \quad = K_L a_{20} \times V \times 10^{-3} \times 9.07$$

Where SOTR= standard oxygen transfer rate (kg $O_2$/h); $k_L a_{20}$ =overall oxygen transfer coefficient at 20°C ($h^{-1}$); $C$*= saturation value of DO at test conditions mg/L; $C_0$ =DO concentration at time $t$= 0 mg/L ; 9.07=saturation value of DO mg/L ; at 20°C and one atmospheric pressure; and $V$ = aeration tank volume.

### C. Standard Aeration Efficiency (SAE):

Standard aeration efficiency was defined as the amount of oxygen transferred per unit of power. In this experiment it gives the performance of cascade aerator. Lawson and Merry (1993).

$$SAE_i = \frac{SOTR(Kg\,O_2)}{P(KW)}$$

$$SAE_m = \frac{SOTR(Kg\,O_2)}{P(KW)}$$

$$SAE_n = \frac{SOTR(Kg\,O_2)}{P(KW)}$$

$$SAE_o = \frac{SOTR(Kg\,O_2)}{P(KW)}$$

### D. ANALYSIS THE EFFECT OF HEIGHT OF CASCADE ON ITS PERFORMANCE

To analysis the effect of height of cascade on its performance, can be done by keeping cascade height constant, and keep on changing the barrier height (6cm,10 cm) and number of barriers (0,1,3,7). To check the condition where can be obtain the maximum oxygen transfer and maximum aeration efficiency. There are four different height of cascade i.e 0.5 m, 1 m, 1.5 m, 2m. For cascade height 0.5m, first without barrier i.e at 0 number of barriers, have to check the percentage of dissolve oxygen. Then again at barrier height 6 cm, changing the number of barriers 1st with 1 number then 3 number of barriers then with 7 number of barriers, have to check the efficiency. This was same for the all cases i.e for 1 m. 1.5m and 2m height. Determine the maximum oxygen transfer and maximum aeration efficiency at different at different condition.

### E. ANALYSIS THE EFFECT OF HEIGHT OF CASCADE ON ITS PERFORMANCE

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## III. RESULT AND DISCUSSION

### A. To analysis the effect of height of cascade on its performance

Performance evaluation of inclined cascade aeration system at different cascade height. To analyses the effect of height of cascade at different height of barriers on performance numbers of experiments have been done.

### B. Effect of cascade height on SOTR at different numbers of barriers, for 10 cm barrier height:

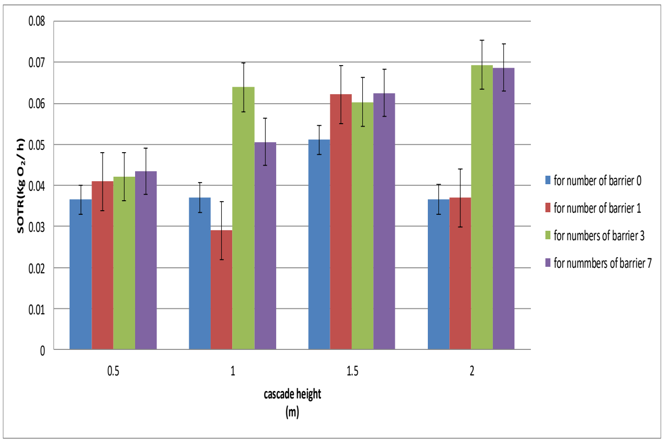


**Figure 1: Effect of cascade height on SOTR at different numbers of barriers**

From the figure 1, it can be seen that at constant barrier height 10cm with different no of barrier and at different cascade height 0.5, 1 ,1.5, 2 respectively barrier number 0, 1, 3, 7. In case of cascade height 0.5m cascade height SOTR increases gradually with the increase of numbers of barriers, but in the other cases it shows different. Another thing can be observed that by varying the cascade height from 0.5, 1, 1.5, 2 without having barrier SOTR increases at the 1.5 cascade height and in other height it was constant. Another thing observed that that by varying the cascade height from 0.5, 1, 1.5, 2 at barrier no 1 SOTR increases at 0.5 m and then decreases at 1 m again it increases at maximum level at 1.5m height and again decreases at height 2m. From fig can be observed that barrier no 1 with cascade height at 1.5m was shown the maximum result. Another thing observed that that by varying the cascade height from 0.5, 1, 1.5, 2 at barrier no 3 SOTR is maximum level at 2 m height and SOTR quite high at barrier no 3 at all different cascade height. From fig can be observed that barrier no 7 with cascade height at 2 m was shown the maximum result. Another thing can be observed that by varying the cascade height from 0.5, 1, 1.5, 2 SOTR increases at the at barrier height 7 constantly. Results shown that SOTR is increased maximum at barrier height 10 cm and at cascade height of 2m with 3 numbers of barrier with the comparison of another barrier no and cascade height.

**C. Effect of cascade height on SOTR at different numbers of barriers, for 6 cm barrier height:**

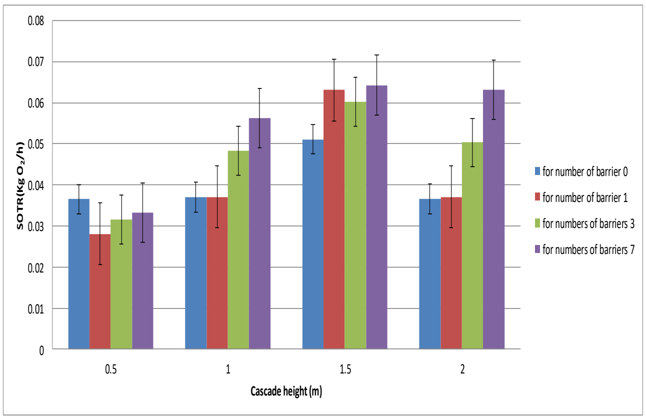


**Figure 2: Effect of cascade height on SOTR at different numbers of barriers**

From the figure 2, at constant barrier height 6cm with different no of barrier and at different cascade height 0.5, 1 ,1.5, 2 respectively barrier number 0, 1, 3, 7 observed different values of standard oxygen transfer rate. In case of cascade height 0.5m SOTR decreases after adding barrier and with different barrier number 0, 1, 3, 7 it reached less SOTR value than without barrier but in the other cases it shows different. Can be observed that by varying the cascade height from 0.5, 1, 1.5, 2 without having barrier SOTR increases at the 1.5 cascade height. Another thing observed that that by varying the cascade height from 0.5, 1, 1.5, 2 at barrier no 1 SOTR decreases at 0.5m and then increases at 1 m and gained it maximum level at 1.5m height and again decreases at height 2m. Same as by varying the cascade height from 0.5, 1, 1.5, 2 at barrier no 3 SOTR is maximum level at 1.5 m height. From fig can be observed that barrier no 7 with cascade height at 1.5 m was shown the maximum result. Another thing can be observed that by varying the cascade height from 0.5, 1, 1.5, 2 SOTR increases constantly at the at barrier height 7. Results shown that SOTR is increased maximum at barrier height 6cm and at cascade height 1.5m with 7 numbers of barrier with the comparison of another barrier no and cascade height.

**D. Effect of cascade height on SAE at different numbers of barriers, for 10 cm barrier height:**

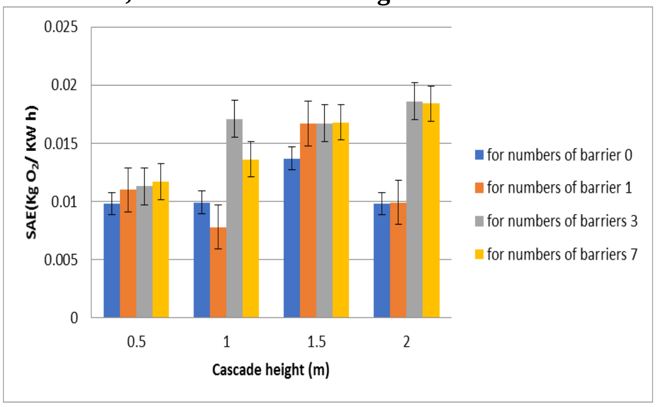


**Figure 3: Effect of cascade height on SAE at different numbers of barriers**

From the figure 3, at constant barrier height 10cm with different no of barrier and at different cascade height 0.5, 1 ,1.5, 2 respectively barrier number 0, 1, 3, 7 observed different values of standard aeration efficiency. In case of cascade height 0.5m SAE increases after adding barrier and with different barrier number 0, 1, 3, 7 it reached high SAE value than without barrier but in the other cases it shows different. Can be observed that by varying the cascade height from 0.5, 1, 1.5, 2 without having barrier SAE increases maximum at the 1.5 cascade height. Another thing observed that that by varying the cascade height from 0.5, 1, 1.5, 2 at barrier no 1 SAE decreases at 1m reaches minimum value and then increases at 1.5 m gained it maximum level and decreases at height 2m. Same as by varying the cascade height from 0.5, 1, 1.5, 2 at barrier no 3 SOTR is maximum level at 2 m height. From fig can be observed that by varying the cascade height from 0.5, 1, 1.5, 2 at barrier no 7 with cascade height at 2m was shown the maximum result.

Another thing can be observed that by varying the cascade height from 0.5, 1, 1.5, 2 SOTR increases constantly at the at barrier height 7. Results shown that SAE is increased maximum at barrier height 10cm and at cascade height 1.5m with 3 no of barrier. Results shown that SAE is increased maximum at barrier height 10 cm and at cascade height 2m with 3 numbers of barrier with the comparison of another barrier no and cascade height.

**E. Effect of Cascade Height on SAE at Different Numbers of Barriers, For 6 Cm Barrier Height:**

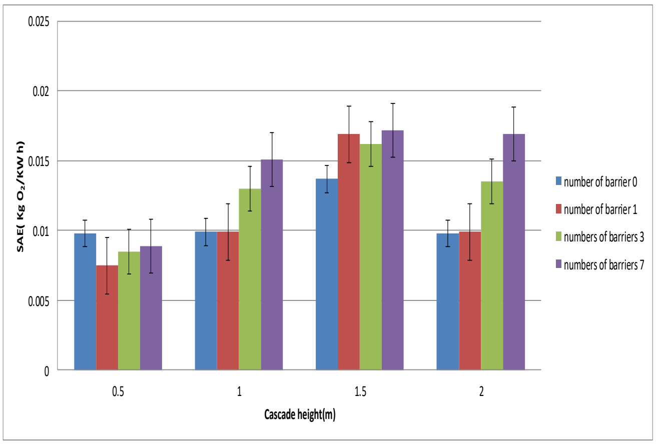


**Figure 4: Effect of cascade height on SAE at different numbers of barriers**

From the figure 4, at constant barrier height 6cm with different no of barrier and at different cascade height 0.5, 1 ,1.5, 2 respectively barrier number 0, 1, 3, 7 observed different values of standard aeration efficiency. In case of cascade height 0.5m SAE decreases after adding barrier but in the other cases it shows different. Can be observed that by varying the cascade height from 0.5, 1, 1.5, 2 without having barrier SAE increases maximum at the 1.5 cascade height. Another thing observed that that by varying the cascade height from 0.5, 1, 2 at without barrier SAE is constant. Same as by varying the cascade height from 0.5, 1, 1.5, 2 at barrier no 1 SAE is maximum level at 1.5 m height. From fig can be observed that by varying the cascade height from 0.5, 1, 1.5, 2 at barrier no 3 with cascade height at 1.5m was shown the maximum result. Another thing can be observed that by varying the cascade height from 0.5, 1, 1.5, 2 SAE increases constantly up to barrier height 1.5m than decreases at 2m height. Same can be observed that by varying the cascade height from 0.5, 1, 1.5, 2 at barrier no 7 with cascade height at 1.5m and 2m was shown the maximum result. Another thing can be observed that by varying the cascade height from 0.5, 1, 1.5, 2 SAE increases constantly. Results shown that SAE is increased maximum at barrier height 6cm and at cascade height 1.5m and 2m with 7 numbers of barrier with the comparison of another barrier no and cascade height.

## IV. CONCLUSION

Standard oxygen transfer rate (SOTR) and Standard Aeration Efficiency **(**SAE) is better comparative parameter for performance evaluation of aerators. Many experiment had done, to evaluate the performance i.e. cascade height of an inclined cascade aerator (h) , aeration were conducted at different values of 0,1,3, 7 numbers of barriers and keeping the cascade height constant 2m and barriers height 10 cm as constant, the results showed that SOTR is maximum at 3 barriers in similar way at different geometric condition keeping the barriers height constant 6cm and varying the cascade height as 0.5m,1m,1.5m,2m and the results showed that SOTR is maximum in 2m and 1.5m at the barrier number 3 and 7. Shown that with increase in cascade height , the number of barrier and height of barrier standard oxygen transfer rate and standard aeration efficiency both is increased. In case of Standard Aeration Efficiency **(**SAE) performance was evaluated and result shows that the at 10 cm height of cascade barrier aeration were conducted at different numbers of barrier 0,1,3, 7 at different cascade height shown that 2m cascade height at 3, 7 number of barrier maximum value of SAE. Same as at 6cm SAE is maximum at 6cm height of cascade barrier aeration were conducted at different numbers of barrier 0,1,3, 7 at different cascade height shown that 1.5m cascade height at 7 number of barrier maximum value of SAE. It showed that with the increase in height and number of barrier performance is also increases.

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