

# **Effect of different aerobic and anoxic time periods on the effluent water quality of a sequence batch reactor in a meat processing plant**

K.P.W. Kahandawa, A.M.N.L. Abesinghe, A.M. Samaraweera  
*Faculty of Animal Science and Export Agriculture, Uva Wellassa University of Sri Lanka*

and

J.K. Dissanayake  
*CIC Poultry Farms Pvt Ltd, Horakandawila, Badalgama, Sri Lanka*

## **Introduction**

A large amount of slaughterhouse wastewater is generated during meat product manufacturing. It contains high concentrations of organic matter, oil and grease and nitrogenous compounds. Hence, releasing waste water to the environment causes many environmental problems such as contamination of groundwater and eutrophication of surface waters (Rodriguez *et al.*, 2010). The treatment of waste water is especially important in this view. Treatment of wastewater by means of biological process has been widely implemented from urban to industrial wastewater. Sequencing batch reactor (SBR) is a modification of activated sludge process and operates by a cycle of periods consisting of fill, react (alternatively aerobic and anoxic periods), settle, decant, and idle (Mahvi, 2008).

In the SBR process there is no standard time combination for aerobic and anoxic period. It will depend on the effluent waste water components and vary plant to plant. Currently aerobic and anoxic period is operated as 2 hr aerobic and 1 hour anoxic period in the waste water treatment plant of CIC meat processing company. The present investigation was undertaken to study best time combination of aerobic and anoxic time period for simultaneous carbon oxidation, nitrification and denitrification performance of sequencing batch reactor to treat slaughterhouse wastewater.

## **Methodology**

The current study was carried out at CIC Poultry Farms Pvt Ltd (Processing Plant), Badalgama. Laboratory analysis was done at CIC Processing Plant Laboratory and Uva Wellassa University laboratories. Model structure of aeration tank which has the capacity of 600 L was used to conduct the research experiments. 180 mL of sludge from SBR unit in CIC meat processing plant and 420 mL volume of wastewater was fed to tank each day of the treatment. Air was supplied to the reactor during aerobic phase of react period with the help of diffused aeration system and Anoxic conditions were maintained by switching off the aerators. Eight different combinations of aerobic and anoxic periods were used. Every sequence was operated totally for 20 hrs of react period by alternating the aerobic and anoxic period according to selected different time combinations (Table 01).

Table 01: Selected time Combinations for Aerobic and Anoxic time periods

	Control T1	T2	T3	T4	T5	T6	T7	T8
Aerobic (Hours)	2	2	3	3	4	4	4	4
Anoxic (Hours)	1	2	1	2	1	2	3	4

The best combination of aerobic and anoxic time period was determined by analyzing water quality parameters as, COD, BOD, ammonium nitrogen, total nitrogen, TSS, TDS and pH. Complete Randomized Design (CRD) was conducted and data obtained from chemical and physical tests were analyzed using analysis of variance (ANOVA) using the General Linear Model (GLM) procedure of SAS (SAS Institute Inc., 2000). Significant means of treatments were separated using the Least Significant Difference ( $P < 0.05$ ) test.

### Results and Discussion

There was a significant difference ( $P < 0.05$ ) between aerobic and anoxic time combinations regarding COD removal, BOD removal, TN removal and ammonium nitrogen removal. 4 hour aerobic and 2 hour anoxic period showed higher COD removal (95%), BOD removal (90%), TN removal (89%), and ammonium nitrogen removal (92%). There was no significant difference ( $P > 0.05$ ) regarding phosphorus removal, TSS removal and TDS removal among different aerobic and anoxic time combinations.

Highest COD and BOD removal occurred in 4 hour aerobic and 2 hour anoxic cycle. Second highest COD removal (92%) was achieved during 4-1 react period. This might be due to during 4-2 hr and 4-1 sequence total aerobic react time is higher than other react cycles. Therefore, longer aeration was achieved. Longer aeration period has been found to be effective in achieving higher degree of nitrification and COD, BOD removal according to the findings of Debsarkar *et al.* (2006).

Due to less total aeration time in 4-3 and 4-4 hr cycles, less COD and BOD removal was achieved. That means one cycle was alternatively operated for 20 hrs totally and in the 4-3 and 4-4 cycles has high anoxic time periods. Therefore, less COD and BOD removal occurred (Kundu *et al.*, 2013).

Treatment 6 (4-2) is significantly different from other treatments and also treatment 5 has high BOD removal. This may be due to long aeration time and effective denitrification. According to Kishida *et al.* (2003), BOD concentration of the effluent was relatively high because the oxygen demand by nitrifying bacteria increased the total BOD, when the NH<sub>4</sub>-N concentration of the effluent was too high (average = 187.1 mg/L). NH<sub>4</sub>-N concentration of the effluent was high due to partial denitrification. According to this experiment ammonium nitrogen concentration also affect to the BOD removal. And treatment 6 had low level of ammonium nitrogen concentration in effluent water (1.048 mg/L  $\square$  1.07 mg/L).

Longer aeration period (5 hour) has been found to be effective in achieving higher degree of nitrification from Debsarkar *et al.* (2006). But according to preliminary study at the middle of

5<sup>th</sup> hour pH is reached to 6.9, but optimum pH for nitrification is 8.2. Therefore, in this experiment longest aeration time per one cycle was selected as 4 hr.

According to the statistical analysis, there is no significant difference ( $P > 0.05$ ) between different aerobic, anoxic time combinations and total dissolved solid and total suspended solids removal. This might be due to activated sludge treatment is not intended to remove dissolved or suspended solids (Sustarsic, 2009).

## Conclusions

The combination of 4 hours aerobic react period and 2 hours anoxic react period has been found to be optimum from the view point of both nitrification and denitrification, and COD, BOD removal. When total aeration time period is low, removal of COD, BOD is not efficient in 4 hr aerobic – 4 hr anoxic and 4 hr aerobic – 3 hr anoxic time combinations.

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