Effect of Calcium Hydroxide and Poly Aluminum Ferric Chloride Concentration on Water Quality Parameters of Meat Processing Plant Effluent

M.J.M. Rodrigo, A.M.N.L. Abesinghe, R.M.H. Tharangani
Uva Wellassa University, Badulla, Sri Lanka

and

B. Liyanaarachchi
Gills Food Products Private Limited, Wattala.

Introduction

As long as the world population continues to grow and demand for food products increase, there are number of environmental and health issues arising. Treatment of both solid wastes and waste water from the meat processing industry has been one of the greatest concerns of the worldwide agro industrial sector, mainly due to the restrictions that international trade agreements have imposed regarding their use and their environmental issues. Many types of substances, when discharged into a receiving body of water, degrade the water quality to such an extent that beneficial uses of the stream are no longer attainable. Normally meat processing plant discharges waste water with high biochemical oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), total dissolved solids (TDS), fat and grease content, turbidity and electrical conductivity (EC). Therefore, waste water should be properly treated before discharging in to the natural water body. Sedimentation and flocculation is one of the waste treatment methods which can be used to maintain water quality parameters within acceptable limits. Poly Aluminum Ferric Chloride (PAFC) is an efficient and cheap flocculent used to treat industrial effluents. However, the efficiency of PAFC is affected by the pH of waste water. Calcium Hydroxide ($Ca(OH)_2$) is one of the alkaline commonly used to maintain pH of waste water (Hammer, 2009). Hence, this research was carried out to determine the appropriate dose of $Ca(OH)_2$ and PAFC for the effluent treatment plant of a meat processing factory.

Methodology

The current study was carried out at the effluent treatment plant (ETP) of the Gills Food Products Private Limited, Wattala. Laboratory analysis was completed at the chemistry laboratory of Uva Wellassa University. First, ETP was studied well to decide the parameters that need to be changed in order to meet water quality parameters of treated effluent with Environmental Protection Agency (EPA) standards. Selected parameters (dose of $Ca(OH)_2$ and PAFC) were changed in two separate stages of ETP. Amount of $Ca(OH)_2$ (Ca = 54.092 % (w/w)) was changed at first retention tank and amount of PAFC (Al_2O_3 = 29 % (w/w), Fe = 4.5 % (w/w)) was changed at the clarifier of the ETP. Laboratory scale preliminary trials were conducted (jar test) to select the effective range of chemicals.

Laboratory scale preliminary trials were used for selecting effective weight ranges of two chemicals. The amount of $Ca(OH)_2$ were changed as; 5 kg and 7 kg. The selected amounts of PAFC were 1 kg, 3 kg and 4 kg. Accordingly, there were six treatments as; 5 kg of $Ca(OH)_2$ and 1 kg of PAFC (T_1), 5 kg of $Ca(OH)_2$ and 3 kg of PAFC (T_2), 5 kg of $Ca(OH)_2$ and 4 kg of PAFC (T_3), 7 kg of $Ca(OH)_2$ and 1 kg of PAFC (T_4), 7 kg of $Ca(OH)_2$ and 3 kg of PAFC (T_5) and 7 kg of $Ca(OH)_2$ and 4 kg of PAFC (T_6). Existing amounts of chemicals were used as the control (4 kg of $Ca(OH)_2$ and 2 kg of PAFC). These combinations were changed once a week. Selected weight of $Ca(OH)_2$ and PAFC were measured using an analytical balance (IND 221, china) and it was dissolved in 20 L of distilled water at ambient temperature. $Ca(OH)_2$ and PAFC solutions were added respectively to the first retention tank and clarifier at 1^{st} day of the week. The rate of adding chemicals was 150 mL per hour. Water samples were collected at 4 locations of the ETP. Those are discharge point from the factory, first collection tank, clarifier and final discharge point. Collected water samples were used to analyze COD, BOD, Dissolved Oxygen (DO) level, TSS, TDS, Turbidity, EC, pH, temperature and color absorbance for determining the effluent quality for each treatment. A Complete Randomized Design (CRD) was used for the experiment. Analysis of variance was followed by a mean separation procedure using Duncan's Multiple Range test. Analyses were performed using SAS (SAS institute Inc., Cary, NC, USA). The data obtained were analyzed at 0.05 level of significance.

Results and Discussion

Table 1 shows the water quality parameters of treated effluent. T_2 was the best treatment among six treatments. COD, EC, TDS, TUR and TSS of treated effluent were lower than the maximum levels prescribed by EPA standards. Further, T_2 resulted higher TDS removal efficiency, higher turbidity removal efficiency and higher EC removal efficiency in the clarifier. pH of the treated effluent was within the acceptable range. Moreover, it was cost effective than the control. Calculated benefit per week was Rs. 1277.50.

Table 1. Water quality parameters of treated effluent of meat processing plant

Treatment	Water Quality Parameters					
	COD (mg/L)	EC (µS)	pH	TDS (ppm)	TUR (NTU)	TSS (ppm)
1	156.8^a	1122.3^a	6.35^d	571^a	13.5^f	680.3^c
2	10.6^e	452^e	6.81^b	125.6^e	51.8^c	130^b
3	105.6^b	706.6^c	6.5^c	351.6^b	95.1^a	870^a
4	24^d	574.3^d	7.15^a	285.6^c	25.8^e	50^e
5	161.06^a	744.6^b	6.44^{dc}	352.3^b	44.6^d	49.6^e
6	47.46^c	394.6^f	6.21^e	200.6^d	63.03^b	830^b
Standard value	250	500	6.5 -8.5	500	50	50

^{a,b,c,d,e} Mean values with different superscript letters are statistically different

Figure 1 shows the pH variation of treated effluent with different treatments. Hammer, (2009) reported that $Ca(OH)_2$ is a good neutralizing and buffering agent. So effect of $Ca(OH)_2$ was clearly shown by pH variation among six treatments. McDermott, (1973) reported that the pH of the process waste water is typically in the 6.5 to 8.5 range. The pH of the first collection tank was in 6.5 to 7.5. So it was similar to the finding of McDermott, (1973). Adjusting the pH of effluent is essential to enhance the fat separation. For better fat separation pH should be around 7. T_5 was the best treatment for adjusting the pH of the factory discharge of meat processing plant.

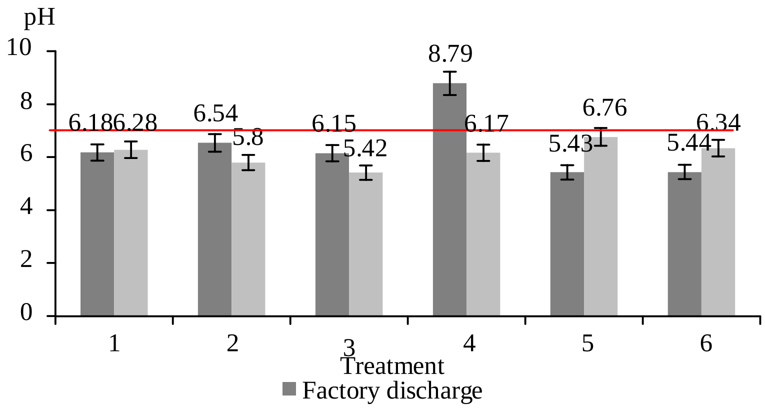

Figure 1. Comparison of pH between factory discharge and first collection tank

Conclusion

Addition of 5 kg of $Ca(OH)_2$ to first retention tank and 1 kg of PAFC to clarifier enhance the efficiency of ETP. Water quality parameters of treated effluent were in conformity with EPA standards for effluent.

References

Hammer, J., 2009. Water and waste water technology, PHI Learning Private Limited, New Delhi.

McDermott. 1973. Volume vs Surcharges. Water and waste water Engineering. 7, D10-D17.