Nutrients Requirements in Biological Industrial Waste Water Treatment

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Abstract:

Pulp and paper mills generate varieties of pollutants depending upon the type of the pulping process. This paper is the state of the art review of treatability of the pulp and paper mill wastewater and performance of available treatment processes. A comparison of all treatment processes is presented. Combinations of anaerobic and aerobic treatment processes are found to be efficient in the removal of soluble biodegradable organic pollutants. Color can be removed effectively by fungal treatment, coagulation, chemical oxidation, and ozonation. Chlorinated phenolic compounds and adsorable organic halides (AOX) can be efficiently reduced by adsorption, ozonation and membrane filtration techniques.

Keywords: Pulp, Pulp and paper, Wastewater, Treatment

Introduction:

Microorganisms involved in the removal of carbonaceous contaminants from wastewater require nitrogen and phosphorous for growth and reproduction. Microorganisms require nitrogen to form proteins, cell wall components, and nucleic acids (Maier, 1999a).Biomass has been universally accepted to have the chemical formula $C_5H_7NO_2P_{0.074}$ (Droste, 1997).When treating wastewater, it is usually stated that the ratio of COD:N:P in the wastewater to be treated should be approximately 100:5:1 for aerobic treatment and 250:5:1 for anaerobic treatment (Metcalf and Eddy, 1991; efficiency and observed biomass yield on nutrient requirements for both aerobic and anaerobic treatments is discussed. It is hypothesized that, for industrial wastewater, more accurate determination of nutrient requirements should be based on both removal efficiency and biomass yield.

Materials and Methods:

The sequencing batch reactor used in this study had an active volume of 2 L. For anaerobic treatment of olive mills wastewater(OMW), it was mixed and kept at 30± 2oC using a magnetic stirrer/hotplate. After the mixing time was completed, mixing and heating were turned off, and the reactor was kept quiescent for 2hr to allow for anaerobic sludge to settle. After that the calculated volume of the supernatant was removed from the reactor and tested for a number of parameters following Standard Methods fort he Examination of Water and Wastewater (APHA, 2000). An equal amount of raw wastewater was added and the whole volume started a new phase of mixing under anaerobic conditions. After the startup phase, the COD of the reactor was kept around 16,000 mg/ l by dilution. Sludge wastage was conducted to keep the volatile suspended solids (VSS) concentration in the reactor

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as constant and as close to 12,000 mg/l as possible. The hydraulic retention time was kept equal to 3 days. pH of the reactor was adjusted to around 7 as found necessary using sodium bicarbonate. For aerobic treatment of pulp and paper mill wastewater, dissolved oxygen concentrations were kept between 2 and 4 mg/l. The treatment mode was extended aeration, because the yield coefficient in this mode is lower than the conventional activated sludge process. Average hydraulic retention time was 24 h. The reactor was fed three times daily each with about 670 ml. Mixed liquor volatile suspended solids concentration (MLVSS) was kept about 2500 mg/l.

Results and discussion:

Wastewater Characteristics

Wastewater from olive mills and paper and pulp industries, have a wide range of characteristics. Table (1) shows the average value of a number of wastewater characteristics for these wastewaters. The table shows that the COD value for olive mills wastewater is very high and therefore anaerobic treatment is necessary for such wastewater. The average ratios of COD to nitrogen(COD: N) and phosphorous concentrations (COD: P) are equal to about 180 and 530, respectively. The COD: N: P ratio then equals 911: 5: 1.7. The maximum ratio that is usually reported in the literature as the required ratio is 250:5:1 to 500:5:1 depending on the extent of loading or COD influent concentrations (Droste, 1997; USEPA,1995). The present ratio suggests that the concentrations of nitrogen and phosphorous are lower than what is Therefore, and according to these figures, nutrients, especially nitrogen, have to be added to the OMW .Similarly, for the pulp and paper mill wastewater, the ratio of C:N:P is lower than what is usually reported in the literature. This suggests that both nitrogen and phosphorous have to be added to the wastewater for effective biological treatment.

COD Removal

Despite the low nitrogen and phosphorous concentrations, the anaerobic reactor treating olive mill wastewater performed at a high level of efficiency as was observed from the low and stable concentration of fatty acids (between 50-90 mg/l), and the high removal of COD (about 80% at 3 days retention time). Sludge wastage was conducted whenever the VSS exceeded 13000 mg/l, about every 6 to 9 days. The average sludge age at these conditions would be around45 days. At 3 days retention time, the COD removal efficiency averaged a value of about 83%. This was achieved without the need for nutrients addition. At these conditions, the observed yield was found to be around0.06 kg VSS per kg COD removed. Similarly, for pulp and paper mill wastewater, removal efficiency of COD was higher than 75% without the addition of any nutrients. The sludge yield coefficient was found to be equal to about 0.31 kg VSS per kg COD removed.

Nutrient Requirements

Nutrient concentrations in the wastewaters reported in The observed yield for the anaerobic biomass treating olive mills wastewater was found to be equal to 0.06 and efficiency of COD removal was equal to 83%. The required COD:N:P ratio will

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then be equal to(41/(0.83)(0.06)): 5: 1, which is equal to 823:5:1. The concentration of nitrogen in the olive mills wastewater is lower than what is required by this formula. It should be noted, however, that for industrial wastewater, the usual sludge age used is very high, especially with low degradable wastewater. For this reason, the usual nitrogen content in biomass is lower than 12.3%(Eckenfelder, 1989). This suggests that in anaerobic In applying Henze and Harremoes (1983) criteria for COD:N requirements for the present study, the following were obtained. For a loading rate of 0.44 kg COD/kg VSS/d, for the olive mills wastewater, the COD:N ratio required would be 682:5 ((1.2/0.44)250:5). According to their method, nitrogen should be added to the wastewater. This method also depends on influent COD concentration, and does not differentiate between different removal efficiencies. Biomass yield is also not considered. Therefore, the use of loading rates for nutrient requirement determination is as misleading as the use of constant ratios of COD to nitrogen and phosphorous. More accurate determination of nutrient requirements should be based on both removal efficiency and biomass yield as suggested above. The following conclusions can be drawn from the present study: (1) Olive mills wastewater and pulp and paper mill wastewater in Jordan have sufficient nitrogen and phosphorous concentrations that addition of such nutrients was not necessary, and (2) the COD:N:P ratio required for aerobic and anaerobic treatment of industrial wastewater should be calculated from a formula that take account of the removal efficiency and observed yield for the wastewater in concern (41/*EYobs*:5:1) instead of using a constant value for all different wastewaters, or based on loading rate.

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