Journal of Applied Sciences

ISSN 1812-5654

Journal of Applied Sciences 11 (13): 2460-2463, 2011
ISSN 1812-5654 / DOI: 10.3923/jas.2011.2460.2463

Specialization of Biochemical Oxygen Demand for Surface Water and Wastewater

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Abstract: Pollution of rivers is attributed to point and non-point sources and marine pollution originates mainly from land-based sources. Therefore in order to control the quality of the water a few parameters have been chosen as the index for determining the water pollution. Amongst the parameters, Biochemical Oxygen Demand, (BOD) is one of the most important and frequently used parameters for estimating the level of water pollution. BOD measures the amount of oxygen consumed by microorganism to utilize biodegradable organic matter. The decomposable reaction of the organic depends on nature and temperature of the waste and the ability of the organism in the system to utilize the waste. From a previous study done Chapra (AUTHOR) recommended that BOD to be speciated into two categories, fast BOD and slow BOD where the former BOD would represent the readily biodegradable fraction and the latter, the slowly biodegradable fraction. These can be achieving by unfiltered sample and filtered sample. The unfiltered sample are presenting readily biodegradable fraction while slowly fraction can be obtain by subtracting the unfiltered BOD measurement with filtered BOD measurement. It is believed in the filtered sample, fast BOD reaction occurred. The samples used were from wastewater effluent discharge from industries such as wastewater from food and beverage industry, Sewage Treatment Plant (STP's) effluent and also surface water from Sg. Klang, Sg. Damansara and Sg.Tebrau.

Key words: Fast BOD, slow BOD, speciation, wastewater, effluent

INTRODUCTION

The Biochemical Oxygen Demand (BOD) test is a bioassay procedure to determine the relative oxygen requirements of polluted river, wastewater and effluents (Davis and Cornwell, 1998). In other words, BOD measure the amount of oxygen consume during stabilization of biodegradable organic matter under aerobic condition. BOD reflects the amount of oxygen consumed through two processes: carbonaceous biochemical oxygen demand (cBOD) and nitrogenous biochemical oxygen demand (nBOD).

The conventional BOD test requires a five day incubation period at 20°C. From the definition of BOD_5, most of the dissolved organic matter was stabilized, typically between 70-80% in most sample test (Chapra *et al*., 2006). However there remain the question of the slowly biodegradable organic fraction which takes longer to decompose which typically consist of non-dissolved organic such as wastewater from Sewage Treatment Plant (STP) and as well as more complex organic molecules from industry. The hypothesis that most of the organic fraction is oxidized within 5 days thus becomes invalid for such cases (Zainuddin, 2008). Under these conditions also, the oxygen demand exerted therefore may be significantly higher than the laboratory tested BOD_5. However, no information is available concerning the fast fraction and slow fraction of BOD.

This study was conducted to observe the slow and fast reaction of oxidizing Biochemical Oxygen Demand (BOD) from various classifications of local ambient water and wastewater samples. The importance of studying the slowly biodegradable organic matters lies in travelling time of the receiving main stem or tributaries of rivers to its downstream segment in which the travelling time was assumed 5 days. The significance of the impact of slowly biodegradable organic can be seen when the travelling time of the organic pollutant is more than 5 days and consists of mainly slowly biodegradable fraction, underestimation of organic pollution strength will occur.

MATERIALS AND METHODS

The BOD procedure used is based on Standard Method for the Examination of Water and Wastewater (21st Ed.) for American Public Health Association (APHA, 1999). Samples from surface water and wastewater discharge form industry and sewage treatment plants (STP's) was collected and placed in a sampling bottle. Prior to the experiment, the dilution water was prepared. It is used to provide oxygen for the bacteria to breath during the incubation period. The dilution water was prepared by

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diluting a buffer pillow of BOD nutrient into 3 Litre of deionised water and the mixture was shaken vigorously for a few minute.

Then, the samples are analyzed for pH, temperature and chlorine. The pH must be in the range of 6.5 to 8.5 and temperature must be at 20±1°C. By using spectrophotometer (Hach *et al.*, 1997), the chlorine content was checked. The present of chlorine must be eliminated because chlorine will cause cellular degradation and the BOD will be invalid.

After all, the sample divided into two parts, which one part of the sample will be filtrated. Filtration is done by filtering the samples through a glass microfiber filter GF/C. Then, the sample is diluted in series. The sample size of each sample depends on the category of the sample. The following are the basis for sample size, 0.00 to 0.1% for strong industrial waste, 1 to 5% for raw and settled wastewater, 5 to 25% for biologically treated effluent and 25 to 100% for polluted river waters (APHA, 1997).

Next, each sample size was diluted into 300 mL BOD bottles and the dilution was done directly in the BOD bottles. For samples that required nitrification inhibitor, the sample was filled up with 0.16 g of 2-Chloro-6-(Trichloromethyl) Pyridine (TCMP) per 300 mL samples. Nitrification Inhibitor was added before they are at least two-third filled with diluted sample. Then the initial Dissolved Oxygen (DO) of each sample was measured using DO meter (YSI 5010 membrane probe). Finally, the samples were incubating in the incubator for 20 days at 20 °C. Daily measurement of DO was done to observe the reaction occurred in the test.

RESULTS

Comparison of BOD reaction in various waste-and surface- water indicated that slowly BOD fraction significantly affects the overall reaction of BOD. The unfiltered sample gave results of total BOD reaction occurred while filtered sample gave the fast reaction of BOD. Nitrogenous demand in BOD reaction was considered as interferences (APHA, 1997); therefore nitrification inhibitor was added in the test to observe reaction of carbonaceous biochemical oxygen demand (cBOD).

Figure 1 and 2 show the BOD and cBOD profile on STP effluent discharge. In Fig. 1, for the unfiltered sample, the BOD_{20} was 22 mg L^{-1} while filtered sample value was 10 mg L^{-1}. The slow BOD_{20} obtained was 12 mg L^{-1}. These value obtained by subtracting the unfiltered sample with filtered sample.

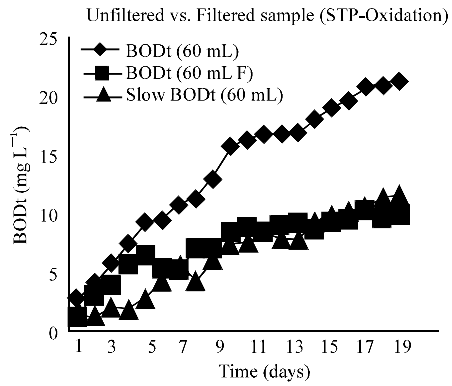

Fig. 1: BOD profile on STP effluent discharge

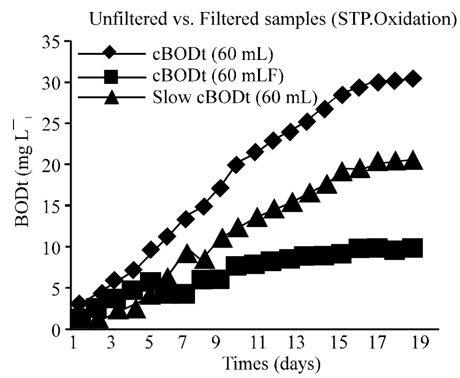

Fig. 2: cBOD profile on STP effluent discharge

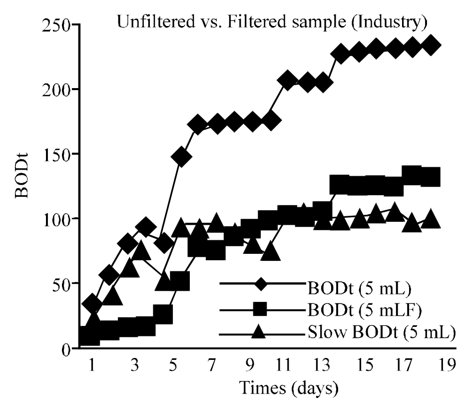

Fig. 3: BOD profile for industry effluent discharge

For Fig. 2, $cBOD_{20}$ for unfiltered sample was 30 mg L^{-1} while filtered sample $cBOD_{20}$ was 10 mg L^{-1}. By subtracting the value of unfiltered sample with filtered sample, the $cBOD_{20}$ for slow fraction was 20 mg L^{-1}.

It can be observed from Fig. 3 that the BOD_{20} measured in unfiltered sample was 215 mg L^{-1} while in filtered sample BOD_{20} was 122 mg L^{-1}. The BOD_{20}

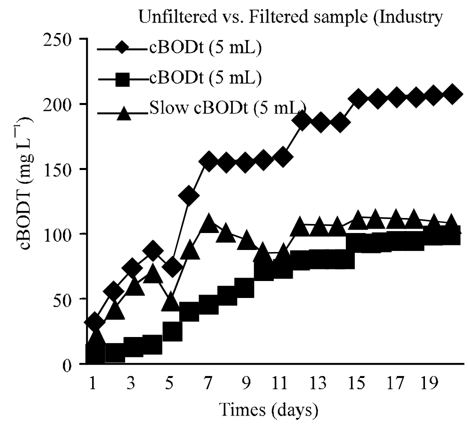

Fig. 4: cBOD profile on industry effluent discharge

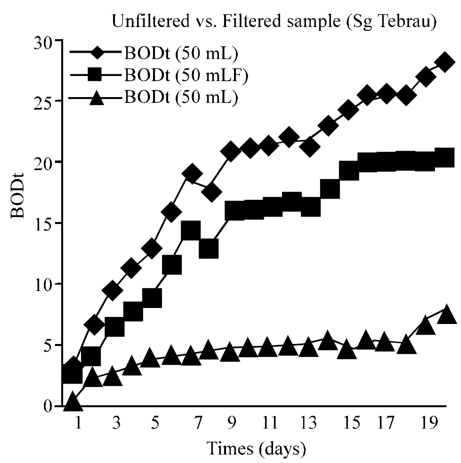

Fig. 5: BOD profile on surface water

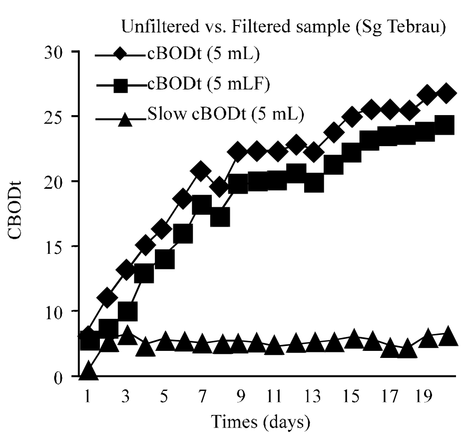

Fig. 6: cBOD profile on surface water

measured in slow fraction was 94 mg L^{-1}. cBOD profile on industry effluent discharge was shown in Fig. 4. It shows that the measured value of $cBOD_{20}$ as 208 mg L^{-1} for unfiltered sample while for filtered sample as 100 mg L^{-1}. Slow $cBOD_{20}$ obtained was 109 mg L^{-1}.

Figure 5 shows the reaction of BOD on surface water which is sample from Sg.Tebrau. The BOD_{20} for unfiltered sample was 28 mg L^{-1} while filtered sample was 20 mg L^{-1}. For slow BOD_{20} obtained by subtracting the unfiltered with filtered value was 8 mg L^{-1}.

As shown in Fig. 6, the ultimate $cBOD_{20}$ was 27 mg L^{-1} for unfiltered sample while for filtered was 24 mg L^{-1}. Slow $cBOD_{20}$ was about 4 mg L^{-1} which these value obtained by subtracting the unfiltered with filtered sample.

DISCUSSION

The experimental data analysis shows the significant impact of slowly biodegradable fraction occurred in the BOD reaction. These can be seen from present results mainly in the reaction of effluent from STPs and industry discharge. From the data obtained, generally, in 5 days, it cannot be concluded that about 70-80% of the organic had been degradable. It takes longer time to decompose and this is directly due to the slow BOD fraction in the composition.

For STP effluent, BOD reaction in unfiltered sample without nitrification inhibitor showed that in 5 days, BOD_5 was about 8 mg L^{-1} while the ultimate BOD_{20} was about 22 mg L^{-1}. Even after 5 days and onwards the consumption of oxygen still occurred in the reaction and this is contributing by the slow fraction of biodegradable organic matter. The ultimate BOD for the slow fraction was about 12 mg L^{-1}. Furthermore, same patterns of reaction occurred in the BOD reaction with and without nitrification inhibition. Inhibited the nitrogenous organic demand, shows that greater cBOD value obtained which were the ultimate cBOD in unfiltered sample, 30 mg L^{-1}, while the ultimate cBOD for slow fraction was 20 mg L^{-1}. Therefore, the impact of slowly biodegradable fraction is very significant in the reaction. These shows that effluent discharge from STP required longer time to decompose and this will give serious impact on the environment. Particularly in Malaysia the primary pollution load to our river are from sewage sources.

The same finding was observed for industrial discharge, where the slowly fraction gave greater influences in the BOD reaction. From these Fig. 3 and 4, it can be observed that the slowly biodegradable contribute half of the overall reaction. In other words, the slow fraction had greater contribution in slowing down the reaction and takes longer time to decompose. In 5-days, for both condition 90 mg L^{-1} out of 220 mg L^{-1} of organic had been degradable. It is about 40% of organic had been decompose in 5 days. Beyond 5 days, stabilization of organic still occurred due to slow biodegradable fraction.

For surface water, it also shows same BOD pattern with other samples. From Fig. 5 and 6, the consumption of oxygen still occurred after 5 days incubation. Therefore, the impact of slowly biodegradable fraction was significant.

CONCLUSION

It can be concluded that, the present of slowly biodegradable organic fraction of BOD is significant in most tested sample. If the slowly BOD fraction does not considered as time goes it can create major disaster. These can poses a threat to human life and aquatic life. As we know, all the discharge of effluent either industrial effluent or sewage treatment plant and others point and non-point source is dumped to receiving water or in other words river. Rivers do provide human the water sources and if the main source of water for human is contaminated what will happen to human without clean water. In addition, excess introduction of organic into a river causes depletion of the dissolved oxygen in the water. This can caused a threat to fish and other higher forms of aquatic life if the concentration of oxygen falls below a critical point. Therefore, it is important to study the impact of slowly biodegradable organic matter towards the environment.

ACKNOWLEDGMENTS

I would like to greatly thankful and appreciation to the both supervisor, Associate Prof. Dr. Norazah and En Zaki Zainudin for their guidance and supervision. Thanks also for the good cooperation between staff of Labarotary Faculty of Chemical Engineering, UiTM Shah Alam. Last but not least thank for all my family and my friends for their help and support along this study was done.

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