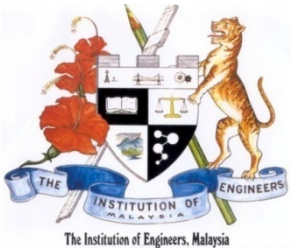
The Institution of Engineers, Malaysia



PROCEEDINGS

TWELFTH ANNUAL IEM WATER RESOURCES COLLOQUIUM

22nd MAY 2010
(Saturday)

C&S Lecture Room
2nd Floor, Wisma IEM
Petaling Jaya, Selangor

Organised by

Water Resources Technical Division
The Institution of Engineers, Malaysia (IEM)

TABLE OF CONTENTS

Editors

Prof. Engr. Dr. Othman A. Karim, MIEM
Dr. Ahmed Al-Shafie

Cetakan Pertama / First Printing, 2010

Diterbitkan di Malaysia oleh / Published in Malaysia by
THE INSTITUTE OF ENGINEERS MALAYSIA
Bangunan Ingenieur, Lot 60/62
Jalan 52/4, Peti Surat 223 (Jalan Sultan)
46720 Petaling Jaya, Selangor Darul Ehsan, Malaysia
Emel:sec@iem.org.my

Dicetak di Malaysia oleh / Printed in Malaysia by
PENERBIT UNIVERSITI KEBANGSAAN MALAYSIA
43600 UKM Bangi, Selangor D.E., Malaysia
http://www.penerbit.ukm.my
emel : penerbit@ukm.my

Perpustakaan Negara Malaysia Data Pengkatalogan-dalam Penerbitan
Cataloging-in-Publication Data

Institute of Engineers Malaysia
12nd Annual IEM Water Resources Colloquium 2010

ISBN 978-983-40616-1-6

Fast And Slow Carbonaceous Bod Speciation Of Sewage Effluent

Norizan Abdullah, Norazah Abdul Rahman, Zaki Zainudin
Faculty of Chemical Engineering,Universiti Teknologi MARA (UiTM), 40450 Shah Alam
Tel:03-55436304 Faks:03-55436300
(Email:norizanabdullah@yahoo.com, noraz695@salam.uitm.edu.my
zakizainudin@gmail.com)

ABSTRACT

The Biochemical Oxygen Demand (BOD) test has been a long standing test method to quantify the amount of biodegradable organic matter present in a water sample. The test is typically conducted over a 5-day period (BOD_5), with the sample being incubated at 20°C. It has been a long standing assumption that over the 5-day period, most of the organic should be stabilized and typically under normal conditions this may be true. Recent developments however have shown that there may significant variation for certain types of wastewater samples where the organic fraction may consists of more *slowly biodegradable organics* (such as particulate organic carbon) than readily *biodegradable organics* (dissolved organics). Under such circumstances, the results of the BOD_5 test may lead to serious underestimation of the total amount of organics present hence also the pollution strength. This study aims to speciate the two organic fractions under two distinct categories termed *slow-BOD* and *fast-BOD*. The speciation is done by filtering the samples (0.12 μm) to separate the dissolved and particulates fractions. The results showed there was a distinct variation between the filtered and unfiltered samples, where the amount of organics stabilized within the five day period for the unfiltered sample was approximately 50% of the total BOD measured. After this period the oxygen depletion continued, which in turn was attributed to the slowly biodegradable organics.
Keywords: fast BOD, slow BOD, speciation, wastewater, effluent

1.0 INTRODUCTION

The Biochemical Oxygen Demand (BOD) test is a bioassay procedure to determine the relative oxygen requirements of polluted river, wastewater and effluents. 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. 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. 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.

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

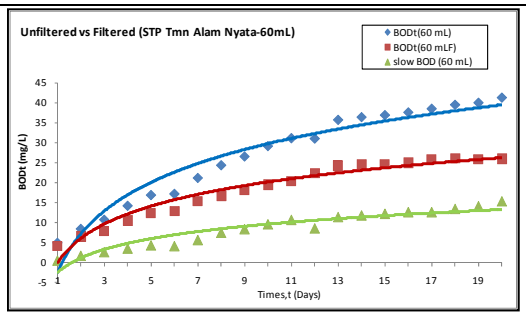
Then, the samples are analyzed for pH, temperature and chlorine. The pH must be in the range of 6.5 to 8.5 and temperature must be at 20 ± 1□C. By using spectrophotometer (HACH DR/2400), the chlorine content was checked. The present of chlorine must be eliminated because chlorine will cause cellular 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 (0.12 µm). 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 (Standard Method APHA 1997).

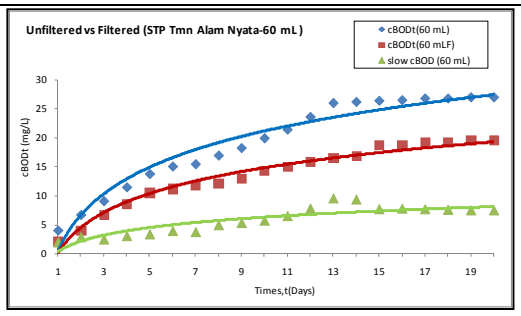
Next, each sample size was diluted into 300 mL BOD bottles and the dilution was done directly in the BOD bottles. For samples that required nitrification inhibitor, the sample was filled up with 0.16 g of 2-Chloro-6-(Trichloromethyl) Pyridine (TCMP) per 300 mL samples. Nitrification Inhibitor was added 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.

3.0 RESULT

Comparison of BOD reaction in various wastewater 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).

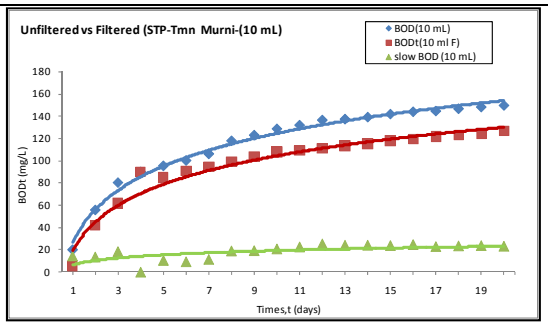


(a)

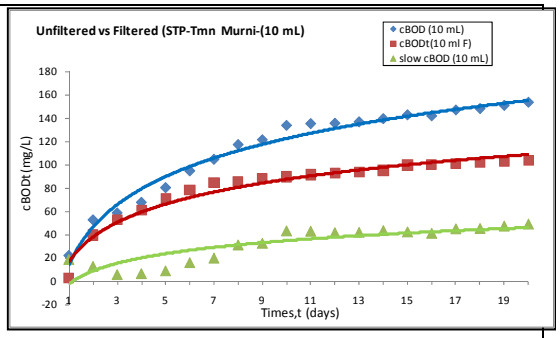


(b)

Figure 1 (a) & (b) : BOD and cBOD profile for STP Tmn Alam Nyata



(a)



(b)

Figure 2 (a) & (b) : BOD and cBOD profile for STP Kuantan

Figure 1 (a & b) and 2 (a & b) shows the BOD and cBOD profile on STP effluent discharge for Taman Alam Nyata and Tmn Murni. Basically, the figure showed the reaction of BOD/cBOD in filtered and unfiltered samples. Theoretically, unfiltered samples showed total reaction of BOD/cBOD reaction while filtered sample present the fast fraction of BOD/cBOD reaction. Slow fraction of BOD/cBOD obtained by subtracting value of unfiltered with filtered sample. In figure 1 and 2 (a), present the BOD profile. In both figures, it shows the slow BOD_{20} was 15 mg/L and 20 mg/L respectively. For cBOD profile shown in figure 1 & 2 (b), the slow BOD_{20} was about 7 mg/L and 40 mg/L respectively.

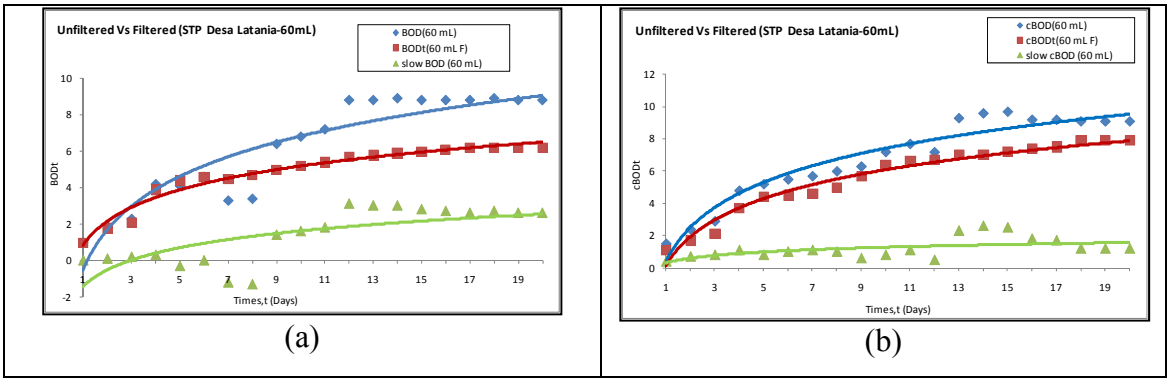


Figure 3 (a) & (b) : BOD and cBOD profile for STP Desa Latania

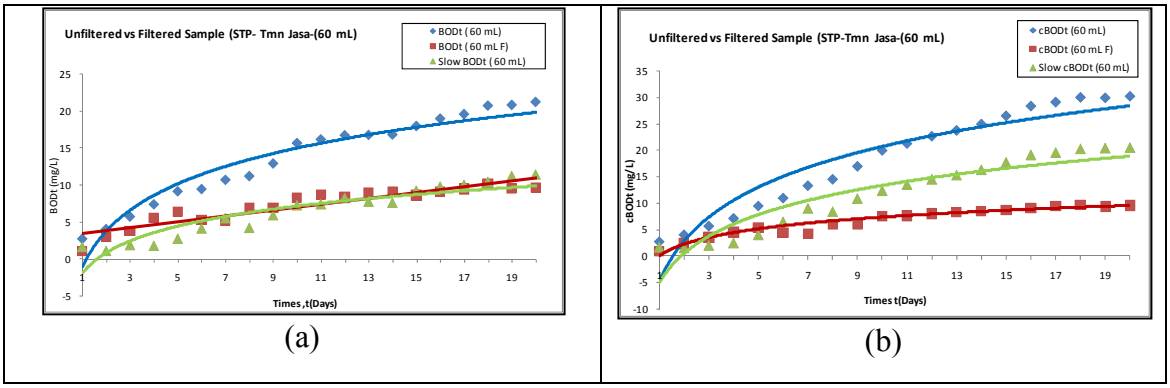


Figure 4 (a) & (b) : BOD and cBOD profile for STP Tmn Jasa

It can be observed from figure 3 (a) that the BOD_{20} measured in unfiltered sample was 10 mg/L while in filtered sample BOD_{20} was 6 mg/L. The BOD_{20} measured in slow fraction was about 2 mg/L. cBOD profile was shown in figure 3 (b). It shows that the measured value of $cBOD_{20}$ as 9 mg/L for unfiltered sample while for filtered sample as 8 mg/L. Slow $cBOD_{20}$ obtained was 1 mg/L. As shown in figure 4 (a & b), the ultimate BOD_{20} and $cBOD_{20}$ for unfiltered was 20 mg/L and 25 mg/L respectively. Filtered BOD_{20} was 7 mg/L while $cBOD_{20}$ was 5 mg/L. Slow BOD_{20} obtained was about 6 mg/L. Slow $cBOD_{20}$ was about 15 mg/L which these value obtained by subtracting the unfiltered with filtered sample.

4.0 DISCUSSION

The experimental data analysis shows the significant impact of slowly biodegradable fraction occurred in the BOD reaction. The trend of slow and fast fraction occurred in BOD test obviously showed. These can be seen in all figures above. 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.

The percentage of completing stabilization in five day was about 41%, 64%, 47% and 43% for sample from Taman Alam Nyatam Taman Murni, Desa Latania and Taman Jasa. The higher the present of organic matter in the sample the more rapid reaction occurred if the right microorganisms consist in the wastewater. It is important to note that the reaction of BOD was influence by the nature of the waste, the ability of

microorganism to decompose the organic and the temperature. Thus, the slow and fast BOD reaction was depend on the organic and microorganism present in the wastewater. It can be said that, the discharge form STP do obviously shows the slow BOD fraction. 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 (Department of Environment (DOE) 2006).

Comparing the result of BOD and cBOD, in some tested sample, the value of BOD gave higher value than in cBOD however in some cases the cBOD value is higher than BOD. Fundamentally, the assumption made was the BOD value should be consistently higher than the cBOD value when nitrification is the sole cause of the discrepancy between BOD and cBOD values and neither the BOD or cBOD value should be consistently higher or lower than the other value if normal variability is the sole cause of the discrepancy between the results for a given sample. The study showed in Taman Alam Nyata and Taman Murni, the BOD_{20} is higher than $cBOD_{20}$ value while for samples from Desa Latania and Taman Jasa the $cBOD_{20}$ was higher than BOD_{20}. It can be said the higher the cBOD result may be related with the normal variation related with the BOD testing procedure or possibly with oxygen demand exerted by biodegradation of the nitrification inhibitor. Although the value of BOD and cBOD is not consistently higher in each tested samples, however the trend of slow and fast BOD fraction in both testing procedure was same and obviously showed. These conclude the finding either BOD or cBOD test procedure carried, the speciation of slow and fast BOD fraction still occurred.

5.0 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 better environment.

ACKNOWLEDGEMENT

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. Thank you also for the good cooperation between staff of Labarotary Faculty of Chemical Engineering, UiTM Shah Alam. Last but not least thank you for all my family and my friends for their help and support along this study was done.

REFERENCES

Mackenzie L.Davis,David A,Cornwell " Introduction to Environment Engineering"3rd edition, Mc Graw Hill1998.

S.C.Chapra," Surface Water Quality Modeling", Prentice Hall,USA 1997.

Peavy, Howard S. "Environmental Engineering" International Edition, Mc Graw Hill 1985.

Zainudin,Zaki "Biochemical Oxygen Demand" 2008

Standard Methods for the Examination of Water and Wastewater by American Public Health Association, American water Works Association, water Environment Federation 1999.

N.Sawyer Clair,L.McCarty,Gene F.Parkin" Chemistry For Environmental Engineering" 4th edition, Mc Graw Hill,1994

F.Heddle John and Tavener Albert, "Evaluation of the Total Carbonaceous Biochemical Oxygen Demand," Meat Industry Research Institute of New Zealand (Inc),Hamilton, New Zealand.

S.C.Chapra, G.Pelletier & H.Tao, "QUAL2K: A Modeling Framework For Simulating River And Stream Water Quality, Version 2.04D"ocumentation And Users Manual, Civil And Environmental Engineering Dept.,Tufts University Medford,MA,2005.

Annual Report for Department Of Environment (DOE) Malaysia 2006.

C.Hach Clifford,L.Klein Robertand R.Gibbs Charles, "Introduction Biochemical Oxygen Demand,"Technical Information Sereis-Booklet 7,1997from http://www.pubmedcentral.nih.govpagerender.fcgiartid243742&pageindex1.pdf