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Assessment of Biochemical Oxygen Demand as Indicator of Organic Load in Wastewaters of Morris County, New Jersey, USA

Dasgupta M* and Yildiz Y

Complete Analysis Laboratories, Analytical Research Department, 1259 Route 46, Suite 4C, Parsippany, NJ, 07054, USA

Abstract

The biochemical oxygen demand (BOD_5) constitutes an important water property for assessing the organic loads of wastewaters. This study on BOD_5 values of commonly occurring wastewaters of Morris County, USA was taken up to develop a basic understanding about the quantum of organic loads in these wastewaters which is the basic requisite for developing any wastewater management strategy. The study showed that the BOD_5 values of the wastewaters depended on the sources of the wastes. Among the three kinds of wastewater studied, industrial waters showed the highest BOD_5 load while pharmaceutical wastewaters showed the lowest values. However, in spite of showing comparatively lower BOD_5 loads, it was suggested that the management of pharmaceutical and hospital wastewaters should be dealt with special care owing to the possible occurrence of some harmful components in such wastewaters. Considerable seasonal variations in BOD_5 values in these wastewaters indicated that this behavior should also be taken into account for making an effective wastewater reclamation program.

Keywords: Biochemical oxygen demand; Contaminated wastewater; Wastewater sources; Seasonal variations

Introduction

Biochemical oxygen demand (BOD) forms the key indicator of organic load in any wastewater system. This property is expressed as the amount of dissolved oxygen required by aerobic biological organisms for degrading organic materials present in a given water sample at certain temperature over a specific time period [1]. When any kind of organic matter is present in water, the microorganisms start breaking down this organic load. During this process, the dissolved oxygen present in the water is consumed through the respiration of aerobic microorganisms, the amount of consumption being dependent on the organic load in the water. Thus a low BOD is an indicator of good quality while high BOD indicates polluted water [2-4]. The BOD is most commonly expressed in milligrams of oxygen consumed per liter of sample during 5 days of incubation at 20°C and is often used as a surrogate of the degree of organic pollution of water. This five-day incubation period has been commonly accepted as a compromise between a short test-period and the detection of a practically complete biological breakdown of organic materials in effluents because while it takes 20 days to achieve a complete degradation, about 70% of the biologically convertible substances are broken down after only 5 days of incubation at 20°C [5,6]. Therefore, the changes in BOD for the first five days of incubation at the temperature of 20°C can fairly indicate how effectively the processes of self-purification of any water will take place and the course and also the effectiveness of wastewater treatment of sewages in the oxygen reactors in the sewage treatment plants [7]. Since BOD is directly connected with the oxygen status of any water body which is essential for sustaining the biological lives in any aquatic system [8], an understanding of the BOD values of different waste waters and the corresponding organic loads which are ultimately released to various aquatic bodies with or without any treatment, appears to be essential [9,10]. The constituents and strength of these wastewaters can vary depending on their source. Commercial wastewaters coming from business complexes, restaurants, manufacturing plants, hospitals etc. are likely to exhibit variations in BOD values depending on the quality as well as the quantity of the pollutants. Such variations have a direct relevance with organic loading to treatment plants and also the functioning of these plants. Under this background, the present study was undertaken to assess the variations in BOD_5 values in different wastewaters found in industrial, pharmaceutical and hospital areas of Morris County of New Jersey, USA. It has been hoped that a gross idea about the BOD_5 values of wastewaters from different sources will indicate the magnitude of biochemical pollution there and will also provide some baseline information for developing suitable management practices for reclaiming such waters.

Materials and Methods

For the purpose of this study, three sources of wastewater *viz.* industrial, pharmaceutical and hospital was selected covering the major wastewater producing areas of Morris County. Wastewater samples were collected from different points under each of these wastewater resources covering four seasons of a year *viz.* winter, spring, summer and fall. Since BOD samples are degraded significantly during storage between collection and analysis resulting in low BOD values, the samples, collected in plastic bottles of one liter size, were cold stored and were taken for analyses within 48 hours. The samples were, however, taken at room temperature before analysis. The standard method of 5 day incubation at 20°C, recognized by U.S. EPA, which is labeled as Method 5210B in the Standard Methods for the Examination of Water and Wastewater [11] was used for this purpose. Since the bacterial population needs various nutrients for their survival and growth, those were added to the dilution water in the form of BOD nutrient buffer pillows. Added one pillow in three liters of distilled water to prepare the dilution water. This dilution water was then aerated for 5-10 mins and incubated at 20°C for 2 hours. The pH of the dilution water was maintained in a range suitable for bacterial growth (6.5 to

***Corresponding author:** M Dasgupta, Complete Analysis Laboratories, Analytical Research Department, 1259 Route 46, Suite 4C, Parsippany, NJ, 07054, USA, Tel: 8624859902; E-mail: manjisthad@yahoo.com

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7.5) through addition of sulfuric acid or sodium hydroxide, as needed to the dilution water to lower or raise the pH respectively. While most natural waters contain adequate amount of microorganisms some effluents, such as untreated industrial wastes, disinfected wastes and wastes that have been heated to a high temperature may contain too few bacteria to perform the test. Hence the samples were seeded with microorganisms for furthering the microbial activities. For guidance on seeding procedures, including the BOD_5 equation when dilution water is seeded, method of American Public Health Association was referred [12].

For carrying out the estimation, an aliquot from well mixed sample was taken and added to the bottle having about 150 ml dilution water plus 2 ml seed solution. Filled the bottle with dilution water to the neck. Prepare three dilutions at a time for each sample before taking the initial DO reading. The initial dissolved oxygen (DO) content and the DO value after 5 days incubation were estimated with the help of a Dissolved Oxygen Meter (YSI Model 59 equipped with oxygen electrode type YSI 5905 DO Probe). The BOD_5 values of the water samples were calculated from the differences in initial and final DO values of the water samples.

Results and Discussion

The test for biochemical oxygen demand (BOD) is a bioassay procedure that measures the oxygen consumed by bacteria from the decomposition of organic matter [1]. Mean BOD_5 values of waste waters collected from industrial areas of Morris County have been presented in Table 1. As observed from the table, the said values varied from 34.6 to 420.2 throughout the period of study with overall mean value of 196.5 mg/L. Considerable variations could be observed in BOD_5 values of wastewaters collected from different zones of the industrial areas of Morris County mean values of which varied from 42.9 to 397.0 mg/L. The values also showed considerable variations among different seasons exhibiting highest mean values during spring and lowest ones during winter and intermediate values during summer and fall season. Such low BOD values of wastewaters collected during winter season may be due to restricted microbiological population in water under this low temperature phase. Although all the samples were seeded with equal amount of microbial culture to induce the microbiological activity, yet these cultures could not probably raise the population and activities of the microorganisms to the levels of other seasonal samples owing to their very low initial occurrence. Such low microbial activity in the winter samples resulted in lesser oxygen consumption in these wastewater environments and thereby showed lower BOD_5 values than the samples collected in warmer seasons.

Waste waters collected from pharmaceutical areas showed comparatively lower BOD_5 values as compared to those of industrial zones with values ranging between 41.3 and 301.3 mg/L (Table 2). These values appeared to be more conducive to reclamation in the waste treatment plants than the industrial wastewaters with regard to organic loads. However some special measures may be required for purifying these pharmaceutical waste waters depending on some specific properties of these waters. Considerable variations were also observed in BOD_5 values of pharmaceutical waste water during different seasons exhibiting highest values in spring season and lowest ones during winter. Similar distributional pattern of BOD in waste waters during different seasons of the year has been reported and explained for industrial waste water earlier.

Wastewaters of hospital areas, in general, showed an intermediate occurrence in terms of BOD_5 with values ranging between 108.1 and 289.6 mg/L (Table 3). Although the BOD_5 values of wastewaters of this zone were substantially lower than industrial areas, yet they may contain some harmful components and special measures need to be taken for cleaning these waters. As in other cases, seasonal variations could be observed in organic loads of wastewaters in different seasons. In general, highest values were observed in spring season and lowest values were observed in winter. The other two seasons showed intermediate BOD_5 values. Similar behavior with regard to BOD_5 values of waste waters have been observed and explained for other kinds of wastewaters also. However the variations in BOD_5 values in the hospital generated wastewaters were not as prominent as were observed in other two wastewaters. Probably these hospital generated waste waters contained more amounts of easily degradable organic components which could be utilized by less diversified microbial community at faster pace thus reducing the seasonal differences to some extent.

	Industrial Area I	Industrial Area II	Industrial Area IIII	Industrial Area IV
Winter	159.8-350.0 (247.3)	96.0-246.0 (152.4)	34.6-50.1 (42.9)	182.9-250.8 (222.7)
Spring	292.0-338.0 (320.6)	122.0-164.4 (169.8)	228.0-321.0 (265.6)	384.2-420.2 (397.0)
Summer	227.0-294.0 (266.0)	143.0-169.0 (156.6)	146.0-263.0 (203.0)	361.8-401.8 (383.5)
Fall	220.3-275.2 (252.1)	66.4-177.0 (117.8)	43.7-214.0 (136.5)	227.4-312.6 (257.6)

(Figures in parenthesis indicate mean values)

Table 1: Seasonal variations in BOD_5 levels (mg/L) of wastewaters in industrial areas of Morris County.

	Pharmaceutical Area I	Pharmaceutical Area II	Pharmaceutical Area IIII	Pharmaceutical Area IV
Winter	27.6-52.7 (41.3)	54.6-114.4 (81.9)	61.1-84.2 (74.8)	68.3-102.6 (87.7)
Spring	186.4-201.0 (191.3)	258.4-330.0 (301.3)	129.4-210.2 (161.1)	183.6-273.0 (237.5)
Summer	145.0-236.0 (178.6)	164.6-212.6 (180.0)	139.6-172.8 (154.6)	147.6-189.2 (167.0)
Fall	66.59-202.0 (142.8)	91.6-136.4 (107.6)	125.6-213.0 (156.6)	119.6-204.6 (149.8)

(Figures in parenthesis indicate mean values)

Table 2: Seasonal variations in BOD_5 levels (mg/L) of wastewaters in pharmaceutical areas of Morris County.

	Hospital Area I	Hospital Area II	Hospital Area IIII
Winter	167.9-245.0 (216.1)	45.6-180.7 (108.1)	146.1-184.6 (169.3)
Spring	245.1-325.6 (289.6)	213.0-245.0 (228.6)	235.6-315.3 (265.3)
Summer	224.0-308.0 (256.6)	189.0-230.0 (212.3)	199.8-277.1 (229.0)
Fall	202.0-212.0 (205.8)	180.8-212.2 (201.2)	189.6-235.6 (210.1)

(Figures in parenthesis indicate mean values)

Table 3: Seasonal variations in BOD_5 levels (mg/L) of wastewaters in hospital areas of Morris County.

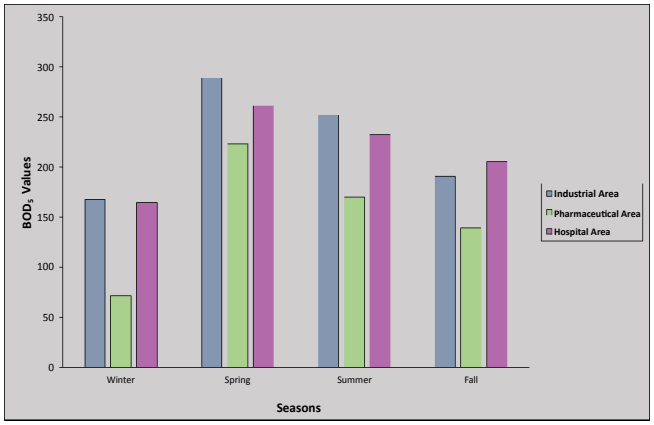

Figure 1: Mean variations in BOD_5 values for varying wastewater sources in different seasons.

Mean BOD_5 values of wastewaters from different sources and their seasonal variation have been shown in Figure 1. The figure indicates the highest BOD_5 values in such wastewaters to occur in spring and the lowest values to be in winter, as discussed earlier. It has been generally observed that BOD_5 values of untreated sewage varies around 600 mg/L in Europe while the values are as low as 200 mg/L in the U.S. The lower values in the U.S. are derived from the much greater water use per capita than in other parts of the world [13]. The BOD_5 values of wastewaters of Morris County also followed the same trend and did not exhibit very high values during any part of the year. This may be considered to be conducive for adopting suitable management strategies for treating such waters.

Conclusion

This study on BOD_5 values of different kinds of wastewaters of Morris County showed that the sources of the wastewaters played important roles in influencing the organic loads of these waters. Among the three kinds of wastewater studied, industrial effluents showed the highest BOD_5 load while pharmaceutical wastewaters showed the lowest values. However, in spite of exhibiting comparatively lower BOD_5 loads, the pharmaceutical and hospital wastewaters need to be treated with caution owing to the possibility of their containing some hazardous and harmful components. Moderate to severe seasonal variations in BOD_5 loads were also observed in these wastewaters. Therefore, depending on the variations in organic loads of these wastewaters in different seasons, suitable strategies may be made for reclaiming such waters.

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References

1. Sawyer CN, McCarty PL (1978) Chemistry for Environmental Engineering. McGraw-Hill Book Company, New York, USA.
2. Lee JD (1951) Simplified method for analysis of BOD data. Sewage and Industrial Wastes 23: 164-166.
3. Marske DM, Polkowski LB (1972) Evaluation of methods for estimating biochemical oxygen demand methods. J Water Pollut Control Fed 44: 1987-2000.
4. Robson MG (2002) Biological Oxygen Demand. Encyclopedia of Public Health.
5. Hütter LA (1992) Water & Water Investigations. Otto Salle Verlag Frankfurt am Main, Germany.
6. Heukelekian H, Gelman I (1951) Studies of biochemical oxidation by direct methods. Sewage and Industrial Wastes 23: 1267-1281.
7. Gajkowska-Stefanska L, Guberski S, Gutowski W, Mamak Z, Szperlinski Z (1994) Laboratoryjne badania wody, ścieków i osadów ściekowych.
8. Chen GH, Leong IM, Liu J, Huang JC, Lo IM, et al. (2000) Oxygen deficit determinations for a major river in eastern Hong Kong, China. Chemosphere 41: 7-13.
9. Nemerow NL (1974) Scientific Stream Pollution Analysis. McGraw-Hill.
10. Tchobanoglous G, Schroeder ED (1987) Water Quality Characteristics, modeling and modification. Addison-Wesley Publishing Company.
11. Clesceri LS, Eaton AD, Rice EW (2005) Standard Methods for Examination of water and Wastewater Method 5210B. Washington DC: American Public Health Association, American Water Works Association, and Water Environment Association.
12. American Public Health Association, American Water Works Association and Water Pollution Control Federation (1998) Standard methods for the analysis of water and wastewater. 20th edn. Washington DC, American Public Health Association, pp: 9-73.
13. Sawyer CN, McCarty PL, Parkin GF (2003) Chemistry for Environmental Engineering and Science. McGraw Hill, New York, USA.

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