NITRIFICATION STAGE IN BOD PROGRESSION

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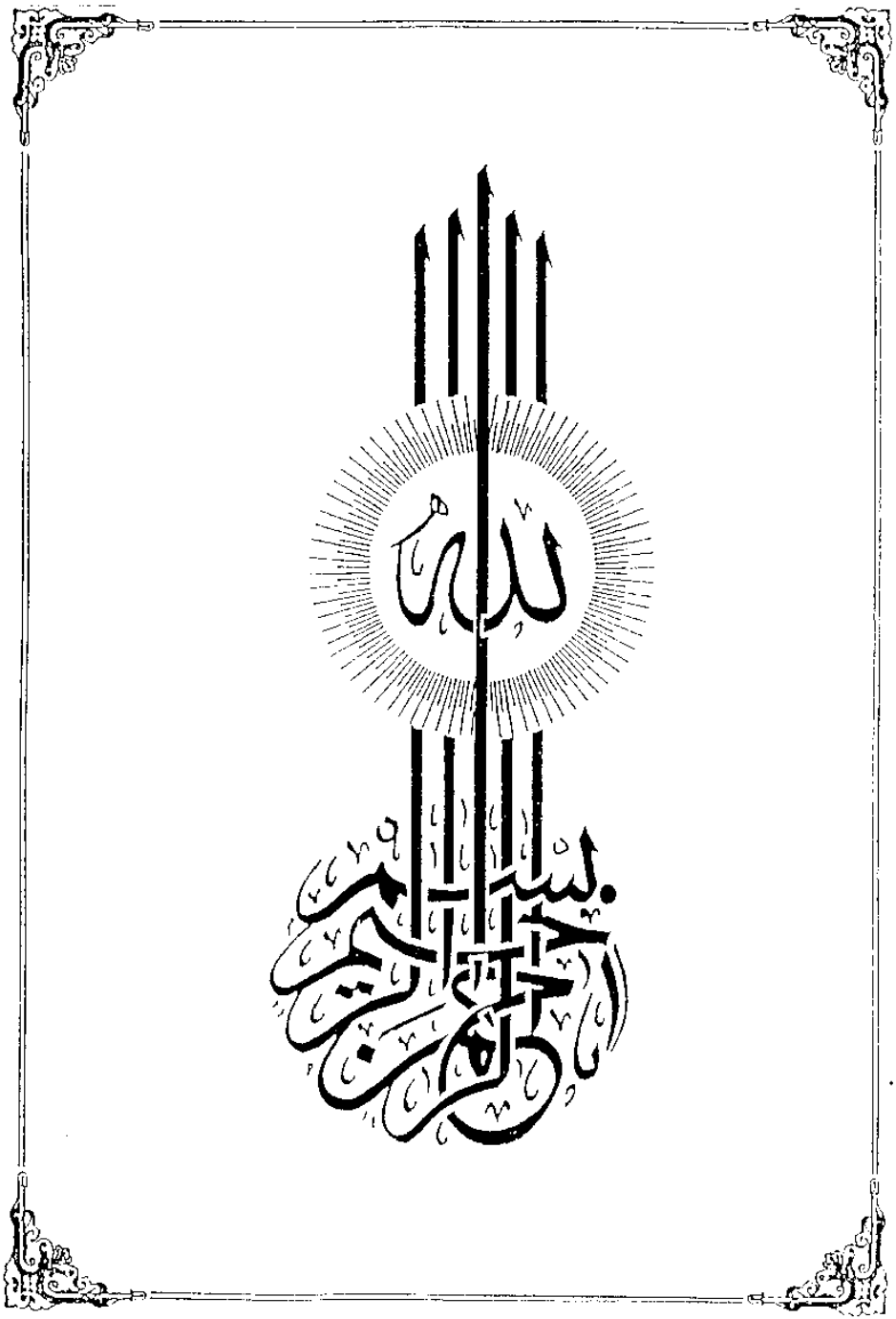

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ABSTRACT

The progressive exertion of BOD of freshly polluted waters normally breaks down into two stages : a first stage in which the carbonaceous material is largely oxidized and a second stage in which significant amount of nitrification takes place.

Nitrifying bacteria are usually present in relatively small numbers in untreated domestic sewage, and their production rate at 20°C is such that their populations do not become sufficiently large to exert an appreciable demand for oxygen until a relatively long period have elapsed in the regular BOD test. This is attributed to the present of excess concentrations of organic matter which inhibits the growth and respiration of nitrifying organisms at the early stages of incubation period. As the time is elapsed, the organic matter concentration reduces gradually until its concentration allow for the respiration and multiplication of nitrifying organisms.

Therefore, this study was undertaken to gain a complete understanding on the effect of carbonaceous organic matter concentration on the activity of nitrifying bacteria. Accordingly, several experiments were conducted on raw,

primary settled and final effluent from activated sludge sewage treatment plant and also on synthetic media to determine the BOD progression characteristics. The following conclusions were drawn from this study :

i- The 5-day BOD values of raw sewage samples ranged between 54 mg/l and 520 mg/l. The average 5-day BOD value of all the tested samples is 184 mg/l. This value represent in average 68% of the ultimate oxygen demand.

The k-values of all the tested samples ranged between 0.05 day^{-1} and 0.19 day^{-1} with an average value 0.085 day^{-1}.

ii- The 5-day BOD values of primary settled sewage ranged between 36 mg/l and 148 mg/l with an average value of the fifteen tested samples equal to 91 mg/l. This value represent in average 68% of the ultimate oxygen demand.

The k-values of all the tested samples ranged between 0.06 day^{-1} and 0.27 day^{-1} with an average value 0.10 day^{-1}.

iii- The 5-day BOD values of final effluent sewage samples varied between 0.90 mg/l and 13.0 mg/l with an average value for all the tested samples equal to 4.68 mg/l.

This value represent 84% of the ultimate oxygen demand.

The k-values of all the tested samples varied between 0.05 day^{-1} and 0.235 day^{-1} with an average value 0.124 day^{-1}.

iv- The presence of organic matter in excess concentrations, inhibits the growth and respiration of nitrifying organisms. One the concentration is reduced to 0.5 mg/l as respresented by the BOD, the activity of the nitrifying bacteria is not influenced by this concentration.

v- The relation between the incubation period "T_R" after with nitrification stage starts and the corresponding residual BOD is best represented by a straight line relationship.

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INTRODUCTION

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Biochamical oxygen demand (BOD) is usually defined as the amount of oxygen required by bacteria while stabilizing decomposable organic matter under aerobic conditions.

The term "decomposable" may be interpreted as meaning that the organic matter can serve as food for the bacteria, and energy is derived from its oxidation.

The BOD test is widely used to determine the pollutional strength of domestic and industrial wasts in terms of the oxygen that they will require if discharged into natural watercourses in which aerobic conditions exist.

The test is one of the most important in stream-pollution-control activities. By its use, it is possible to determine the degree of pollution in streams at any time. This test is of prime importance in regulatory work and in studies designed to evaluate the purification capacity of receiving bodies of water.

The BOD test is essentially a bioassay procedure involving the measurement of oxygen consumed by living organisms (mainly bacteria) while utilizing the organic matter present in a waste, under conditions as similar as

possible to those that occur in nature.

In order to make the test quantitative, the samples must be protected from the air to prevent reaeration as the dissolved-oxygen level diminshes. In addition, because of the limited solubility of oxygen in water, about 9 mg/l. at 20°C, strong wastes must be diluted to levels of demand in keeping with this value to ensure that dissolved oxygen will be present throughout the period of the test. Toxic substances must be absent and all accessory nutrients needed for bacterial growth, such as nitrogen, phosphorus, and certain trace elements, must be present.

Biological degradation of organic matter under natural conditions is brought about by adiverse group of organisms that carry the oxidation essentially to complete, i.e., almost entirely to carbon dioxide and water.

Therefore it is important that a mixed group of organisms, commonly called "seed" be present in the test.

The BOD test may be considered as a wet oxidation procedure in which the living organisms serve as the medium for oxidation of the organic matter to carbon dicxide and water.

It is possible to interpret BOD data in terms of organic matter, as well as the amount of oxygen used during its oxidation.

This concept is fundamental to an understanding of the rate at which BOD is exerted.

The oxidative reactions involved in the BOD test are a result of biological activity, and the rate at which the reactions proceed is governed to a major extent by population numbers and temperature.

Temperature effects are held constant by performing the test at 20°C, which is, more or less, a median value as far as natural bodies of water are concerned.

The predominant organisms responsible for the stabiligation of organic matter in natural waters are forms native to the soil. The rate of their metabolic processes at 20°C and under conditions of the test is such that time must be reckoned in days. Theoritically an infinte time is required for complete biological oxidation of organic matter, but for all practical purposes, the reaction may be considered complete in 20 days.

However, a 20-day period is too long to wait for results in most instances.

It has been found by experience that a reasonably large percentage of the total BOD is exerted in 5 days ; consequently the test has been developed on the basis of a 5-day incubation period.

It should be remembered, therefore, that 5-day BOD values represent only a portion of the total BOD.

The exact percentage depends upon the character of the "Seed" and the nature of the organic matter, and can be determined only by experiment.

In case of domestic and many industrial wastewaters, it has been found that the 5-day BOD value is about 70 to 80 percent of the total BOD.

This is a large enough percentage of the total so that 5-day values are used for many considerations.

The BOD or oxygen - used curve is shown in Fig.(1).

The BOD reaction is closely related to a first - order type of reaction, a plot of the amount of BOD versus time yields a parabolic curve during the first 8 to 10 days and it yields to the equation :

$$Y = L (1 - 10^{-Kt})$$

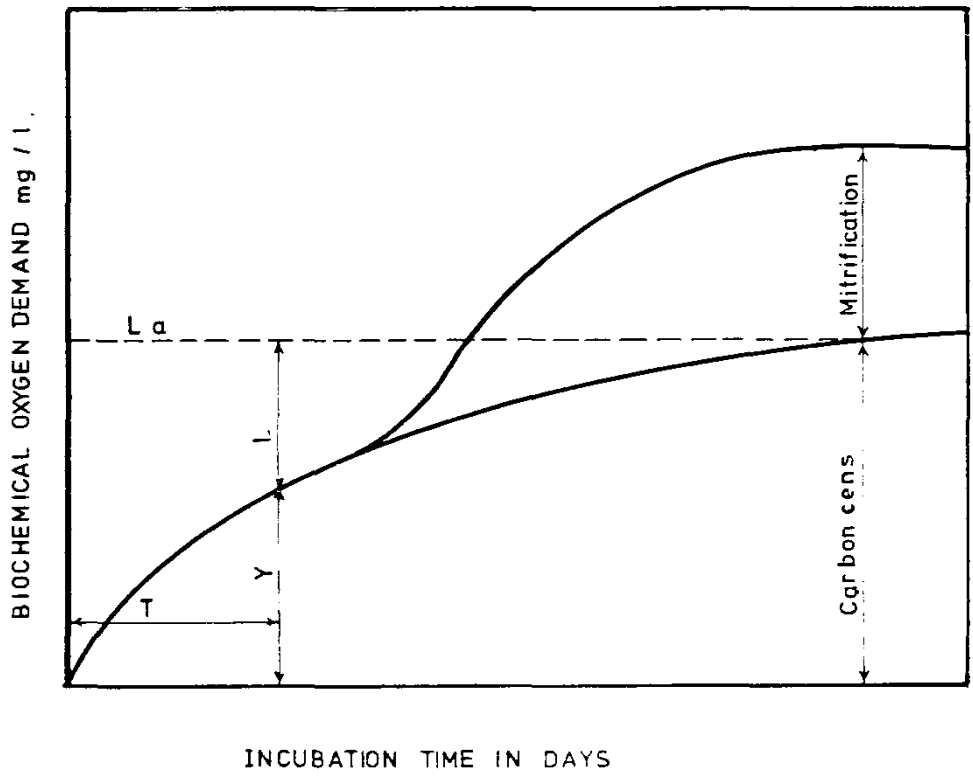

Fig. 1_ PROGRESS OF BIOCHEMICA OXYGEN DEMAND OF FRESHLY POLLUTED WATER

where Y = BOD at any time t.

L = the total or ultimate BOD.

K = It is determined by experiment.

Following that, the BOD curve digresses radically from the course it would be expected to follow as a unimolecular or first-order reaction.

The importance of having a mixed culture of organisms corresponding to those in the soil, for proper measurement of BOD, has been mentioned.

Such cultures, when derived from the soil or domestic sewage, contain large numbers of saprophytic bacteria and other organisms that utilize the carbonaceous matter present in the samples subjected to BOD analysis, and use oxygen in a corresponding amount.

In addition, they normally contain certain autotrophic bacteria, particularly nitrifying bacteria, which oxidize noncarbonaceous matter for energy.

The nitrifying bacteria, as the members of the family Nitrobacteraceae are called, include species of diverse morphological types - rods, cocci, and spiral - shaped cells. They are polar-flagellated, non-sporulating, and gram-negative. Physiologically. They are