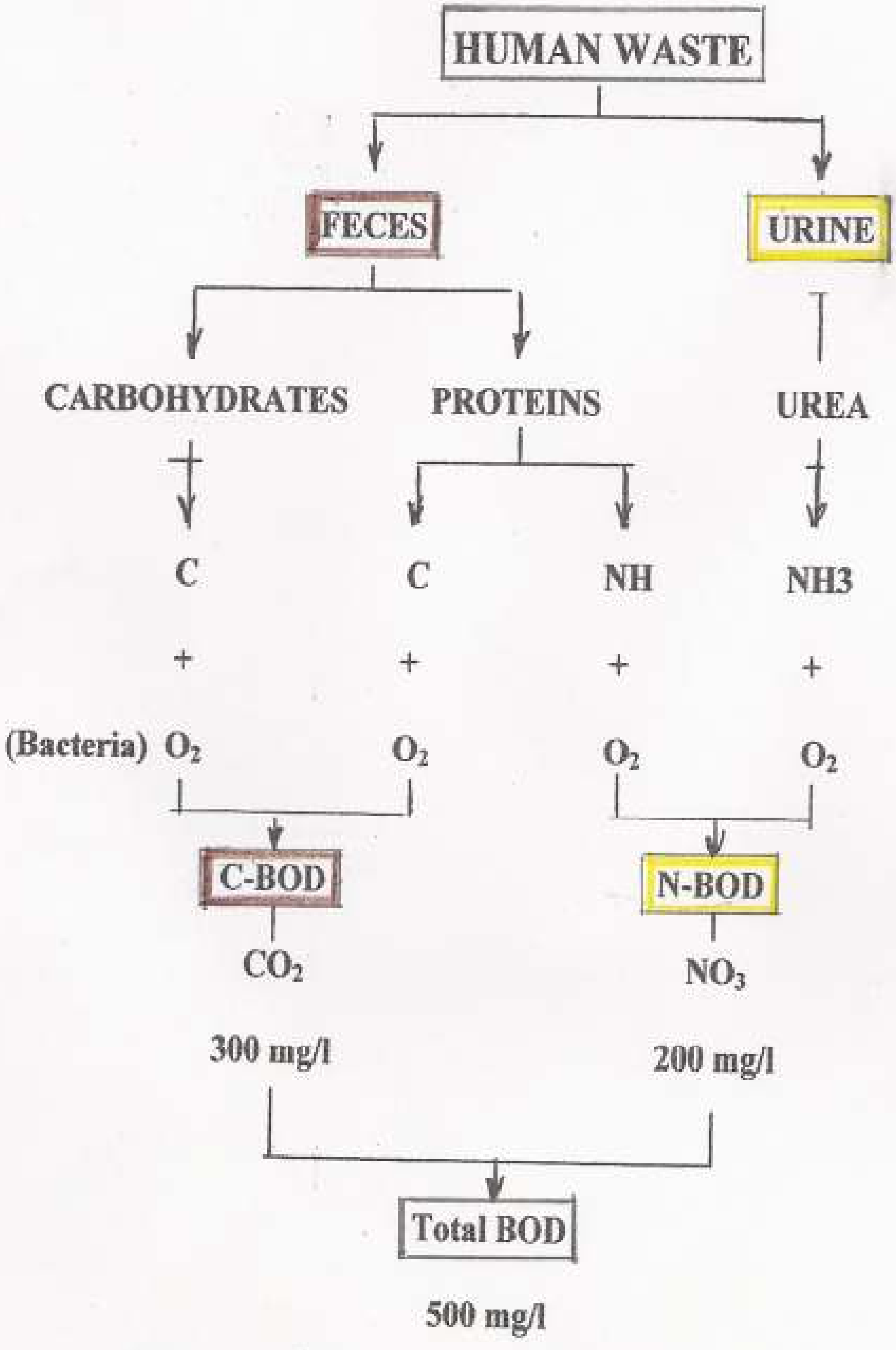
HUMAN WASTE
FECES
URINE
CARBOHYDRATES
PROTEINS
UREA
C
C
NH
NH3
+
+
+
+
(Bacteria) O2
O2
O2
O2
C-BOD
N-BOD
CO2
NO3
300 mg/l
200 mg/l
Total BOD
500 mg/l

What is sewage treatment?
Until 1970 its purpose was to reduce or eliminate nuisances and sewage treatment technologies, developed more then a century ago, represented this purpose.

Of course now we know that sewage causes more then nuisance problems and are part of the food chain. Unfortunately sewage treatment is still shrouded by in some kind of mystery and many unrelated 'treatment' processes are often mixed up, making it even more confusing, which often opens the door to exaggerated black box solutions.

The basic principle of water and sewage treatment is the separation of unwanted solids from the water carrying these solids. What type of separation method is used is a function of the physical conditions of these solids. If they are big they can be filtered out, of course based on the filter used. If they are heavy and settle out by gravity, they can be separated using settling or such action can be enhanced by using coagulating chemicals, as very common in treating drinking water and some industrial wastewater treatment applications.

Depending the goal of treatment, which solids have to be removed, this is often sufficient (as is the case in drinking water), but in case solids that can not be filtered out or settled out, they first have to be adsorbed by another medium, which then can be separated from the water, by settling or filtration. Any unwanted solids in drinking water, that can not be removed by filtration or settling, can be removed by activated carbon, while in sewage treatment activated sludge (biomass) is used for this adsorption, followed by the settling process, to achieve separation..

The adsorption/settling action depends on the biomass maintained and the actual removal of solids from the sewage with biomass consequently yields the removed solids as sludge.

The efficiency of a sewage treatment plant mainly depends how efficient these solids are adsorbed to the activated sludge and therefore is a function of the composition of the biomass maintained. The different biological sewage 'treatment' processes are thus a function of the composition of biomass maintained in a system. It basically is a feedlot operation, except one does not want to raise the bugs, but want the bugs the remove waste.

Carbonaceous waste basically is adsorbed and used by heterotrophic bacteria, while nitrogenous waste is directly used by autotrophic bacteria, both requiring oxygen for their survival. Heterotrophic bacteria grow fast and are very hardy, surviving in nearly all environments where there is food and oxygen, while autotrophic bacteria grow slower and do require a more suitable environment. Both however can survive in the same environment and when the biological process of a sewage treatment plant is properly designed, both carbonaceous and nitrogenous waste can be taken care of.

The tricky 'design' part here is not only the hourly fluctuating flows, but also its food composition. These fluctuation can be taken care of, not only hydraulically (fluctuating flows) but by maintaining a biomass acclimated to such food composition fluctuation.

Since odor problems were mostly related to carbonaceous waste, sewage treatment plant were mostly designed to maintain a heterotrophic biomass. This biomass was maintained either grown on stones in trickling filters or suspended in different activated suspended sludge reactors, each claiming their special advantages.

For a period it was assumed that heterotrophic and autotrophic bacteria required separated environments (reactors), which resulted in actually two different treatment/separation processes and which of course was very expensive. Hence probably the fact that EPA did not want to address nitrogenous waste in sewage, although it is more likely that was caused by a lack of understanding, mainly caused by the lack of understanding of the BOD (Biochemical Oxygen Demand) test.

One however can not stop Mother Nature and when food and oxygen is available autotrophic bacteria will survive in a treatment system supposedly solely designed to hold heterotrophic bacteria taking care of carbonaceous waste. Here the problem is that when ammonia is nitrified into nitrates, this, in the final clarifiers (where there is no supply of oxygen), facultative bacteria reduce the nitrates into nitrogen gas and when this small gas bubbles adhere to the biomass, the biomass will not settle, but actually floats. The separation process consequently does occur, as was planned and the biomass leaves the plant with the effluent. And when one loses biomass the entire treatment process fails.

Since regulations do not require proper testing, the limited test data available is insufficient to even determine how a sewage treatment plants perform. It clearly is also impossible to analyze any problems occurring in plants.

We also have seen technical papers dealing with sewage treatment side effects, like conditions of excess sludge or aerosols, which do not even look at what biological processes, are applied in such sewage treatment plants.

Although probably not initially intended, Dr. Pasveer in 1946 developed the oxidation ditch, which basically created a controlled environment for all the biological processes, we as humans do not like to happen in our rivers. The biomass in this process does not only contain the necessary heterotrophic and autotrophic bacteria but also higher order micro-organisms, such as rotifers, representing the next level in the food chain.

These oxidation ditches operated by sequencing aeration/mixing and settling to maintain the biomass in the ditch. They were reliable and very easy to operate and also much less expensive to built as conventional sewage treatment plants.

Still there is and was reluctance in the engineering profession to build them, mainly because, due to incomplete testing, nobody recognized how well these systems perform.

If the BOD test had been properly applied, as it was developed in 1920 (the C-BOD5 in combination with the TKN test), we not only would have known what is in sewage (how much carbonaceous and how much nitrogenous waste) but we also would have known how well sewage treatment plants worked and could have made correct cost benefits analyses of the different systems. IF this data would have been available in the seventies, nobody would have even considered building the conventional odor control plants and we would well have achieved the interim (swimmable and fishable rivers) goal of the CWA and even have come close (95 to 98% treatment to the ultimate goal: the elimination of all pollution, thereby only assuming 'conventional' human municipal waste.

When we are concerned with excess sludge and how PPCP's are treated in sewage treatment plants, we should also look at the biological processes maintained and not assume that all sewage treatment is the same.

Hindsight is always 20/20, but there is no reason why we can not learn from our mistakes in the past and correct what we knowingly have been doing wrong. The Western world is in a financial position to start over, but by not exposing the fact what this incorrect testing has done to our Western World environmental programs, we run the risk that the same mistakes are made in less developed countries.

BOD TEST.

By: Peter Maier, Ph.D., P.E.
February 17, 1993.

INTRODUCTION.

Early research in sewage treatment identified sewage as a food source for microorganisms. Biochemical oxidation processes use oxygen and are causing a depletion of dissolved oxygen in open waters receiving sewage. In order to predict this depletion of dissolved oxygen in rivers, English researchers early this century developed the BOD test. BOD stands for Biochemical Oxygen Demand and the test measures the utilization of oxygen by microorganism ‘feeding’ on carbonaceous and nitrogenous compounds in sewage. Although the food chain incorporates many elements, the carbon and nitrogen compounds are mainly responsible for the depletion of dissolved oxygen when sewage is discharged into open waters. Although originally developed for the prediction of dissolved oxygen depletion to determine the oxygen sag in rivers, the BOD test in the fifties and later was commonly used to decide if wastewater was biodegradable, to evaluate the performances of a sewage treatment plants and to design sewage treatment facilities. EPA in 1972 selected the BOD_5 test to be the backbone of its nationwide NPDES regulatory program.

DESCRIPTION OF THE BOD TEST.

A sample to be tested is put into a test bottle with a certain amount of water saturated with oxygen and sometimes seeded with microorganisms and kept at a temperature of 20 degrees Celsius. The daily dissolved oxygen level can be used to calculate the oxygen used for biochemical oxidation and this can be graphically displayed in the BOD curve. Most organic matter is completely biodegraded in about 30 days at 20 degrees Celsius temperature. With other words no more food left after 30 days.

If applied on raw sewage, this graphical display actually represents two BOD curves. The C-BOD (Carbonaceous BOD) curve as the result of heterotrophic organisms using carbonaceous (fecal) waste and the N-BOD (Nitrogenous BOD) curve, as a result of nitrifiers (autotrophic microorganisms) using nitrogenous (urine and proteins) waste. Based on early research, it is assumed that the nitrifiers only use measurable amounts of oxygen after the test is six to eight days in progress. A phenomenon explained in the literature with the following reasons:

1. Limited amount of nitrifiers in raw sewage
2. Nitrifiers grow slower than heterotrophic organisms.
3. Nitrifiers can not compete for oxygen with the heterotrophic organisms, therefor do not proliferate during this period.

The 5 day reading of the test, therefore was considered to represent the C-BOD_5 value of the total BOD test. The total BOD test (C-BOD and N-BOD) would require at least 30 days at a temperature of 20 degrees Celsius. Since the N-BOD could be measured with the TKN (Total Kjeldahl Nitrogen) test, it became common to use the 5 day BOD test value in combination with the TKN test value, in order to save time (see figure 1). The total BOD value could be calculated by using the following formula:

$$\text{Total BOD} = 1.5 \times BOD_5 + 4.6 \times TKN.$$

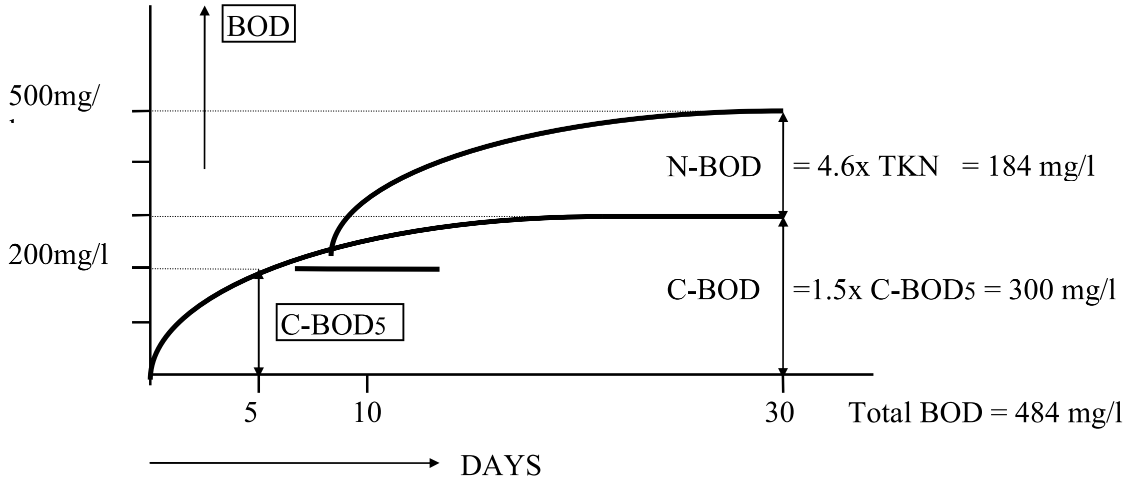

FIGURE 1: BOD curve representing raw sewage with the generally assumed values in most literature.

Although clearly intended to be used as a time saver, the engineering profession started to use the BOD5 test in the early fifties by itself and its value was often equated with the oxygen required to stabilize all organic matter in sewage. When the EPA initiated its NPDES permit program, it selected the BOD5 test for its 85% treatment standards. The graph clearly shows that the 85% BOD5 treatment in reality is 85% of 41% equals 35% BOD treatment. The lack of nitrifiers, neither the restrictive growth conditions exist, in case the BOD test is applied on the effluent of a sewage treatment facility. The 5 day test value of the test, consequently, does not necessarily represent the C-BOD5 value alone, but can be the summation of C-BOD5 and N-BOD5.

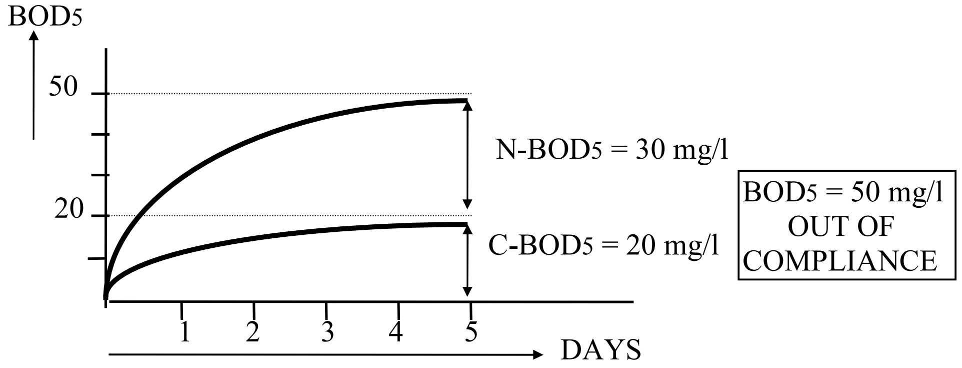

FIGURE 2. BOD5 curve performed on effluent of treatment facility

High BOD5 test values on an effluent could cause a sewage treatment facility to be out of compliance with its NPDES discharge permit, while a large fraction of the BOD5 test value represented N-BOD5, a form of water pollution, similar and more damaging than the C-BOD5 water pollution, but not regulated by the NPDES regulatory program.

The BOD5 test value by itself should not be used, since the results are incomplete and misleading as the following examples clearly show.

EXAMPLES.

Average strength raw sewage, according to literature will have the following test values:

BOD$_5$ = 200 mg/1
TKN = 40 mg/1, if tested, but not required for discharge permit.
Total BOD = 1.5 x 200 + 4.6 x 40 = 484 mg/1.

Secondary Treatment, in accordance to NPDES permit: BOD$_5$ < 30 mg/1, TKN not controlled by NPDES permit and not tested.

Treatment Results of **Plant A**:

BOD$_5$ [C-BOD$_5$] = 25 mg/1.

[TKN = 40 mg/1 , but not tested.]
Effluent BOD = 1.5 x 25 + 4.6 x 40 = 222 mg/1.

The treatment efficiency is only 54 %, but the plant is in compliance with its NPDES discharge permit.

Treatment Results of **Plant B**:

BOD$_5$ = 35 mg/l (out of compliance)
[C-BOD$_5$ = 20 mg/l, if properly tested]
TKN = 20 mg/l.
Effluent BOD = 1.5 x 20 + 4.6 x 20 = 122 mg/l.

The treatment efficiency is 75%, but the plant, prior to 1984, would be out of compliance with its NPDES discharge permit. NPDES regulation change in 1984 now allows the use of the C-BOD$_5$ test and a simple addition of chemical in the test bottle brings the facility in compliance with its NPDES permit.

Treatment Results of **Plant C**: (Best available biological treatment)

BOD$_5$ =10 mg/1

[C-BOD$_5$ = 6 mg/1 and TKN = 5 mg/1]

Effluent BOD = 1.5 x 5 + 4.6 x 5 = 31 mg/1.

The treatment efficiency is 94%.

All the above given examples are assuming that incoming sewage has a BOD$_5$ test value equal to the C-BOD$_5$ test value, which assumption may be wrong in many cases. The test results at the Salt Lake City sewage treatment facility would yield the following BOD curve for its incoming sewage and clearly deviates from the assumed BOD curve for raw sewage commonly accepted in the literature

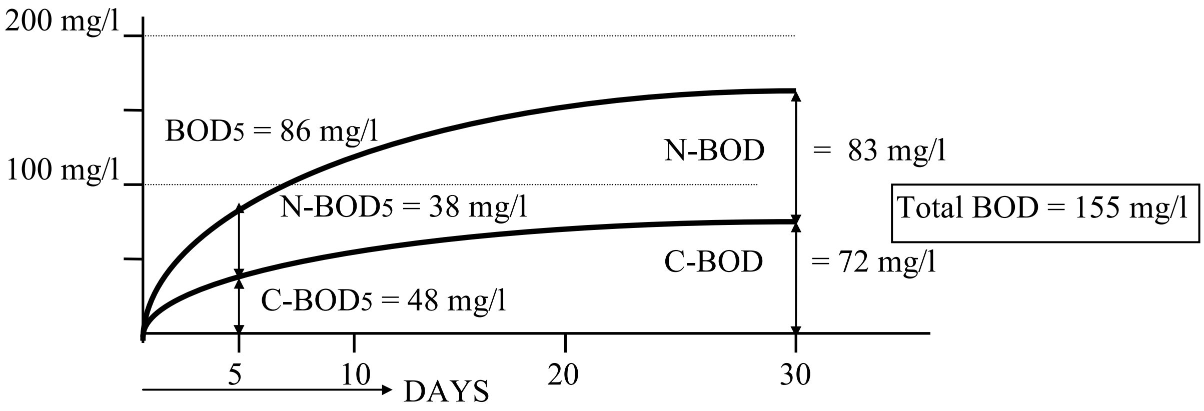

FIGURE 3. BOD test curve, representing incoming sewage in Salt Lake City's sewage treatment facility. C-BOD5 = 48 mg/l and TKN = 18 mg/l.

CONCLUSION.

Correct test data on raw sewage is unfortunately hardly available, since it is generally assumed that the BOD5 test data represents the C-BOD5 test data. This assumption is still maintained in the TEN STATE STANDARDS and consequently in many State standards. The BOD5 test data is also still used for the design of the biological treatment process in sewage treatment facilities.

The correct testing in Salt Lake City clearly showed that the plant was under-loaded for the waste (C-BOD) it was designed to handle, but that the plant in stead was receiving waste (N-BOD) it clearly could not handle, since nitrification did not occur in the plant. The nitrifying organisms, contrary to the general assumptions, are already present in the sewage when it arrives at the facility and did not grow in the "under-loaded" facility. C-BOD5 test results in Chicago and San Diego indicate that the Salt Lake City's test results are not unique and that similar conditions are more then likely to exist in other cities, especially when the sewage detention time in the collection systems is long, temperature elevated and a supply of oxygen available.

To evaluate water pollution caused by wastewater and to properly design a wastewater treatment facility, it is essential to know if the wastewater contains carbonaceous or nitrogenous waste. This is only possible if the BOD test is properly applied, i.e. the C-BOD5 test in combination with the TKN test. The independent use of the BOD5 test should not be allowed, since its value does not have any technical meaning, is misleading and only creates problems.

Letters Journal WPCF, Volume 54, Number 7

More on the BOD$_5$ test

We wish to submit the following rebuttal to a letter by Russell, Heddle, and Cooper that appeared in the December 1981 issue of the *Journal* (pp. 1666-1667) and raised some questions about our article published in the July 1981 *Journal* ("Alterations in the BOD procedure for the 15th edition of 'Standard Methods for the Examination of Water and Wastewater,'" pp. 1253-1259).

The questions raised by Russell *et al.* with regard to the uses of and problems with the BOD test relate to concerns of the BOD Task Group. One goal of the BOD Task Group was to correct problems—including nitrification—with the BOD test technique that affect accuracy and precision and usefulness of test results. We believe this goal was largely accomplished, but the writers wish to take this opportunity to respond to specific points raised by Russell *et al.*

- Nitrification. The consideration of nitrification is not new; its impact on BOD tests has been recognized since the 1920s. A major question is whether nitrogenous oxygen demand should be considered as part of the "standard" BOD measurement. To understand this question and the impact of nitrification on BOD test results, one must go back to the 1920s and 1930s when in-depth investigations of the BOD test were conducted.

At that time, the "first-stage," or carbonaceous BOD, and "second-stage," or nitrogenous demand, were recognized and separated for purposes of describing oxygen demand reactions and for evaluating the impact of waste loads on receiving streams. The classical Streeter-Phelps oxygen sag model contains separate terms to account for the different effects of carbonaceous and nitrogenous oxygen demand. One problem with establishing modern stream standards and discharge regulations was that this differentiation between carbonaceous and nitrogen oxygen demand was ignored or forgotten. To allow some or all of the nitrogenous demand to be included in the carbonaceous oxygen demand term of oxygen sag models, as suggested by Russell *et al.*, was and still is erroneous.

Similarly, inadequate knowledge of the effect of nitrification on BOD tests has caused difficulties with use of the test for measurement of treatment plant performance and with defining and complying with "secondary treatment" regulations. Unfortunately, at the time secondary treatment was defined in terms of BOD (<30 mg/l average, 45 mg/l maximum 30 days), the relationship between nitrification in BOD tests and treatment plant performance was not recognized even though inhibition of nitrification in some manner has been available for decades. It was not invented for the 15th edition of "Standard Methods." Improved treatment brought this need into greater frequency. When nitrifying organisms become more numerous in the treatment system they are present in sufficient numbers in treated effluents to exert a substantial use of oxygen in incubated BOD bottles. In effect, as carbonaceous BOD removal by a treatment process improves, the measure of performance—the BOD test—fails and indicates poorer performance. Numerous field tests have verified that it is not possible to consistently provide effluents of "secondary treatment" quality unless nitrification is controlled in the BOD test by using appropriate procedures for its inhibition. Further discussion of these problems with nitrification is presented by Dague[1] and by Barth[2] in recent issues of the *Journal.*

Thus, at least two "uses" of the BOD test—prediction of the impact of waste loads on streams and evaluation of treatment plant performance—have been seriously affected by failure to exclude the nitrogenous oxygen demand from BOD test results. The routine separation of carbonaceous and nitrogenous oxygen demands will bring about proper conduct and use of the procedure and will provide a better measure of the biological reaction it is designed to measure. If the impact of nitrogenous oxygen demand of streams is important, then more accurate data will be available for making these determinations. If nitrogenous oxygen demand is not important, then the treatment plant will not be faulted.

- Toxicity Assessment. Russell *et al.* mentioned the use of respirometers as a more appropriate means of assessing the effect of toxic wastes. This is recognized by the BOD Task Group, and work is in progress to develop an acceptable respirometric test technique.

- Reproducibility (Accuracy and Precision). We agree that further improvements are needed to reduce variability in BOD test results, and the BOD Task Group generally is aware of sources of variation such as temperature, time of incubation, mixing, and seeding. However, at this time, the magnitude of variability attributed by Russell *et al.* to incubation time (1.4 to 9.6% for ± 4 hours' variation), temperature (7 to 17% for a 2°C variation), and stirring (2.7%) is difficult to accept by the writers. It seems quite possible that this variability can be attributed to uncontrolled nitrification that could be occurring with the high-nitrogen albumin wastes in the referenced tests. Stirring of samples in BOD bottles was addressed by the task group but was not considered to provide sufficient benefit to offset the complications it would introduce.

The BOD Task Group will reconsider these and other factors in future deliberations as better information on their effects become available and would appreciate receiving well-controlled test data from Russell *et al.* and others who are interested in improving the BOD test procedure.

James C. Young
Iowa State University
Ames, Iowa

Gerald N. McDermott
The Procter and
Gamble Company
Cincinnati, Ohio

David Jenkins
The University of

PROCEEDINGS OF THE

UTAH WATER POLLUTION CONTROL ASSOCIATION

1983 ANNUAL MEETING

APRIL 20-21,1983
PARK CITY,UTAH

Compiled by
Stanley L. Klemetson

College of Engineering & Technology
Brigham Young University
Provo,Utah 84602

ARE POLLUTION REGULATIONS IN TOUCH WITH REALITY?

Peter Maier

INTRODUCTION

Public Policy

> Whereas the pollution of the waters of this state constitute a menace to public health and welfare, creates public nuisances, is harmful to wildlife, fish and aquatic life, and impairs domestic, agricultural, industrial, recreational and other legitimate beneficial uses of water, and whereas such pollution is contrary to the best interests of the state and its policy for the conservation of the water resources of the state, it is hereby declared to be the public policy of this state to conserve the waters of the state and to protect, maintain and improve the quality thereof for public water supplies, for the propagation of wildlife, fish and aquatic life, and for domestic, agricultural, industrial, recreational and other legitimate beneficial uses; to provide that no waste be discharged into any waters of the state without first being given the degree of treatment necessary to protect the legitimate beneficial uses of such waters; to provide for the prevention, abatement and control of new or existing water pollution; to place first in priority those control measures directed toward elimination of pollution which creates hazards to the public health, to insure due consideration of financial problems imposed on water polluters through pursuit of these objectives; and to cooperate with other agencies of the state, agencies of other states and the federal government in carrying out these objectives. (Section 73-14-1, Utah Code Annotated 1953, as amended.)

The wording and intent of this policy is clear—no discharge of harmful waste in public waters. This, however, is a rather general statement. The implementation, therefore, depends on the rules and regulations, which should be more specific in order to effectively protect the water quality of public waters.

WATER QUALITY

To protect the water quality of public waters, it is necessary to establish water quality criteria, and it should be realized how these criteria are effected by certain discharges. The most sensible water quality criteria are related to the physical and chemical characteristics of the waterbody in its natural state, thereby realizing that several element recycling processes do occur as part of essential life cycles.

SEWAGE

Sewage normally contains solids and creates a visual increase of turbidity in the receiving waterbody. However, sewage is also a food source for microorganisms and as such will stimulate biological activity and growth. In turn, this activity utilizes oxygen that is dissolved in the water. In case the consumption of oxygen is larger than the oxygen supply out of the atmosphere, this will result in a lowering of the dissolved oxygen level in the waterbody, which consequently will affect the ecological balance. Sewage also may contain pathogenic bacteria.

WATER POLLUTION REGULATIONS

The regulations are the specific tools to enforce public policy and to protect the water quality of a waterbody. In general, regulations emphasize four pollution categories:

1. Visual pollution.
2. Depletion of dissolved oxygen, due to biological activity.
3. Bacteriological contamination.
4. Toxicity, due to specific chemical discharges.

The first three categories are relatively simple to test and quantify. Visual pollution relates to the SS (Suspended Solids), the depletion of oxygen relates to the BOD (Biochemical Oxygen Demand) and the bacteriological contamination relates to the E-Coli test. The fourth category, toxicity, is more difficult to qualify and quantify and requires sophisticated analytical testing.

POLICY ENFORCEMENT

The enforcement of the regulations is achieved by a system of discharge permits issued by the appropriate public agency. In this paper only the BOD value and the effects of chlorination are closely examined, in terms of their function and their application in the regulations.

BOD (BIOCHEMICAL OXYGEN DEMAND)

Biochemical processes are extremely complex, where it concerns the numerous individual chemical reactions. In general the cellular processes, where they concern energy production and the use of external oxygen, are identical. Figure 1 shows the chain of chemical reactions which are the basis for the energy cycle in the cells. It is important to realize that the oxygen from the environment is utilized in the respiration chain to react with the hydrogen carrying electrons for oxidation.

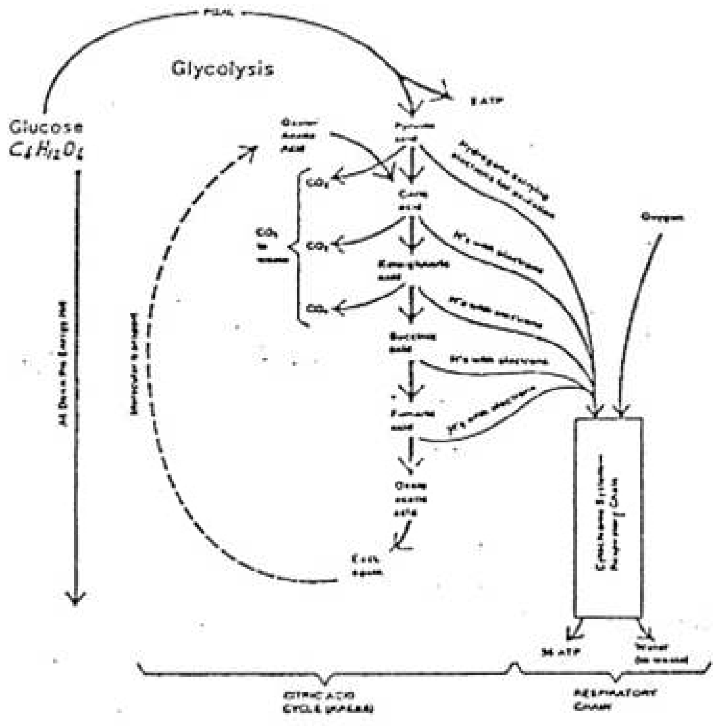

FIGURE 1 RESPIRATION IN CELLS.

BOD TEST ON RAW SEWAGE

Figure 2 shows the graphical results of a typical BOD test performed on raw sewage. Although hundreds of different microorganisms species are involved, they can be categorized in two classes:

1. Autotrophs, utilizing inorganic carbon.

2. Heterotrophs, utilizing organic carbon.

When the biochemical oxygen demand is allocated on the basis of autotrophs and heterotrophs, two curves appear, often referred to as carbonaceous BOD (heterotrophs) and nitrogenous BOD (autotrophs), more known as nitrification.

In case raw sewage is tested under standard conditions, the test results during the first five days are mainly the results of the activities of the heterotrophs, as the environment during this period is too competitive for the autotrophs. The activities of the autotrophs, better known as nitrifiers, will become more important after five to eight days, provided no special measures are taken. The separate curves certainly have academical value, but it should be emphasized that the receiving waterbody will be subject to both demands. In fact, the value after five days ($BOD^{20}/5$) is only valuable as a time saver. Ignoring the biochemical oxygen demand exertion by the nitrifiers is incorrect and leads to misunderstanding and misinterpretation.

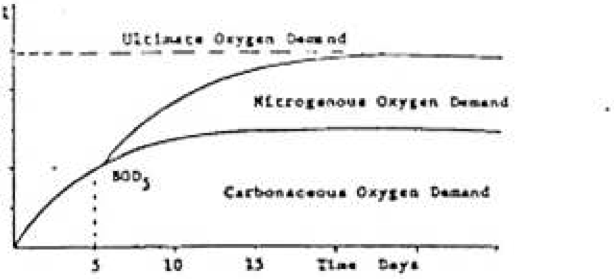

Figure 2. BOD test on raw sewage.
Typical sewage: BOD_5^{20} = 200 mg/l, TKN = 40 mg/l
Ultimate BOD : 1.5 x BOD_5 + 4.6 x TKN =484 mg/l

$BOD^{20}/5$ TEST ON THE TREATED SEWAGE

In treated sewage there does not exist a competitive environment for the nitrifiers, since the carbonaceous BOD is largely satisfied. Nitrogenous oxygen consumption, therefore, is not delayed and the result of the $BOD^{20}/5$ test can be a summation of carbonaceous and nitrogenous BOD, as is shown in Figure 3.

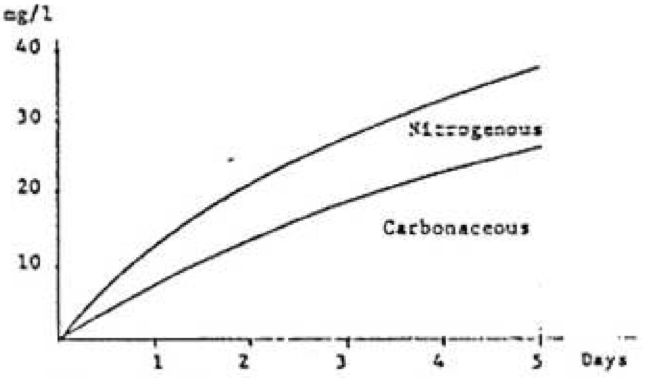

Figure 3. BOD_5 test on treated sewage.

EVALUATION OF TREATMENT PLANT PERFORMANCE

Sewage treatment plants are primarily designed to meet discharge permits, and operating tests normally reflect this objective. Unfortunately, the discharge permits do not differentiate between carbonaceous and nitrogenous BOD and, up until recently, did not set any standards for nitrogen. Consequently, most plants only have data related to BOD_5 and SS, without any nitrogen data. Therefore, it is not possible to evaluate plant performance properly.

PRACTICAL CONSEQUENCES

Relying on BOD_5 and SS values can lead to the following practical consequences:

SEWAGE : 200 mg BOD_5/l　　　$BOD_{ult.}$ = 483 mg/l
40 mg TKN /l

Effluent Requirement : 30 mg BOD_5/l
no nitrification

Plant 1. Activated Sludge, without nitrification.

Effluent　25 mg BOD_5/l
40 mg TKN /l

Remaining O_2 demand : 1.5 x 25 + 4.6 x 40 = 222 mg/l
Removal = 54 %　　In compliance.

Plant 2. Two-Stage Trickling Filter.

Effluent　33 mg BOD_5/l ----- 23 mg BOD_5^c/l
----- 10 mg BOD_5^n/l
15 mg TKN /l

Remaining O_2 demand : 47 + 4.6 x 15 = 116 mg/l
Removal = 76 %
Out of compliance.

DISINFECTION OF TREATED SEWAGE

Figure 4 shows all the chemical reactions involved when treated sewage is contacted with chlorine. Since free chlorine is toxic to fish, its discharge clearly violates public policy. The simplistic approach to omit this violation is to require de-chlorination, but is this really providing a solution? During the last decade, information has become available which seriously questions the need for disinfection at all. Not only that the effectiveness of disinfection (destruction of pathogens) is highly questionable, but more concern is presently given to the extraneous chemical reactions during the chlorination process. Several of the formed chlorinated hydrocarbons are known carcinogens. Already twenty-five states have dropped disinfection as a general requirement, in spite of the controversies that still surround this issue.

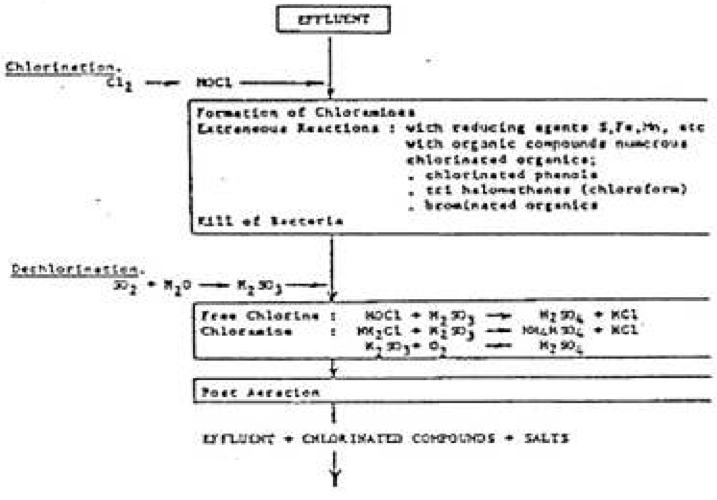

Figure 4. Disinfection of treated sewage.

CONCLUSION

The past regulations, which were solely based on BOD_5, SS and E-Coli, clearly were not the right tools to implement public policy. Even the present incorporation of ammonia limitations do not reflect a scientific approach to the water pollution policies, but in fact will only contribute to the confusion. To make the implementation of public policies effective, regulations should be based on science.

The objectives in the WPCF's constitution are centered around a better understanding of water pollution problems; consequently, it is well within the realm of the Association to support an action to change the present regulations.

REFERENCES

1. Biology. Observation and Concepts. By James F. Case (1971).
2. Inhibition of nitrogenous BOD and treatment plant performance valuation. By Richard E. Dague, WPCF Journal, December 1981.
3. More on the BOD_5 test. Letters WPCF Journal, July 1982, by BOD Task Group (Jenkins, Young and McDermott).
4. WPCF Manual of Practice No. 8. Wastewater Treatment Plant Design, 1977.
5. Standard Methods. 15th Edition, 1980.