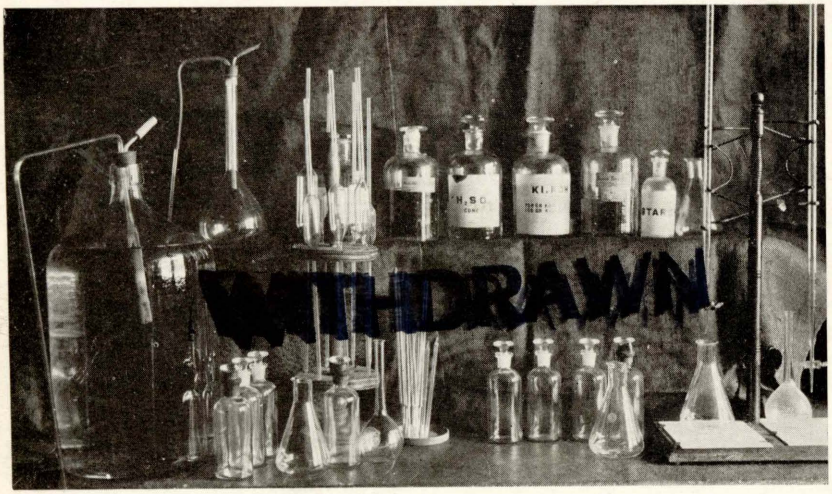
IOWA STATE COLLEGE
OF AGRICULTURE AND MECHANIC ARTS
OFFICIAL PUBLICATION

VOL XXIII | February 25, 1925 | No. 39

THE PRACTICAL APPLICATION OF THE BIOCHEMICAL OXYGEN-DEMAND TEST

By J. A. CHILDS

Presented at the Sixth Conference on Sewage Treatment
at Ames, Iowa, October 28, 29 and 30, 1924



Bulletin 73

ENGINEERING EXTENSION DEPARTMENT
IOWA STATE COLLEGE
AMES, IOWA

Published weekly by Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa. Entered as Second-class matter and accepted for mailing at the special rate of postage provided for in Section 429, P. L. & R., Act of August 24, 1912, authorized April 12, 1920.

CONFERENCES on sewage treatment are held annually at Iowa State College under the auspices of the Engineering Extension Department. These meetings are of a practical nature and are arranged for municipal officials and all others directly or indirectly responsible for the operation of sewage-treatment plants.

This publication is one of the more general papers that were presented at the 1924 conference. Several others from this meeting are to be published. In addition to the more formal papers, considerable time on the program was devoted to the consideration of sewage-treatment plant construction and operation, as well as to the individual problems of those in attendance.

THE PRACTICAL APPLICATION OF THE BIOCHEMICAL OXYGEN-DEMAND TEST

By J. A. CHILDS

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The purpose of this paper is to discuss briefly the practical importance of the biochemical oxygen-demand test as applied to the routine work of the sanitary engineer or the operator of a sewage-treatment plant. The details of the actual procedure used in determining the biochemical oxygen-demand of a sample by what is known as the excess-oxygen method, together with authentic and very complete information relative to the apparatus and chemicals required and the precautions to be observed, are contained in various publications.*

Value of the Test

The value of this test, when compared with other analytical determinations ordinarily applied to sewage, is very clearly stated in the following paragraphs taken from Public Health Bulletin No. 132 on "Sewage Treatment in the United States":

"The test appears to furnish by far the most valuable information as to the behavior of the plants and the efficiency of the various devices used in sewage purification. With suitable precautions, a high degree of accuracy is attainable, and once a routine has been established the time and labor involved is no greater than is required for a nitrate determination or an oxygen-consumed test. The oxygen demand determination has the decided advantage that it is applicable to sewage in all stages of purification, and the information that it furnishes can be used independently of the results of other determinations.

"When dilutions are made with raw sewage, the degree of dilution can be used in estimating its effect on a receiving body of water. In the absence of bacteriological data the determination of the oxygen demand of a stream above and below the point where an effluent is discharged is probably the best index of the effect of the sewage on the stream."

Principle Easy to Understand

The greatest drawback to many of the analytical tests that have heretofore been commonly applied to sewage is that the results are

*"Studies on the Treatment and Disposal of Industrial Wastes," Public Health Bulletin No. 97, U.S. Public Health Service, October, 1918.
"Sewage Treatment in the United States," Public Health Bulletin No. 132, U.S. Public Health Service, July, 1923.
"Standard Methods of Water Analysis," American Public Health Association, 1923 Edition.

expressed in chemical terms which are not readily understood by the average sewage-plant operator, or for that matter by many engineers. The oxygen-demand test is simply a measure of the oxygen that may be required in a given time (usually five days) by a sewage, trade waste, or water, in order to replace the oxygen that combines in a natural manner with the organic or mineral matter in the water, sewage, or waste under consideration. It may be likened somewhat to a measurement of the amount of air required to burn a given quantity of wood or coal in a furnace, the amount of air required depending upon the character or the relative heating value of the fuel. Likewise, a strong sewage or waste will require more oxygen to render it stable than will a weak sewage or waste. Thus it is easy for almost anyone to understand that a sewage having a 5-day oxygen demand of 200 is about twice as strong as one having a 5-day oxygen demand of 100. It is a test that places the highly-trained chemist upon a common ground of understanding with the average plant operator or engineer.

An Industrial Analogy

A sewage-treatment plant has been likened to a factory: the raw sewage representing the raw material coming in, and the treated effluent representing the finished factory output. In order that an industrial establishment may operate successfully, the finished product must come up to certain standards. Each department must operate with a certain degree of efficiency, or the industry cannot survive. It is the practice in most industrial establishments to keep a close check on the operating efficiency of each department, in order that the costs of producing the finished product may be accurately known. The operation of a sewage-treatment plant may be patterned after an industry operated on a cost basis—the screens, settling basins, filters, re-settling tanks, etc., representing the various departments of the industrial establishment. The cost of the construction and operation of each unit of the plant can be accurately determined.

By the application of the oxygen-demand test the relative value of the treatment can be measured at every step of the process, and the efficiency of every step thus determined. This information is of considerable value in the case of existing sewage-treatment plants, because nearly all plants must eventually be enlarged. With information at hand as to the relative efficiency of every step of the process, it is possible to so coordinate additions to the plant with existing works as to produce the desired results at a minimum cost, thus effecting savings to the taxpayers amounting to thousands of dollars.

As an illustration of this point, we might take for consideration a sewage in which the settleable solid content was relatively small and of a nature that would not settle out readily. The dissolved

organic content of such a sewage might be relatively high, due to the presence of certain industrial wastes. When the oxygen-demand test is applied, it would probably be found that the reduction in oxygen demand by sedimentation would be relatively low, this indicating that the oxidizing process, to be carried out in the percolating filter, sand filter or activated-sludge treatment, would constitute the greater part of the treatment if a well-stabilized effluent was to be turned out. In such a case it might be possible to enlarge upon the secondary treatment without the expense of materially increasing the settling-chamber capacity of the plant.

Application to Study of Industrial Wastes

Another instance of the value of the oxygen-demand determination would be the case where a plant had been designed for the treatment of ordinary domestic sewage of a normal strength, but where, due to the location of industries of various kinds in the municipality (such as cheese factories, creameries, paper mills, and packing plants), the strength of the sewage had so increased that the plant could no longer be operated satisfactorily. By the application of this test the municipality might be in a position to demonstrate that the just and reasonable procedure would be for each such industry to install a treatment plant, by means of which its waste could be so reduced as no longer to interfere with or to throw an excessive burden upon the operation of the municipal sewage-treatment plant. The effect of the addition of industrial waste to a domestic sewage can be quite readily understood when it is realized that creamery waste may have a 5-day oxygen demand of from 500 to 5,000 p.p.m., cheese-factory waste as high as 30,000 p.p.m., packing-plant waste of from 500 to 2,500 p.p.m., and rendering-plant waste as high as 70,000 p.p.m.; while the 5-day oxygen demand or normal untreated domestic sewage will seldom average more than 200 p.p.m.

A Measure of Stream Pollution

This test is also of considerable value in determining the effect the discharge of sewage or wastes into a stream or lake. In cases where the municipal sewage and the industrial waste may be discharged into a stream through separate outlets, this test often furnishes a very definite measurement of the relative effect of the different materials contributing to the pollution of the stream. In case sewage treatment may be necessary to relieve a nuisance, the oxygen-demand determinations (together with dissolved-oxygen tests) will constitute an intelligible basis from which to determine the degree of treatment that may be required. The oxygen-demand test, in connection with the bacteriological and dissolved-oxygen tests, may be used as a basis for specifying the degree of contamination to be

permitted in any given stream or lake, thus enabling the engineer to proceed intelligently with the design of the necessary treatment works.

Simplicity and Importance of the Test

As has already been stated, the oxygen-demand test is one which may be very readily understood by the average engineer or the operator of a sewage-treatment plant, or in fact anyone who may not have had the opportunity of acquiring a technical education. Even if this test were not a very rational one from a technical standpoint, it would commend itself to general use for the reason that it can be so readily understood by the average layman. It is capable of assuming the same relative importance, in connection with sewage-treatment and stream-pollution problems, that the butter-fat determination is to the dairy farmer, or the B.T.U. test to the user of coal.

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