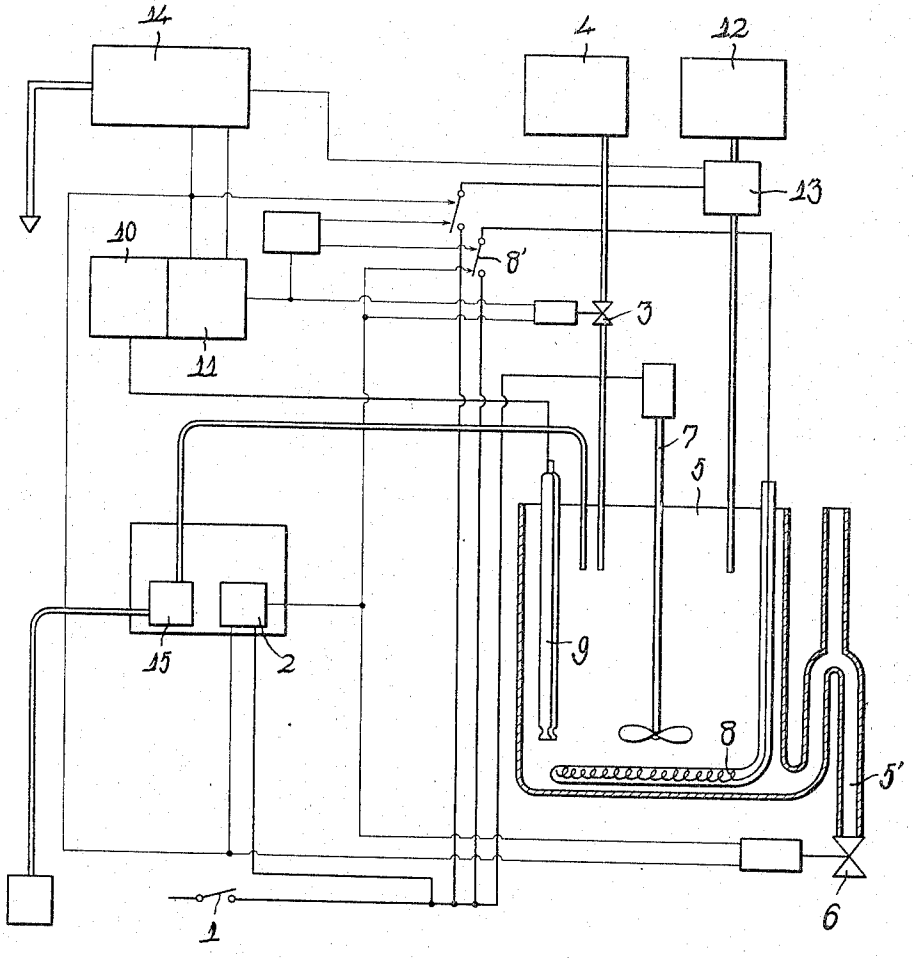
March 19, 1968 HIDEO SUZUKI 3,374,065

BIOCHEMICAL OXYGEN DEMAND CONTINUAL DETECTING APPARATUS

Filed Dec. 16, 1964

Fig. 1



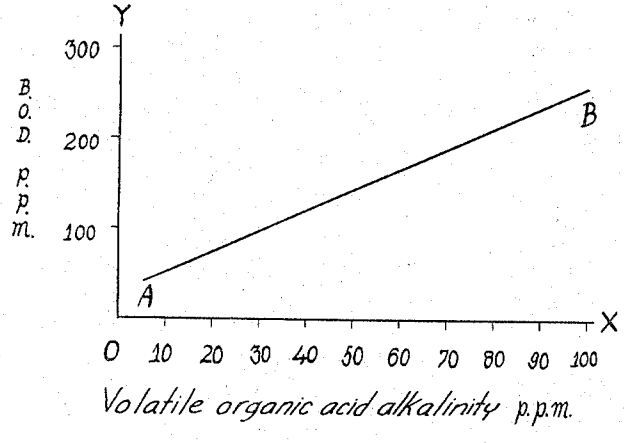


Fig. 2

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BIOCHEMICAL OXYGEN DEMAND CONTINUAL DETECTING APPARATUS

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1 Claim. (Cl. 23—253)

ABSTRACT OF THE DISCLOSURE

An apparatus for the automatic detection of the B.O.D. value, comprising a container and means for injecting a test material into the container. Means are provided for injecting a non-organic acid into the container to form a mixture. Means for mixing and heating the mixture causes a removal of the basic group, such as carbonate, bi-carbonate or carbonate anhydride, etc. During this stage, means for continuously detecting the lowering pH value causes a valve to close, thereby closing the non-organic acid injecting means when a low pH value is reached. Means for injecting an alkaline having a predetermined density into the mixture is provided and a recording meter is provided for showing the pH value increase. A measuring means determines the B.O.D. value by measuring an operating period of the alkaline injecting means over a pH value range indicating the volatile organic acid alkalinity.

The present invention relates to an apparatus for continuously detecting and estimating B.O.D. (Biochemical Oxygen Demand) value existing in drainages, rivers, etc.

In spite of a serious need for sufficient detection of the B.O.D. value in the public health field, there has never been, heretofore, an appropriate method for estimating the B.O.D. value on a continual basis due to a difficulty of measuring the varying B.O.D. in flowing drain water.

It has been desired to maintain drainages and rivers within a predetermined or normal B.O.D. value; however, an exact measurement of the B.O.D. value in water streams could not be satisfactorily achieved due to the continuous change of the B.O.D. value.

It is an object of the present invention to provide an epoch making apparatus for continuously estimating the B.O.D. value in water streams.

It is another object of the present invention to provide an apparatus which substantially utilizes a close chemical relation which exists between volatile organic acid alkalinity and the B.O.D. value.

In accordance with the present invention, the B.O.D. value in water streams can be precisely measured continuously, even though the B.O.D. value is irregular.

A further feature of the present invention is that the B.O.D. value can be indirectly measured by obtaining

the volatile organic acid alkalinity contained in the stream to be measured.

After due experimental studies performed by the inventor, it was successfully discovered that organic substances in water streams relate to the B.O.D. value and usually consist of acetic acid, propionic acid, butyric acid, etc.; and that 30–50% of the B.O.D. value may always be correlated with the lower fatty acid content.

Also, fatty acids having comparatively large molecules together with unsaponifiable matters other than suspended matters may, however, contain, fatty acids which are always the central base of those substances.

In order to clarify the aforesaid description, the following comparative table between the rate of volatile acidic alkali and the measured value of the B.O.D. is provided:

Kind of soils (p.p.m.)	River-water	River-water	River-water	Chemical treated urinate water	After Biochemical treatment	Drain (A)	Drain (B)
Volatile acid alkalinity by direct titration	26.9	19.8	15.8	607.6	75.2	34.5	44.2
Organic acid by steam distillation method	43.7	23.4	13.2	380.6	127.2	65.0	54.9
B.O.D	34.3	30.9	9.1	1,330.0	61.3	117.5	108.1

As apparent from the above table, a mutual relation is confirmed between the volatile acidic alkali and the B.O.D. value.

In order to estimate the B.O.D. value in water streams, the present invention provides a detecting apparatus which essentially consists of a complete line of an automatic pumping device together with other means whereby the volatile organic acid alkalinity and the B.O.D. value can be automatically measured with a continuous recording system.

In detail, this apparatus is constructed with a testing tube, an automatic sampler which takes the proposed sample in the base of a periodic time interval, a pH meter, an acid reservoir, an alkali tank, a pump for a predetermined volume, a recorder for the B.O.D., etc.

With these and other objects in view, which will become apparent in the following detailed description, the present invention will be clearly understood in connection with the accompanying drawing, in which:

FIGURE 1 is a schematic diagram of an embodimnt of the present invention; and

FIG. 2 is a graph showing a mutual relation between the B.O.D. value (p.p.m.) and the volatile organic acid alkalinity.

Referring now to the drawing, a test material is initially conducted by a pump **15** into a testing tube **5** and an electric switch **1** is turned on.

A sampler-timer **2** is then actuated and an acid is supplied into the testing water of the testing tube **5**. At the same time, valve **6**, attached to an outlet pipe of the test material **5'**, and provided on the testing tube **5**, is closed and a mixing treatment with heat is performed by mixer **7** together with heater **8** as switch **8'** is turned on. At the moment when the pH contained in the test material shows a lower value than any desired value, for instance, such as 3.5, an indicating signal is transmitting to a pH meter **10** by means of a glass-electrode **9** on which a fixed thermostat is contained in the testing tube **5**, whereby a valve **3** of an acid tank **4** is closed by an operation of a shifting switch **11** which is connected to the pH meter **10**.

On the other hand, heater circuit **8** of the testing tube **5** is simultaneously cut within five minutes, being effected by the timer **2**, and an alkaline solution having a

normal cardinal number is supplied into the testing tube **5** at a constant speed by means of a quantitative pump **13** fixed in the tank **12**. If the pH contained in the test material shows a value, for instance 4, an operation of a B.O.D. indicator **14** is commenced.

The B.O.D. indicator **14** is designed so as to record an operating period of the quantitative pump **13**, and accordingly a volatile organic acid alkalinity is shown in the indicator through the quantity of the alkaline solution supplied by the quantitative pump **13**.

Thus a scale on the indicator may be directly read as the B.O.D. value, for instance, from a reference line *A.B.* $y=2.18x+34.8$ (where, $y=B.O.D.$ in p.p.m., and x=volatile organic alkalinity in p.p.m.) as shown in FIG. 2. Further, OY and OX in FIG. 2 respectively show the B.O.D. in p.p.m. and the volatile organic acid alkalinity in p.p.m.

Assuming the pH becomes 7, then the alkaline quantitative pump **13** stops and the indication of the B.O.D. recording indicator **14** is terminated. Then, the valve **6** of the outlet pipe **5'** for the test material on the testing tube **5** opens and supplies the test material into the testing tube **5**. At this moment, a test material, readily measured, is exhausted through the outlet pipe **5'** being effected by an operation of the pump **15** being controlled by the sampler-timer **2**. Then, by supplying the test material into the testing tube **5**, another test material supplied previously is accordingly replaced and a normal water level of the test material may be maintained in the testing tube since the pump will be automatically stopped. If the sampler pump **15** suspends its operation, the same state as the commencing operative state occurs in which the electric switch is on and the aforesaid process can be repeated.

Now, for a further appreciation and better understanding of the present invention, three experimental examples are provided.

Example 1

With a 500.00 cc. testing tube, successive titration of acid and alkali of which the cardinal number is N/10 was performed at a chemical treating laboratory on drainage.

After twelve hours of successive operation with ten minute time intervals for thirty two times, the reference line shows $y=1.33x+605.7$ (where, $y=B.O.D.$ in p.p.m., and x=volatile organic acid alkinity in p.p.m.). The scale indication on the recording paper detected the reference formula.

Example 2

With a 300.00 cc. testing tube, the B.O.D. value existing in the neighborhood of an overflowing reservoir outlet was measured twenty-one times. Each measurement was processed for fifteen minutes having been kept continuously for twenty-four hours, successively.

The reference line detected was $y=2.18x+34.8$ ($y=B.O.D.$ in p.p.m., and x=alkaline degree of organic acid in p.p.m.).

Example 3

With a 300.00 cc. testing tube, and fifteen minute measurements, the B.O.D. value in river water was successively made twenty-two times in two days. The respective

time intervals between experiments were two hours. The reference line showed $y=1.55x-0.77$ ($y=B.O.D.$ in p.p.m., x=volatile organic acid alkalinity in p.p.m.).

As is apparent from the above examples, the present continuous B.O.D. detecting apparatus can be easily utilized for detecting the B.O.D. value such as, for example, from river water, drain water and any type of sewages by means of classifying scales, testing tube capacities, cardinal numbers of acid and alkali of the recording form into several groups depending upon the proposed drainage to be tested.

The present B.O.D. detecting apparatus provides a remarkable means for detecting B.O.D. in river water, drain water and any other type of sewages by usefully utilizing a close chemical relationship between volatile organic acid alkalinity and the B.O.D. value.

The present invention successfully provides an inventive detecting for the B.O.D. value without being affected by the continuous changes of the water quality.

While I have disclosed one embodiment of the present invention, it is to be understood that this embodiment is given by example only and not in a limiting sense, the scope of the present invention being determined by the objects and the claim.

What I claim is:

1. An apparatus for the automatic detection of the B.O.D. value of a test material comprising

a container used as a testing tube,

means for injecting the test material into said container,

means for injecting a non-organic acid into said container to form a mixture,

means for mixing and heating said mixture,

means responsive to a predetermined low pH value for closing said non-organic acid injecting means,

means for injecting an alkali having a predetermined density into said mixture at a predetermined rate,

recording meter means for showing the pH value increase, and

determining the B.O.D. value by recording the time during which the alkali is injected until the pH reaches a predetermined high value, whereby the total alkali added is determined and is a measure of the fatty acid content of said test material and correlated to the B.O.D. value thereof, whereby the B.O.D. value of said test material is determined.

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