Course Number : CE 332
Course Name : Environmental Engineering Lab
Course Credit : 1.50

Experiment No.11
Determination of Chemical Oxygen Demand (COD)

INTRODUCTION

The chemical oxygen demand (COD) test is widely used as a means of measuring the organic strength of domestic and industrial wastes. This test allows measurement of a waste in terms of the total quantity of oxygen required for oxidation to carbon dioxide and water. The test is based on the fact that all organic compounds, with a few exceptions, can be oxidized by the action of strong oxidizing agents under acid conditions.

During the determination of COD, organic matter is converted to carbon dioxide and water regardless of the biological assimilability of the substance. For example, glucose and lignin are both oxidized completely. As a result, COD values are greater than BOD values, especially when biologically resistant organic matter (e.g., lignin) is present.

One of the chief limitations of COD test is its inability to differentiate between biologically oxidizable (biodegradable) and biologically inert (non-biodegradable) organic matter. In addition, it does not provide any evidence of the rate at which the biologically active material would be stabilized under conditions that exist in nature.

The major advantage of COD test is the short time required for evaluation. The determination can be made in about 3 hours rather than the 5-days required for the measurement of BOD. For this reason, it is used as a substitute for the BOD test in many instances.

THEORY

Potassium dichromate or potassium permanganate is usually used as the oxidizing agent in the determination of COD. In this class potassium permanganate would be used in the determination of COD. Potassium permanganate is selective in the reaction and attacks the carbonaceous and not the nitrogenous matter.

In any method of measuring COD, an excess of oxidizing agent must be present to ensure that all organic matter is oxidized as completely as possible within the power of the reagent. This requires that a reasonable excess be present in all samples. It is necessary, therefore, to measure the excess in some manner so that the actual amount can be determined. For this purpose, a solution of a reducing agent (e.g., ammonium oxalate) is usually used.

REAGENTS

1. Dilute sulfuric acid
2. Standard potassium permanganate
3. Standard Ammonium Oxalate

APPARATUS

1. Beaker (250 ml) :1 no.
2. Dropper 1 no.
3. Stirrer I no.

PROCEDURE (For water)

(1) Pipette 100 ml of the sample into a 250 ml Erlenmeyer flask.
(2) Add 10 ml. of diluted sulfuric acid and 10 ml of standard potassium permanganate.
(3) Heat the flask in a boiling water bath for exactly 30 minutes, keeping the water in the bath above the level of the solution in the flask. The heating enhances the rate of oxidation reaction in the flask.
(4) If the solution becomes faintly colored, it means that most of the potassium permanganate has been utilized in the oxidation of organic matter. In such a case, repeat the above using a smaller sample diluted to 100 ml with distilled water.
(5) After 30 minutes in the water bath, add 10 ml of standard ammonium oxalate into the flask. This 10 ml ammonium oxalate, which is a reducing agent, is just equivalent to the 10 ml potassium permanganate (oxidizing agent) added earlier. The excess of reducing agent (ammonium oxalate) now remaining in the flask is just equivalent to the amount of the oxidizing agent (potassium permanganate) used in the oxidation of organic matter.
(6) The quantity of ammonium oxalate remaining in the flask is now determined by titration with standard potassium permanganate. Titrate the content of the flask, while hot, with standard potassium permanganate to the first pink coloration. Record the ml of potassium permanganate used.

CALCULATION

COD (mg/l) = [mL of $KMnO_4$ used in Step (6) × (100) / mL of sample used]

ASSIGNMENT QUESTIONS

(1) What are the principal advantages and disadvantages of the COD test over the BOD test.
(2) Explain why COD values are greater than BOD values.
(3) What would be inferred from the following analytical results regarding the relative ease of biodegradability of each waste?

Waste type	5-day BOD (mg/l)	COD (mg/l)
A	240	300
B	100	500
C	120	240