COD Manual

Do-It-Yourself Manual

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Chemical Oxygen Demand (COD) Test

Introduction:-

The chemical oxygen demand (COD) is an indicative measure of the amount of oxygen that can be consumed by reactions in a measured solution. It is commonly expressed in mass of oxygen consumed over volume of solution which in SI units is milligrams per liter (mg/L). A COD test can be used to easily quantify the amount of organics in water. The most common application of COD is in quantifying the amount of oxidizable pollutants found in surface water (e.g. lakes and rivers) or wastewater. COD is useful in terms of Water quality by providing a metric to determine the effect an effluent will have on the receiving body, much like biochemical oxygen demand (BOD).

Chemical oxygen demand testing is typically performed using a strong oxidizing chemical. Organic matter is oxidized into carbon dioxide and water in an acidic condition. The quantity of organic matter or the demand of oxygen is calculated by determining how much oxidizing chemical was consumed during the test. Chemical oxygen demand tests are typically performed on wastewater. The pollution level is calculated by measuring the amount of organic matter in the water. Water with too much organic material can have a negative effect on the environment in which the wastewater is discharged. The COD test is often used in conjunction with the BOD test to estimate the amount of non-biodegradable organic material in wastewater. In the case of biodegradable organics, the COD is normally in the range of 1.3 to 1.5 times the BOD. When the result of a COD test is more than twice that of the BOD test, there is good reason to suspect that a significant portion of the organic material in the sample is not biodegradable by ordinary microorganisms. To carry out these tests, an apparatus is used; this apparatus is called a COD Digester.

The wastewater or other substances (on which these tests are carried) are mixed with the chemicals in specific amounts in this test tube and then these test tubes are to be heated at 150 degree in a digester for 2 hrs. for completion of their reaction. COD Digester is the most accepted Thermo reactor for Determination of Chemical Oxygen Demand in Various Substances. According to no. of tests to be carried in at one time, the size of cod digesters varies. In cod tests, there is one blank solution and other test tubes are filled with solutions of which cod value is to be known. The cod digesters which are available in the market consist of aluminum block or stainless steel. The overall cost changes according to the number of test tubes (15 or 24 test tubes). For making the cod digester, instead of using aluminum blocks, and container filled with oil can be used for carrying the COD test where this oil would act as a medium for heat transfer. In Vigyan ashram, using oil as a heat transfer medium, a cod apparatus was made.

1.1 What is chemical oxygen demand?

Chemical oxygen demand, also known as COD, indirectly measures the organic matter in water samples. COD is regularly performed in wastewater as it is a quicker and more convenient test to perform than biological oxygen demand (BOD). Careful monitoring of COD and then following up with the BOD test can allow for proactive corrections to the waste water treatment. Many times, COD testing is a requirement for wastewater treatment plants; and this testing all leads to time and cost savings for the plants.

Applications:

- The chemical oxygen demand (COD) is a measure of water and waste water quality.
- COD test is used widely for better operation of wastewater facilities because of its speed analysis.
- Used extensively in analysis of gray water samples.
- The COD test is often used to monitor water treatment plant efficiency.

- The COD test requires only 2-3 hours while the biochemical oxygen demand (BOD) test requires 5 days.

Working Principle

The chemical oxygen demand is a measure of water & waste water quality. The COD test is often used to monitor water treatment plant efficiency. This test is based on the fact that a strong oxidizing agent, under acidic conditions, can fully oxidize almost any organic compound to carbon dioxide (CO_2).

Generally speaking when someone says clean water, we tend to think of drinking water. However we also need clean water as a byproduct of our wastewater system .When the water is done being used in the kitchen or flushed down a toilet, how does it become clean again and how do we know the water is actually clean? Conducting tests called Chemical Oxygen Demand can be performed to interfere with the pollutant levels in a water sample at any water treatment facility.

Organic & oxidizable inorganic substances in the sample are oxidized by potassium dichromate in 98% sulfuric acid solution at reflux temperature silver sulphate is used as catalyst. Mercuric sulphate is added to remove chloride interference.

The excess dichromate is titrated with standard FAS (ferrous ammonium sulphate) using Ferron as an indicator.

Materials

Materials required for making digester and the stand on which it resides:

1. MS sheet
2. Stainless steel
3. circular storing unit
4. Square tube of size 20x 20 x 6 mm
5. G I sheet

Materials required for electronic circuit and heating purpose:

1. TC513 (temperature controller)
2. 4 pole contactor
3. Pt-100 RTD
4. Heater (3kw)
5. Wires (3 core wire and single core wire)

Materials used for insulation and sealing purpose:

1. Anabond
2. Glass wool
3. Non asbestos gasket

Part - 1

Methodology :-

1. Shape selection:

The shape of the digester is a crucial part of a design. The Cod digesters which are available in the market are generally of rectangular shape (basically a rectangular solid block made up of aluminum.).

2. Selection of type of oil:

The oil acts as a medium through which the heat is to be supplied. The selection of oil is based on the specific heat of oil. The oils considered for acting as a medium were vegetable oil and paraffin oil; vegetable oil with specific heat value of 1.67Kj/Kg K whereas paraffin oil with specific heat value of 2.13Kj/Kg K2.1)

3. Heat Required:-

- Volume =0.0284m^3
- Mass Density =930(kg/m^3) or 0.0284m^3
- Mass = 26.412
- Heat Required =5513.5kj=5513.3kws.

4. The arrangement of the test tube:

- Number of COD tubes -12 & 4.
- Distance between two tubes is equal.
- Diameter of whole for test tube to 50mm.

5. Rubber gasket for plate:

A circular rubber sheet is to be attached to the plate so that the oil over the test tube is removed and it remains back over the rims of the rubber sheet. The rubber sheet is cut into circle of outer diameter of 70 cm and inner diameter of 40 cm

6. Insulation: -

To minimize the heat loss insulation must be provided. It is another crucial part of the design. There are various types of insulations like glass wool, polyurethane foam and spray foam. All these insulations are classified according to their thermal properties like temperature, amongst this glass wool is preferred due to its low cost and temperature range because the temperature inside the digester is about 1500C and it has a range of about 00C to 2500C which would be affordable for the COD Digester.

7. Material selection of digester:-

The material selection of inner vessels was made on property of thermal conductivity & corrosion free.

Stainless steel was chosen over aluminum because it had high thermal conductivity.

8. Temperature control unit:

In this cod test, the test tube is to be heated up to 150 degree celsius for 2 hours to complete the process. The temperature controller circuit will be needed so as to heater gives only needed heat for 2 hrs. to maintain the given temperature. The temperature control which will be needed for carrying out these tests will be TC513, a temperature controller device which not only indicates but also controls the heater.

9. Designing of COD digester:

• Diameter :	35 cm
• Height :	35 cm
• Thickness :	0.8 mm.

COD digester

10. Fabrication of COD digester:

- Fabrication of outer vessel of digester
- Material= Milled steel sheet
- Size = 37.2 cm x 113.4cm.
- Thickness = 0.8mm.

11. Fabrication of test tube arrangement plate:-

- This arrangement of test tube is important for equal heating
- This plate is made of milled steel
- Diameter-330 mm
- Thickness-0.8mm

Test tube arrangement plate

12. Fabrication of electrical junction box:-

- The electrical junction box was made up from a GI sheet.
- Dimension: 20 X 12 cm.

13. Fabrication of stand:-

The fabrication of stand consists of four square tubes of 20 x 20 x 6 mm size of length 90 cm and eight square tube of 20 x 20 x 6 mm size of length 40 cm.

Electrical junction box

Digester Stand

Part - 2

Chemical test method

Materials for COD test:-

1. Potassium dichromate ($K_2Cr_2O_7$).
2. Mercuric sulphate ($HgSO_4$)
3. Sulfuric acid (H_2SO_4)
4. Ferrous ammonium sulphate (FAS)
5. Ferron indicator
6. Potassium hydrogen phosphate (KHP)
7. 250 ml Erlenmeyer flask
8. Reflux condenser
9. COD tubes
10. Measuring cylinder
11. Analytical balance
12. COD tube stands
13. Hand gloves

Preparation of chemicals: -

1. **Preparation of 0.25 N potassium dichromate solution: -**

   12.25 gm. potassium dichromate powder dissolved in 1000 ml distilled water in 1000 ml volumetric flask.

2. **Preparation of Ammonium Ferrous Sulphate solution: -**

   24.5 gm. Ammonium Ferrous sulphate powder dissolved in 250 ml distilled water in 250 ml distilled water in 250 ml volumetric flask. Add 5ml Sulphuric acid.

3. **Preparation of Potassium Hydrogen Phosphate solution: -**

   0.425 gm. of dried KHP powder dissolved in 1000 ml distilled water in 1000 ml volumetric flask. (Dried this powder for 2 hours in oven)

Procedure: -

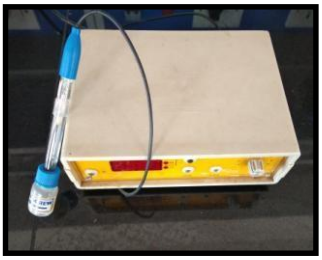
1. Take 0.4 gm. HgSo4 (mercuric sulphate) in COD tubes.
2. Add 20 ml sample in each COD tube (20 ml water sample, 20 ml KHP solution).
3. Add 20 ml distilled water in each COD tube.
4. Add stones (crush on beads) 1 or 2 pieces.
5. Add 10 ml (0.25 N) $K_2Cr_2O_7$ Potassium dichromate solutions.
6. Add 30 ml conc sulfuric acid slowly along with swirling.
7. If the solution turns green add more known quantities of $K_2Cr_2O_7$ solution.
8. Kept COD tubes in COD apparatus to digest the sample..
9. Attach condenser & set 150 Degree Celsius temperature.
10. Kept for 2 hours filled COD tubes in COD apparatus for 150 degree Celsius.
11. After 2 hours switch off & remove COD tubes & cooled sample for room temperature.
12. Take the above sample in a conical flask. Add 150 ml distilled water.
13. Titration: - Titrate above solution with 0.1 N FAS (ferrous ammonium sulphate) solution by using Ferron indicator (add 3-4 drops). The end point of this titration is blue green to reddish brown.

During titration take blank solution & sample solution in conical flask and FAS solution fill up in burets When color changes from blue green / yellowish green to reddish brown then note the end point.

Precautions:-

1) Sulphuric acid is a hazardous chemical, so handle carefully.
2) COD tubes should not be opened whilst hot as pressure build-up may cause acid spillage. Do not open tubes during sample digestion.

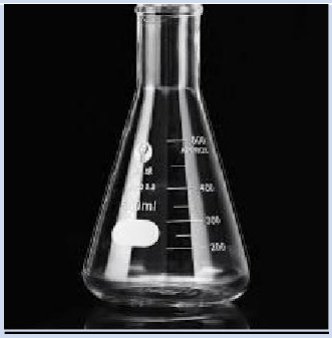
Instrument required for development of this method:

Sr.No.	Equipment Name	Description	Image
1.	Water distillation unit	This unit was designed in Vigyan Ashram with a cooker and Condenser.	
2.	pH meter	To check PH of water.	

3.	Weighing balance	It is required to measure the chemicals before preparation of solutions required to analyze the Samples.	
4.	Magnetic stirrer	It is required for proper Mixing the chemicals in the reagents.	

Glassware required for this method

Sr no.	Glassware Name	Description	Image
1.	**COD tubes**	For digestion these tubes are useful.	

2	**COD condenser:**	These condensers are attached to COD tubes. These are useful for condensed samples.	
3.	**Erlenmeyer flask**	During Titration 250 ml Erlenmeyer flask is useful. It is used for mixing and storing chemicals and solutions.	
4	**Burette**	To measure the volume of a liquid	

COD Formula:-

COD = (a-b_) X N X 8000/ml of sample solution

Where,

1. A-Reading blank solution.
2. B-Reading with sample solutions.
3. N- Normality of FAS solution

Chemical Oxygen Demand (COD) test & COD apparatus developed at vigyan ashram has following features

1. Low-cost COD apparatus /digester as compared to COD apparatus available in market.

2. Affordable & easy to operate COD digester & COD test for rural lab & education institute.

3. The running cost of electricity per batch is very cheap. The cod digester was constructed with comparatively less price than cod apparatus available in the market (40,000 rs).