**Methods to Determine extent of water pollution:**

* 1. **Biological Oxygen Demand (BOD)**
  2. **Chemical Oxygen Demand (COD)**

Biological Oxygen Demand: (BOD)

**Biochemical oxygen demand** (**BOD**) is the amount of dissolved oxygen needed (i.e. demanded) by aerobic biological organisms to break down organic material present in a given water sample at certain temperature over a specific time period. The BOD value is most commonly expressed in milligrams of oxygen consumed per litre of sample during 5 days of incubation at 20 °C

Determination of BOD:

1. Specialized 300 mL BOD bottles designed to allow full filling with no air space and provide an airtight seal are used. The bottles are filled with the sample to be tested or dilution (distilled or deionized) water and various amounts of the wastewater sample are added to reflect different dilutions. At least one bottle is filled only with dilution water as a control or "blank."
2. A DO meter is used to measure the initial dissolved oxygen concentration (mg/L) in each bottle, which should be a least 8.0 mg/L. Each bottle in then placed into a dark incubator at 20°C for five days.
3. After five days (± 3 hours) the DO meter is used again to measure a final dissolved oxygen concentration (mg/L), which ideally will be a reduction of at least 4.0 mg/L.
4. The final DO reading is then subtracted from the initial DO reading and the result is the BOD concentration (mg/L). If the wastewater sample required dilution, the BOD concentration reading is multiplied by the dilution factor.

BOD = (Dob –DO5) x dilution factor

= (Dob –DO5) x Volume of diluted sample

Volume of effluent sample

Significance of BOD:

Biochemical oxygen demand / biological oxygen demand is an important water quality parameter because it provides an index to assess the effect discharged wastewater will have on the receiving environment.  The BOD is important in sewage treatment because it indicates the amount of decomposable organic matter in sewage water. The higher the value of BOD higher will be decomposable organic matter present in wastewater.

Chemical Oxygen Demand:

The chemical oxygen demand (COD) is a measure of water and wastewater quality. The COD test is often used to monitor water treatment plant efficiency. The COD is the amount of oxygen consumed to chemically oxidize organic water contaminants to inorganic end products. The COD is often measured using a strong oxidant (e.g. potassium dichromate) under acidic conditions.

* A known volume of waste water sample (say 250 ml) is refluxed with a known excess of standard potassium dichromate (1 N) and dilute sulfuric acid mixture in the presence of silver sulphate catalyst for about 3 hours.
* This oxidases organic matter to CO2, NH3 and H2O.
* The unreacted potassium dichromate is titrated against Ferrous ammonium sulphate (Mohr’s salt) with ferroin indicator till blue colour changes to wine red, the reading is **(Vt).**
* This gives the amount of potassium dichromate consumed (in terms of equivalent oxygen) required for degradation of organic pollutants.

Blank titration is performed initially with known volume of distilled water sample and added acidified standard potassium dichromate titrated against Ferrous ammonium sulphate (Mohr’s salt) with ferroin indicator till blue colour changes to wine red, the reading is **(Vb)** (zero minute reading)

Measurement of COD:

Blank Titration:

H2SO4

Distilled water + K2Cr2O7---------🡪 D.W + K2Cr2O7

Excess HgSO4 Total

* Sample Titration:

H2SO4

Waste water + K2Cr2O7---------🡪 CO2 + H2O + K2Cr2O7

Excess HgSO4 Unreacted Formula:

COD = (Vb –Vs) x NFAS x 8000

Volume of sample

Where,

Vb : Volume of FAS for blank titration

Vs : Volume of FAS for sample titration

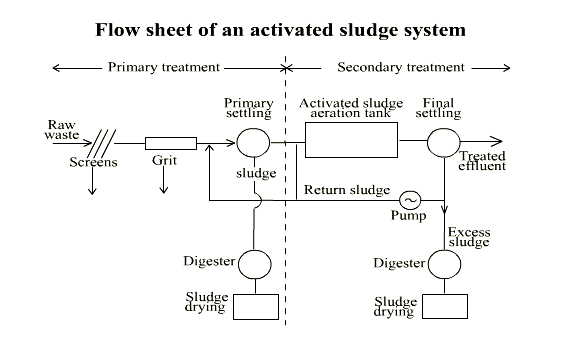
Significance of COD:

* The COD test only takes a few hours to complete, giving it a major advantage over the 5-day BOD test. Wastewater treatment system personnel can use COD as an almost real-time operational adjustment parameter.
* COD can test wastewater that is too toxic for the BOD test.
* The COD test should be considered an independent measure of the organic matter in a wastewater sample rather than a substitute for the BOD test.
* The COD test uses a chemical (potassium dichromate in a 50% sulfuric acid solution) that “oxidizes” both organic (predominate) and inorganic substances in a wastewater sample, which results in a higher COD concentration than BOD concentration for the same wastewater sample since only organic compounds are consumed during BOD testing.

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| BOD | COD |
| 1. It is oxygen required or demanded by micro-organism for aerobic oxidation of organic matter present in waste water. | 1. It is oxygen required or demanded for oxidation of organic as well as inorganic matter present in waste water using strong chemical oxidant like K2Cr2O7 |
| 2. It uses microorganism for degradation | 2. It uses chemical oxidant for degradation |
| 3. It is slow process require 5 days’ time | 3. It is fast process require only few hours |
| 4. Pollutants are not break down completely only | 4. Pollutants are oxidizes completely. |
| 5. organic matter oxidizes by micro organism | 5. Both organic and inorganic matter oxidizes by chemical oxidant |
| 6. BOD values are generally lower than that of COD | 6. COD values are generally higher than that of BOD |
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**Treatment of sewage / Industrial waste:**

In activated sludge process wastewater containing organic matter is aerated in an aeration basin in which micro-organisms metabolize the suspended and soluble organic matter. In activated sludge systems a part of this settled biomass, described as activated sludge is returned to the aeration tank and the remaining forms waste or excess sludge. In activated sludge process wastewater containing organic matter is aerated in an aeration basin in which micro-organisms metabolize the suspended and soluble organic matter. A part of this settled biomass, described as activated sludge is returned to the aeration tank and the remaining forms waste or excess sludge.



**Step 1: Screening and Pumping**

The incoming wastewater passes through screening equipment where objects such as rags, wood fragments, plastics, and grease are removed. The material removed is washed and pressed and disposed of in a landfill. The screened wastewater is then pumped to the next step: grit removal.

**Step 2: Grit Removal**In this step, heavy but fine material such as sand and gravel is removed from the wastewater. This material is also disposed of in a landfill.

**Step 3: Primary Settling**The material, which will settle, but at a slower rate than step two, is taken out using large circular tanks called clarifiers. The settled material, called primary sludge, is pumped off the bottom and the wastewater exits the tank from the top. Floating debris such as grease is skimmed off the top and sent with the settled material to digesters. In this step, chemicals are also added to remove phosphorus.

**Step 4: Aeration / Activated Sludge**In this step, the wastewater receives most of its treatment. Through biological degradation, the pollutants are consumed by microorganisms and transformed into cell tissue, water, and nitrogen. The biological activity occurring in this step is very similar to what occurs at the bottom of lakes and rivers, but in these areas the degradation takes years to accomplish.

**Step 5: Secondary Settling**Large circular tanks called secondary clarifiers allow the treated wastewater to separate from the activated sludge from the aeration tanks at this step, yielding an effluent, which is now over 90% treated. The biology (activated sludge) is continuously pumped from the bottom of the clarifiers and returned to the aeration tanks in step four.

**Step 6: Disinfection**To assure the treated wastewater is virtually free of bacteria, ultraviolet disinfection is used after the filtration step. The ultraviolet treatment process kills remaining bacteria to levels within our discharge permit.