Lab - 4

1.1 Turbidity

- Scattering of light by particulate or colloidal matter in water, gives water a turbid appearance.
- Turbid waters have an aesthetically unappealing quality, and hence are unsuitable for drinking purpose.
- Additionally, turbid water may also contain a high concentration of microorganisms and suspended solids.

Measurement of Turbidity:

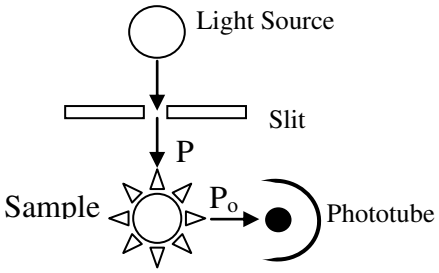


Figure 4.1: Nephelometry

- Turbidity measurement is based on comparison of the amount of light scattered by the sample in defined conditions with the amount of light scattered by a standard reference suspension. The scattered light from sample can be measured by a light detector placed at right angle to the original light path; this technique is known as Nephelometry (Figure 4.1). ***(P_0/P) will be lower for samples that are less turbid.***

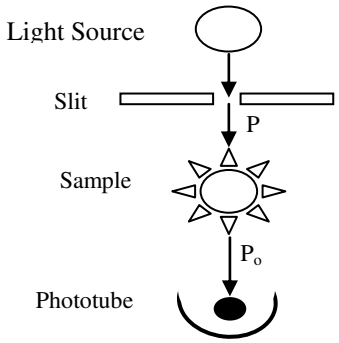


Figure 4.2: Turbidimetry

- Turbidity can also be measured by shining light through a sample and measuring the degree of light penetration as measured by a light detector placed in line to the original light path. This measuring technique is known as Turbidimetry (Figure 4.2). ***(P_0/P) will be higher in this case for samples that are less turbid.***

Turbidity standards are prepared as follows:

- Solution I: Dissolve 1 g hydrazine sulphate in 100 mL distilled water
- Solution II: Dissolve 10 g hexamethylenetetramine in 100 mL distilled water
- In a 100 mL volumetric flask, mix 5 mL of solution I with 5 mL of solution II. Let stand for 24 hours and make up the volume to 100 ml. The Turbidity of this solution is 4000 NTU (nephelometric turbidity units).
- Suitable turbidity standards are prepared by diluting this primary standard.
- For turbidity analysis in laboratory you will use digital direct reading turbidity meter which is a true Nephelometer, which measures amount of scattered light at the mandated 90° angle between the photo detector and the incident light beam.
- Calibrate the turbidity meter using given two standards for zero and 40 NTU

What you must know after this laboratory:

- How to prepare turbidity standards
- How to calibrate the turbidimeter
- How to measure turbidity

Please do the following:

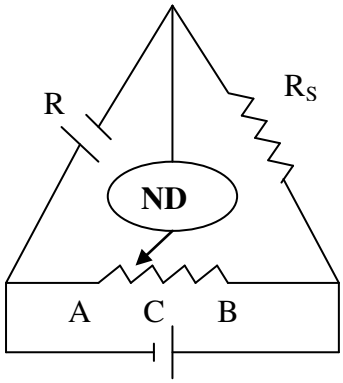
- Measure turbidity of sample
- Measure turbidity of the synthetic samples provided
- You are given two samples, one containing 100 mg/L of 1μm particles and the other 100 mg/L of 0.1 μm particles. Which will have more turbidity and why?

1.2 Conductivity

- Conductivity of a water sample gives us a measure of the concentration of dissolved ions in that sample. Pure water itself is not a very good conductor of electricity, however, it is the inorganic ions, e.g., chloride, nitrates, sulphates, sodium, potassium, calcium, etc., that carry electricity. Conductivity is the measure of electricity carrying capacity of the solution.
- Water with high conductivity generally has high dissolved solids concentrations. Waters with high dissolved solids often have unpleasant tastes, and hence are not suitable for drinking purposes.

Conductivity Measurement:

- Remember that conductance has the unit of "mho", and is the inverse of resistance, which has the units of "ohm". Conductivity or specific conductance has the units of mhos/cm. Resistivity or specific resistance has the units of ohm.cm.



- In order to measure conductivity, we actually measure resistance of the water sample using a Wheatstone bridge apparatus.
- The measured resistance is then reported suitably as conductivity.

- In the Wheatstone bridge apparatus, also known as conductivity meter, R_x is the unknown resistance that is to be measured using the conductivity electrode, AB is a linear resistor,R_s is the variable resistor, which can be present to various values depending on the value of unknown R_x.
- After the electrodes are dipped in solution, the null detector is moved along the linear resistor, until it shows no current. At this point,

  $R_X / R_{AC} = R_S / R_{BC}$, or, $R_X = R_S . R_{AC} / R_{BC}$
- Conductance is the inverse of resistance. Conductivity of the sample is obtained by multiplying conductance by the cell constant, which is an unique property of that particular conductivity electrode.
- **The cell constant of the electrode is determined by the following way:**
  - Dissolve 745.6 mg anhydrous KCl in 1000 mL of distilled water. This solution has conductivity of 1412 □mhos/cm.
  - The conductance of this solution is measured using the conductivity meter. Division of the known conductivity value by the conductance value of the standard solution gives the value of the cell constant.

What you must know after this laboratory:

- To find the cell constant of the conductivity meter.
- To use the conductivity meter to find the conductivity of various environmental samples.

Please do the following:

- Measure the electrical conductivity (EC) of the following solutions: 1, 10, 50, 100, and 500 mg/L KCl solutions.
- Plot the graph of the measured EC versus total dissolved solids (TDS) concentration for these solutions. What is the slope of this curve?
- Measure EC of sample. Based on the curve drawn earlier, what is the TDS concentration in sample?

1.3 Solids

Determination of Total Solids (TS), Total Suspended Solids (TSS), and Total Dissolved Solids (TDS) in a sample of water

Total Solids (TS):

- Take 50 mL aliquot of the water sample in a pre-weighed beaker
- Put the sample in an oven at 100-105 ^{0}C overnight, or until the water evaporates
- Take the beaker out of the oven, and cool it in a desiccator
- Weigh the beaker
- From the difference in the weight the concentration of **Total Solids (TS)** in the sample may be calculated in mg/L

Example problem (to be solved in the laboratory):

Empty weight of the beaker:	60.32 g
Sample added to the beaker:	50 mL
Weight of the beaker after drying and desiccation:	60.75 g

What is the **TS** concentration of the sample in mg/L?

Total Suspended Solids (TSS) and Total Dissolved Solids (TDS):

- Take 50 mL aliquot of the water sample in a beaker
- Filter the sample through a pre-weighed GF/C filter paper
- Dry the GF/C filter paper in an oven at 100-105 ^{0}C overnight, or until the water evaporates
- Weigh the filter paper
- From the difference in the weight of the filter paper the concentration of **Total Suspended Solids (TSS)** in the sample can be calculated
- Collect the filtrate from the GF/C filter in the pre-weighed beaker
- Put the sample in an oven at 180 ^{0}C overnight, or until the water evaporates.
- Take the beaker out of the oven, and cool it in a desiccator
- Weigh the beaker
- From the difference in the beaker weight the concentration of **Total Dissolved Solids (TDS)** in the sample may be calculated.

Example problem (to be solved in the laboratory):

Sample volume:	50 mL
Weight of the filter paper:	0.23 g
Weight of filter paper after desiccation:	0.32 g
Weight of beaker:	59.80 g
Weight of beaker after desiccation:	60.15 g

What is the **TSS and TDS** concentration of the sample?

Remember: TS = TSS + TDS

Determination of Total Solids (TS), Total Volatile Solids (TVS) and Total Fixed Solids (TFS) in a sample of wastewater

Total Solids (TS):

- Take 50 mL aliquot of the wastewater sample in a pre-weighed crucible.
- Put the sample in an oven at 100-105 ^{0}C overnight, or until the water evaporates.
- Take a crucible out of the oven, and cool it in a desiccator
- Weigh the crucible
- From the difference in the weight the concentration of **Total Solids (TS)** in the sample may be calculated.

Total Volatile Solids (TVS) and Total Fixed Solids (TFS)

- Take the crucible used for **TS** determination (with **TS** residues still in the crucible) and put it in muffle furnace at 550-600^{0}C for 15 minutes
- Take the crucible out of the oven, and cool it in a desiccator.
- Weigh the crucible.
- From the difference in the weight of the crucible before and after putting in the muffle furnace gives the concentration of **Total Volatile Solids (TVS)** in the sample may be calculated.

Example Problem (to be solved in the laboratory):

Sample Volume:	50 mL
Weight of the crucible:	160.15 g
Weight of the crucible after oven:	160.83 g
Weight of the crucible after Muffle Furnace:	160.43 g

What are the **TS, TVS and TFS** concentration of the sample?

Remember: TS = TVS + TFS

Determination of Settleable Solids (SS) in a sample of wastewater by Gravimetric and Volumetric Methods

Volumetric method for Settleable Solids (SS):

- Put 1000 mL of wastewater in an Imhoff cone.
- Let it settle for 1 hour.
- Read off directly, the volume of solids deposited
- Express the results in mL of solids/L wastewater.

Example Problem (to be solved in the laboratory):
Determine the settleable solids concentration (mL/L) by the Imhoff cone test. Assuming that the sludge deposited is 6% solids by weight, and the specific gravity of the sludge is 1.025, determine the dry weight of the sludge solids.

Gravimetric method for Settleable Solids (SS):

- Determine total solids (TS) concentration of the wastewater sample.
- Collect 50 mL sample from the centre of the Imhoff cone after 1 hour settling.
- Determine the total solids concentration in this sample. This is the non-settleable solids concentration (NS).
- **Then, SS concentration = TS-NS**

Example Problem (to be solved in the laboratory):

Sample Volume:	50 mL
Empty weight of the beaker A (TS):	60.15 g
Weight of the beaker A after desiccation:	61.10 g
Empty weight of the beaker B (NS):	59.80 g
Weight of the beaker B after desiccation:	60.25 g

Determine the TS, SS, and NS concentration in the sample.

Lab Exercise – 4

4A Turbidity of Water (35 Marks)

Q.1. Discuss the significance of determination of turbidity in water.
Q.2. Discuss the nature of materials causing turbidity in
- a. River water during flash flood
- b. Polluted river water
- c. Domestic wastewater

Q.3. List the situations (for example drinking water, river water, irrigation water, etc.), where you find turbidity in water to be objectionable and why?
Q.4. What is the limit of turbidity in drinking water?
Q.5. Why is silica no longer the preferred materials for preparing turbidity standards?
Q.6. What is NTU?
Q.7. You are given 2 samples, one containing 100 g/L of 1 μm particles & the other 100 mg/L of 0.1 μm particles. Which will have more turbidity and why?

4B Conductivity of Water (20 Marks)

1. What is the principle behind conductivity measurement?
2. The conductivity of a sample depends on Temperature.
   a) True
   b) False
3. Conductivity is highest for _____ water.
   a) Distilled
   b) Deionized
   c) Ground
   d) Sea
4. From the conductivity values of a water sample, approximate estimation of ___ can be done.
   a) Total solids
   b) Total dissolved solids
   c) Colloidal solids
   d) Suspended solids

4C Understanding About Solids in Water (5 Marks)

Q.1. Can you call dissolved solids as non-settleable solids & vice versa? Up to what size range, a particle can be called dissolved?

Q.2. What are the major things which constitute TDS, TSS & TVS in a natural surface water stream?

Q.3. What is it that differentiates between total solids, total dissolved solids, and total suspended solids in liquid samples?

Q.4. (a) Why is 103 to 105 ^{o}C the drying temperature generally used for total solids analysis?

(b) Under what conditions and why is 180^{o}C sometimes used as the drying temperatures?

Q.5. (a) Why was 550^{o}C chosen as the combustion temperature in the volatile solids estimation?

(b) What possible problems would result if either a lower or a higher temperature were used?

4D Estimation of Solids

Q1. Using the following parameters, determine the total suspended solids (TSS), in mg/L, of the sample. Weight of dry filter = 1.1224 g; Weight of filter and dried solids = 1.1424 g; Volume of sample = 250 mL **(10 Marks)**

Q2. After burning the dried solids on the filter in the problem above, find the volatile suspended solids (VSS), in mg/L, of the sample if the weight of the filter with solids after ignition is 1.1385 g. **(10 Marks)**

Q3. Given the following data from solids test, calculate total solids (TS), volatile solids (VS), dissolved solids (DS), total suspended solids (TSS) and total volatile suspended solids (TVSS). Sample volume was 300 mL in solids test. **(20 Marks)**

Tare weight of evaporating dish = 24.3520 g
Weight of evaporating dish plus residue after evaporating at 105 ^{o}C = 24.3970 g
Weight of evaporating dish plus residue after ignition at 550 ^{o}C = 24.3850 g
Weight of filter paper and tare = 1.5103 g
Weight of filter paper and tare plus residue after evaporating at 105 ^{o}C = 1.5439 g
Weight of filter paper and tare plus residue after ignition at 550 ^{o}C =1.5199 g