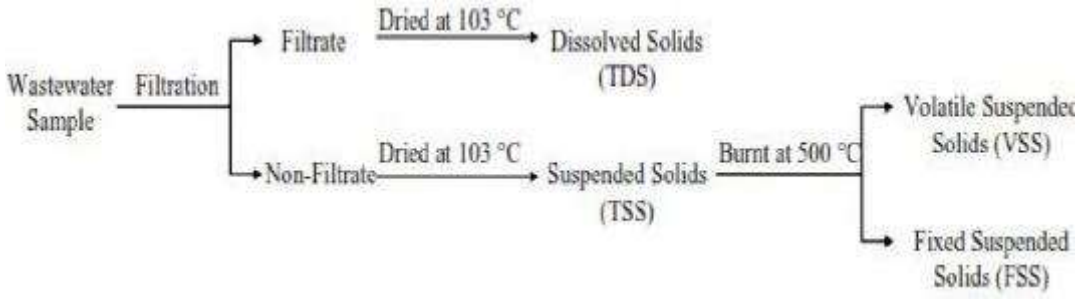
Experiment 4
Determination of Total Solids, Dissolved Solids and Suspended Solids in Water



Introduction:

Environmental engineering is concerned with the solid material in a wide range of natural waters and wastewaters. The usual definition of solids (referred to as "total solids") is the matter that remains as residue upon evaporation at 103~105°C. The various components of "total solids" can be simplified as follows



Total Solids (TS) are the total of all solids in a water sample. They include the total suspended solids and total dissolved solids. Total Suspended Solids (TSS) is the amount of filterable solids in a water sample. Samples are filtered through a glass fiber filter. The filters are dried and weighed to determine the amount of total suspended solids in mg/l of sample. Total Dissolved Solids (TDS) are those solids that pass through a filter with a pore size of 2.0 micron (1/1000000th of a meter, Also known as a Micrometer) or smaller. They are said to be non-filterable. After filtration the filtrate (liquid) is dried and the remaining residue is weighed and calculated as mg/l of Total Dissolved Solids.

Environmental significance:

Total solids measurements can be useful as an indicator of the effects of runoff from construction, agricultural practices, logging activities, sewage treatment plant discharges, and other sources. Total solids also affect water clarity. Higher solids decrease the passage of light through water, thereby slowing more rapidly and hold more heat; this, in turn, might adversely affect photosynthesis by aquatic plants. Water will heat up affect aquatic life that has adapted to a lower temperature regime. As with turbidity, concentrations often increase sharply during rainfall, especially in developed watersheds. They can also rise sharply during dry weather if earth-disturbing activities are occurring in or near the stream without erosion control practices in place. Regular monitoring of total solids can help detect trends that might indicate increasing erosion in developing watersheds. Total solids are related closely to stream flow and velocity and should be correlated with these factors. Any change in total solids over time should be measured at the same site at the same flow. Water with total solids generally is of inferior palatability and may induce an unfavorable physiological reaction. It may be esthetically unsatisfactory for purposes such as bathing. Total solids will be higher in highly mineralized waters, which result in unsuitability for many industrial applications. It indicates effectiveness of sedimentation process and it affects effectiveness of disinfection process in killing microorganisms. It is used to assess the suitability of potential supply of water for various uses. In the case of water softening, amount of total solids determine the type of softening procedure. Corrosion control is frequently accomplished by the production of stabilized waters through pH adjustment. The pH stabilization depends to some extent upon the total solids present as well as alkalinity and temperature.

Solids analyses are important in the control of biological and physical wastewater treatment processes and for assessing compliance with regulatory agency wastewater effluent limitations

Although the waste water or sewage normally contains 99.9 percent of water and only 0.1 percent of solids, but it is the solids that have the nuisance value. The amount of solids in wastewater is frequently used to describe the strength of the water. The more solids present in a particular wastewater, the stronger that wastewater will be. The environmental impacts of solids in all forms have detrimental effects on quality since they cause putrefaction problems. If the solids in wastewater are mostly organic, the impact on a treatment plant is greater than if the solids are mostly inorganic.

In the realm of municipal wastewater, suspended solids analysis is by far the most important gravimetric method. It is used to evaluate the strength of the raw wastewater as well as the overall efficiency of treatment. Furthermore, most waste water treatment plants (WWTP's) have effluent standards of 10 to 30 mg/L suspended solids which may be legally enforceable. As was the case with municipal wastewater, suspended solids analysis is useful as a means of assessing the strength of industrial wastewaters and the efficiency of industrial wastewater treatment.

Some Typical Solids Concentrations

Source		Concentration (mg/L)		
		Low	Avg	High
Fresh Natural Water	TDS	20	120	1,000
Raw Domestic Wastewater	TDS	350	600	900
	TSS	100	200	350
Storm Water	TSS	5	300	3,000

Dissolved minerals, gases and organic constituents may produce aesthetically displeasing color, taste and odor. Some dissolved organic chemicals may deplete the dissolved oxygen in the receiving waters and some may be inert to biological oxidation, yet others have been identified as carcinogens. Water with higher solids content often has a laxative and sometimes the reverse effect upon people whose bodies are not adjusted to them. Estimation of total dissolved solids is useful to determine whether the water is suitable for drinking purpose, agriculture and industrial purpose. Suspended material is aesthetically displeasing and provides adsorption sites for chemical and biological agents. Suspended organic solids which are degraded anaerobically may release obnoxious odors. Biologically active suspended solids may include disease causing organisms as well as organisms such as toxic producing strains of algae. The suspended solids parameter is used to measure the quality of wastewater influent and effluent. Suspended solids determination is extremely valuable in the analysis of polluted waters. Suspended solids exclude light, thus reducing the growth of oxygen producing plants. High concentration of dissolved solids about 3000 mg/L may also produce distress in livestock. In industries, the use of water with high amount of dissolved solids may lead to scaling in boilers, corrosion and degraded quality of the product.

Guideline:
According to Bangladesh Environment Conservation Rules (2023), potable water should not contain more than 1000 mg/l of total dissolved solids (TDS).

Principle:
The measurement of solids is by means of the gravimetric procedure. The various forms of solids are determined by weighing after the appropriate handling procedures. The total solids concentration of a sample can be found directly by weighing the sample before and after drying at 103°C. However, the remaining forms, TDS and TSS require filtration of the sample. For liquid samples, all these solids levels are reported in mg/L.

A rapid assessment of the dissolved solids content of water can be obtained by specific conductance measurements. Such measurement indicates the capacity of a sample to carry an electric current which in turn is related to the concentration of ionized substances in the water. Most dissolved inorganic substances in water are in ionized form and so contribute to the specific conductance. Although the nature of the various ions, their relative concentrations, and the ionic strength of the water affect this measurement, such measurement can give practical estimate of the dissolved mineral content of water. The TDS content can be approximated by multiplying the specific conductance in micro-Siemens per cm (µS/cm) by an empirical factor varying from 0.55 to 0.90 depending on the chemical composition of the TDS.

Sample handling and preservation:
Preservation of sample is not practical. Because biological activity will continue after a sample has been taken, changes may occur during handling and storage. Both the characteristics and the amount of solids may change. To reduce this change in samples taken for solids determinations, keep all samples at 4° C. Do not allow samples to freeze. Analysis should begin as soon as possible.

Precautions:
The following precautions should be observed while performing the experiment:

- Water or Wastewater samples which contain high concentrations of calcium, chloride, magnesium or sulphate can rapidly absorb moisture from the air. Such samples may need to be dried for a longer period of time, cooled under proper desiccation and weighed rapidly in order to achieve a reasonable constant weight. We should be aware prolonged drying may result in loss of constituents, particularly nitrates and chlorides.
- Non-representative particulates such as leaves, sticks, fish and lumps of fecal matter should be excluded from the sample if it is determined that their inclusion is not desired in the final result.
- Floating oil and grease, if present, should be included in the sample and dispersed by a blender device before sub-sampling.
- Volume of sample should be adjusted to have residue left after drying as 100 to 200mg. It is mainly to prevent large amount of residue in entrapping water during evaporation.
- Highly mineralized water containing significant concentration of calcium, magnesium, chloride, and/or sulphate may be hygroscopic. Hence prolonged drying, desiccation and rapid weighing.
- We should be aware prolonged drying may result in loss of constituents, particularly nitrates and chlorides.

Apparatus:

1. Balance
2. Beaker
3. Measuring Cylinder
4. Filter paper
5. Funnel
6. Dropper

Procedure:

Measurement of Total Solids (TS)

(1) Take a clear dry glass beaker (which was kept at 103°C in an oven for 1 hour) of 150ml. capacity and put appropriate identification mark on it. Weight the beaker and note the weight.
(2) Pour 100ml. of the thoroughly mixed sample, measured by the measuring cylinder, in the beaker.
(3) Place the beaker in an oven maintained at 103°C for 24hours. After 24 hours, cool the beaker and weight. Find out the weight of solids in the beaker by subtracting the weight of the clean beaker determined in step (1)
(4) Calculate total solids (TS) as follows:

Measurement of Total Dissolved Solids (TDS)

(1) Same as above (step 1 of total solids).
(2) Take a 100 ml. of sample and filter it through a double layered filter paper and collect the filtrate in a beaker.
(3) The repeat the same procedure as in steps (3) and (4) of the total solids determination and determine the dissolved solids contents as follows:

Calculation:

Total Solids, TS (mg/L) = mg of solids in the beaker x 1000 / (volume of sample)

Total Dissolved Solids, TDS (mg/L) =mg of solids in the beaker x1000 /(volume of sample)

Total Suspended Solids, TSS (mg/L) = TS (mg/L) – TDS (mg/L)

Assignment:

1. Discuss possible sources of solids in ground water and surface water.
2. "Groundwater usually has higher dissolved solids and surface water usually has higher suspended solids"- Explain.
3. Why water is evaporated at 103°C rather than 100 °C in assessment of solid of water?

DATA SHEET

Experiment Name :
Experiment Date :

Student's Name :
Student's ID :
Year/ Semester :
Section :
Group :

Table

Sample No	Source of Sample	TS (mg/L)	TDS (mg/L)	TSS (mg/L)

Signature of the course teacher and date