

LABORATORY 2: SOLIDS

OBJECTIVES:

1. Define total solids (TS), total suspended solids (TSS), total dissolved solids (TDS) and fixed suspended solids (FSS)
2. Measure the concentration of total solids (TS), total suspended solids (TSS) and fixed suspended solids (FSS) in a water sample
3. Compare the concentration against the standards

INTRODUCTION

Solids refer to the matter suspended or dissolved in water or wastewater. Water high in dissolved solids generally tastes bad, requiring water treatment facilities to reduce the dissolved solids concentration below 500 mg/L. If the concentration of suspended solids is high, the water may be deemed unsuitable for bathing or cooking. High mineral content, whether suspended or dissolved, may make water unsuitable for industrial processes. The concentration of solids in wastewater effluent is also used to determine compliance with wastewater discharge permits and to monitor treatment plant performance.

The total solids (TS), is the residual remaining after evaporating a representative sample of water/wastewater. Evaporation is usually conducted in an oven set at 103°C, which is slightly above the boiling point of water. In drinking water or river water samples, it is common to further subdivide the TS into the suspended (TSS) and dissolved fractions (TDS). This is done by filtering through a 1.2 mm pore size glass fiber filter. Because the colloidal fraction of the TS will also pass through this filter, it is commonly included with the dissolved fraction. It is important to note that colloidal particles are largely from clay, ranging in size from 10^{-3} to 1 mm. In wastewater treatment, particularly processes involving sludge treatment, the TS, TSS, and TDS are further divided into either organic or inorganic fractions. The organic fraction is referred to as the volatile fraction, whereas the inorganic fraction is considered the fixed fraction. To determine the fraction of each, samples remaining from the measurement of the TS and TSS are placed in an oven at 550°C. The remaining residual is assumed to be the inorganic fraction. However, some inorganic material, such as mineral salts, may burn at this high temperature.

TSS regulated in wastewater 30 mg/L; varies for surface water; The surface water criterion is 25 mg/L in trout waters and 40 mg/L in non-trout waters in New Jersey. VSS indicates organic content of sample; used for measure of bacteria in WWTPs. TDS is related to conductivity; Drinking water limit at 500 mg/L typically

MATERIALS AND METHODS

Materials: Gooch Crucibles, Glass Fiber Filter Papers (Whatman 934 AH, 47 mm), Gloves, Tongs, Tweezers. Aluminum Dishes

Apparatus: Filtration apparatus, Drying Oven (103°C), Muffle Furnace (550°C), Analytical Balance, Dessicator, Graduated Cylinders

Measurement of the Total Solids Concentration

1. Weigh a Gooch crucible (W_o).
2. Place 100 ml of sample in the crucible.
3. Evaporate sample at 103°C overnight (Note: The oven may show the temperature in °F)
4. Cool in a dessicator and weigh again (W_f).
5. Calculate total solids in mg/L.

Measurement of the Total Suspended Solids Concentration

1. Prewash glass fiber filters by placing filters (*wrinkled side up*) on a filtration apparatus and rinsing them each 3 times with 25 ml of DI water.
2. Dry filter papers in a muffle furnace at 550± 50°C for 15 minutes.
3. Cool the filter papers in a dessicator to room temperature.
4. Label the filter paper tray and weigh it with filter paper (W_o).
5. Record volume of sample to be filtered.
6. Place filter paper in filtration apparatus and filter the instructed volume of sample.
7. Continue vacuum suction for 30 seconds after filtering is complete.
8. Carefully remove filter paper with tweezers and place it back in the tray.
9. Place in drying oven at 105°C for 1.5 hours.
10. Cool in dessicator to room temperature and weigh crucible+filter again.
11. Calculate suspended solids and filterable dissolved solids.

Thanks to Student Worker for prewashing filter papers and drying them.

Measurement of Volatile Suspended Solids Concentration

1. Place tray and filter from previous experiment in a muffle furnace at 550°C for 15-20 minutes.
2. Cool in dessicator to room temperature and weigh crucible+filter again.
3. Calculate fixed suspended solids and volatile suspended solids.

SAFETY:

- This lab requires working with objects at high temperatures so make sure you are vigilant and use appropriate safety procedures when handling the samples.
- Gloves are to be worn during the sample handling process.
- Extra precaution should be taken when handling samples for VSS analyses in the muffle furnace. Use appropriate gloves and tongs.

References

Standard Methods for the Examination of Water and Wastewater, 20th Ed. Published jointly by APHA, AWWA and WPCF, 2004.

SAMPLE DATA SHEET

All data must be recorded in your laboratory notebooks. Yellow pages must be included with the laboratory report.

Total Solids (TS)

Sample ID #	Sample Volume (V)	Initial Weight of Crucible (W _o)	Final Weight of Crucible + Sample (W _f)

The concentration of the total solids can be calculated as follows:

$$TS = \frac{W_f - W_o}{V}$$

Total Suspended Solids (TSS), Total Dissolved Solids (TDS), Fixed Suspended Solids (FSS), Volatile Suspended Solids (VSS)

Sample ID #	Sample Volume (V)	Initial Weight of Tray + Filter Paper (W _o)	Final Weight of Tray + Filter Paper (105°C) (W _d)	Final Weight of Crucible + Filter Paper (550°C) (W _f)

The concentration of suspended solids is calculated as follows

$$SS = \frac{W_d - W_o}{V}$$

The concentration of the volatile suspended solids (VSS) is calculated as follows

$$VSS = \frac{W_d - W_f}{V}$$

The concentration of fixed suspended solids (FSS) is calculated as follows

$$FSS = \frac{W_f - W_o}{V}$$

The concentration of the total dissolved solids (TDS) is calculated as follows

$$TS - TSS = TDS$$

DELIVERABLES

1. Title page
2. Letter of Transmittal
3. Abstract
4. Introduction (state your objective at the end)
5. Materials and Methods
 - List all the materials and apparatus used in the lab
 - Indicate the standard method used and explain the method in your own words (do not write bullet points or numbered lists)
 - List all the equations used for calculations (equations should be numbered, and all parameters used in the equation should be explained under each equation)
6. Results and discussion
 - Report the raw data with appropriate headings/titles/labels
 - Report the TS, TSS, VSS, and FSS. Compare your results with standards
 - Include a schematic of a conventional wastewater treatment plant (cite your sources) and discuss where the solids are measured during the treatment process
7. Appendix
 - Include a copy of your excel worksheet (if used)
 - Include a sample hand calculation of your results
8. References

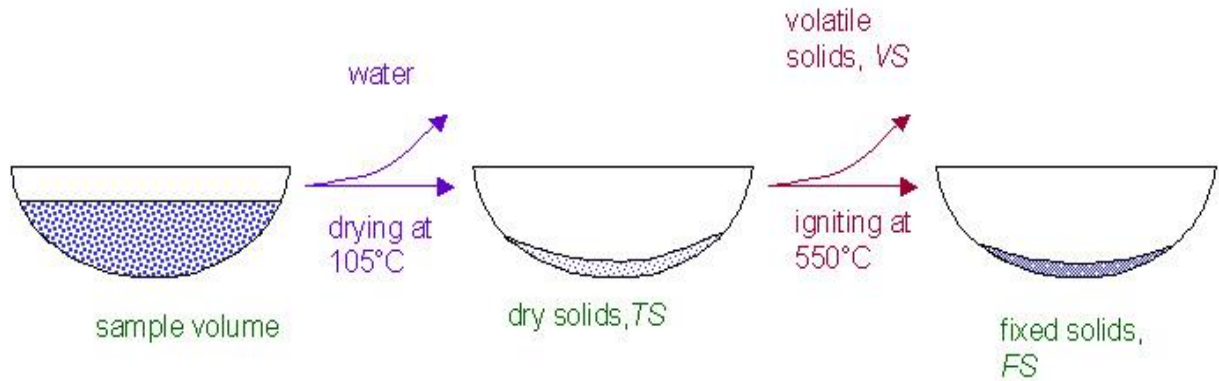


Figure 1. Generalized schematic of steps to determine *TS*, *VS*, and *FS*.

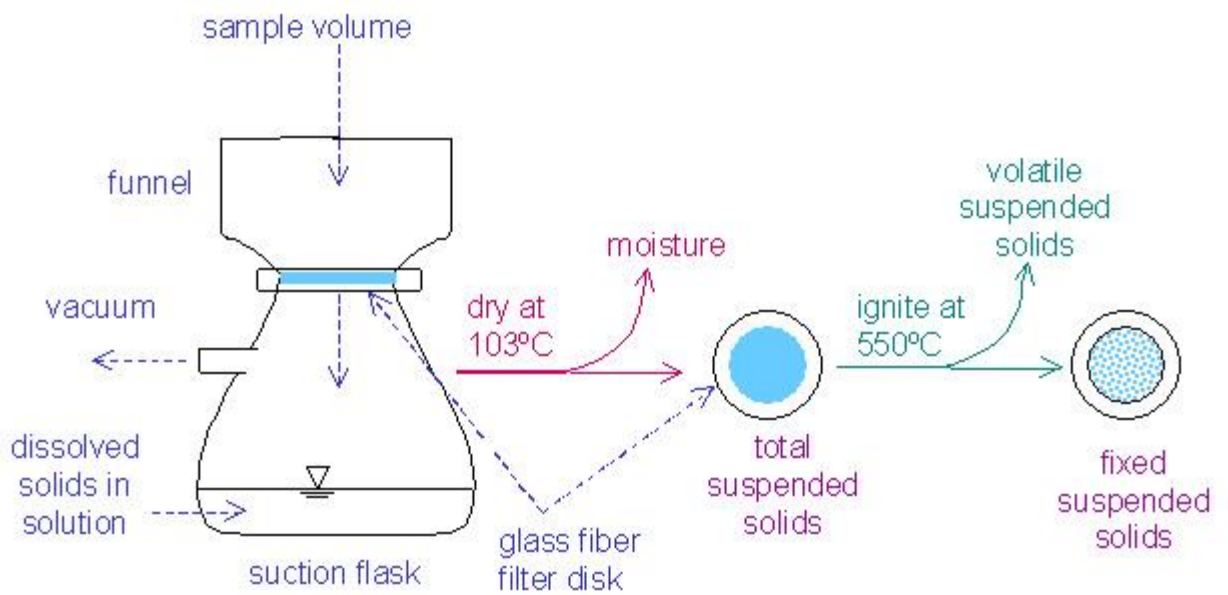


Figure 2. Generalized schematic of steps to determine *TSS*, *VSS*, and *FSS*.