Mapua University
School of School of Chemical, Biological, and Materials Engineering and Sciences

Chemistry for Engineers Laboratory

First Quarter SY 2019-2020

Experiment 5: Water Analysis

Alyssa L. Grantusa

CM011L-B10

Abstract

Water is a vital component in Earth which is one of the primary sources of life of the living creatures on earth, especially to humans. Since water comes naturally in our Earth such as surface waters, this contains variety of solid or impurities that can be hazardous to health when not treated properly. Thus, water treatment facilities provide treatment and examinations to the quality of water. The experimentation held has an objective of determining the total, dissolved and suspended solids in water sample and to determine the ions present in the solids of a water sample. Total dissolved solids are small amounts of organic matter that are dissolved in waters. Testing for the presence of carbonate and bicarbonate, halides and calcium are done to the water sample to identify the minerals dissolved in the water. Total suspended solids are the quantity of material such as silt and dirt suspended in a known volume of water that cannot pass through a filter. When the amount of total dissolved solid and total suspended solid are added, these results to the amount of total solid in water. The result shows an amount of 10.60 *ppt* for the total dissolved solid, 13.97 *ppt* for the total suspended solid and 24.57 for the total solid present in the water sample. Moreover the water sample is identified to have carbonate and bicarbonate, halides and calcium ions.

Keywords: Water; Total dissolved solids; Total suspended solids; Total solids

1. Introduction

Water dominates the surface of the Earth and is one of the vital components on our planet that helps on the survival of living creatures. One of the major uses of water is for rehydration. Major sources of water originate from surface waters such as streams, rivers, lakes and many more. This environmental water contains variety of solid or dissolved impurities. Thus, to be able to drink the water, it needs to be treated and all impurities are needed to be extracted. By a water treatment facility, surface water is further tested and impurities such as bacteria and solid particles are removed (Weiner, 2019). The experimentation done has an objective of determining the total, dissolved and suspended solids in water sample and to determine the ions present in the solids of a water sample

There several types of solid that water may contain that when left unfiltered, it may cause various diseases. All sources of natural water contain dissolved substances and minerals on it. These minerals are measured as the Total dissolved solids or TDS. Total dissolved solids are small amounts of organic matter that are dissolved in waters. These are commonly mineral or salt such as calcium, magnesium, potassium, sodium, bicarbonates, chlorides, and sulfates. For a drinking water, the total dissolved solids may also com from sewages, urban run-off, industrial wastewater, chemical used in the water, and the hardware or piping used to distribute water.

Total dissolved solids are identified as parts per million (ppm) or mg/L. For a drinking water it is suggested to have a TDS limit of up to 500 mg/L. The water containing 500 mg/L, deposits in the water are noticeable and it has a salty taste or staining in the water. Furthermore, Total dissolved solids are the total cations and anion in in the water. It gives off the number of total dissolved ions but do not tells the nature or ion relationship, therefore, total dissolved solids can be used as a test indicator to determine the general quality of water.

Carbonate (HCO_3^-) and bicarbonate (CO_3^{2-}) are accounted for the salinity of water. Salinity is the total concentration of salt content in water. It is expressed as parts per thousand (ppt) or grams of salt per kilograms of water (*g/kg*). Fresh water contains very little salt with commonly containing less than 0.5 ppt. Brackish waters or waters found in estuaries or coastal marshes have salinity of 0.5 – 17 ppt, or water having more salinity than water but less than sea water. Seawaters has an average of 35 ppt but can range in 30 to 40 ppt

(Friedl, 2019). To test for the presence of carbonates and bicarbonates in water, drops of Nitric acid (HNO_3) is added to the sample. This produces a gas evolution reaction where acid reacts with carbonate producing salt, water and carbon dioxide. Below is an example chemical equation of Nitric acid reacting with sodium carbonate forming sodium nitrate, carbon dioxide and water. (Agnew, 2018)

$$2HNO_3(aq)+Na_2CO_3(aq)\rightarrow 2NaNO_3(aq)+CO_2(g)+H_2O(l)$$

For the presence of halides, silver nitrate ($AgNO_3$) is used. Halides are an ion of halogen atom having a charge of -1. F^-, Cl^-, Br^-, I^- are some examples of halide ions. When drop of silver nitrate is added, Cl^- produces a color of white precipitate, Br^- produces a color of pale cream precipitate and I^- produces a pale yellow precipitate (Clark, 2019).

One of common ions present ion present in water is calcium. Calcium ion is a determinant of water hardness. Sea waters usually contains approximately 400 ppm calcium and abundant in water due to its natural occurrence in Earth's crust. To test the present of calcium ions in water, a drop of water and a drop of potassium oxalate ($K_2C_2O_4$) is used.

Total suspended solid or TSS are another water quality parameter used to identify the quantity of material suspended in a known volume of water. They are particles large enough to not pass the filter to separate them from water. This can include variety of material, such as silt, decaying plant and animal matter, industrial wastes, and sewage that high concentration of this causes problems in health and decrease the effectiveness of drinking water disinfection agents by allowing microorganisms to hide from disinfectants within solid aggregates (Murphy, 2007).

Lastly the Total solid is the total dissolved solid plus suspended solid in water. This also includes the portion of solids that passes through a filter. This can be measured by evaporating a water sample in weighes dish and drying the residue in an oven 103° to 105° *C.*

$$total\ solid\ (TS) = total\ suspended\ solid\ (TTS) + total\ dissolved\ solid\ (TDS) \quad (1)$$

Experimentally, Tota solid and Total dissolved solid is determined thus, total suspended solid is determines by rearranging the equation above.

$$total\ suspended\ solid\ (TSS) = total\ solid\ (TS) - total\ dissolved\ solid\ (TDS) \quad (2)$$

Nomenclature

HNO_3	Nitric acid
$AgNO_3$	Silver nitrate
$K_2C_2O_4$	Potassium oxalate
H_2O	Water

2. Methodology

By experimental procedure, the total dissolved solids, total suspended solid and total solid is determined.

2.1 Equipment and Reagents

Enlisted below are the following equipment and reagents needed in the experiment.

- Nitric acid (HNO_3)
- Water (H_2O)
- Silver nitrate ($AgNO_3$)
- Potassium oxalate ($K_2C_2O_4$)
- Evaporating dish
- Watch glass
- Bunsen burner
- Wire gauze
- Filter paper
- 100 mL Beaker
- Crucible tongs

- Pipette
- Stirrer
- Spatula
- Digital scale
- Iron rod

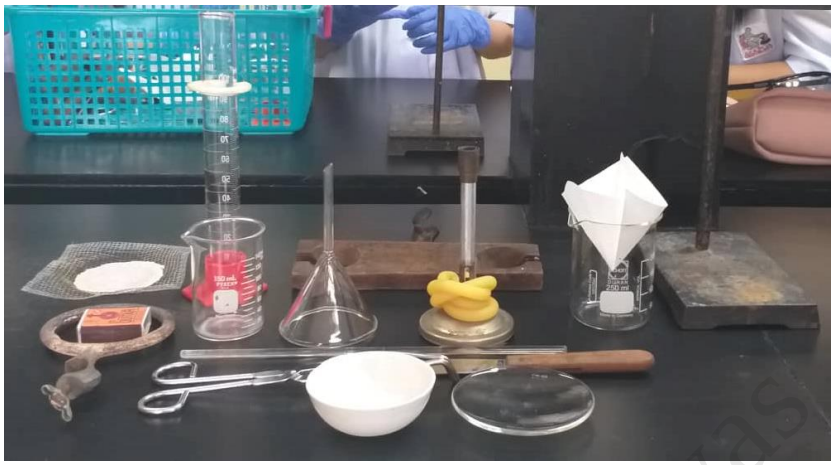

Fig. 1. Materials and equipment needed

2.2 Procedure

2.2.1 Total Dissolved Solids

2.2.1.1 Preparation of the Sample and Evaporating Dish

Filter 30 mL sample to a 100 mL beaker. Measure the mass of the clean evaporating dish then pipette 25 mL of the filtered sample to the evaporating dish and measure the combined mass of the evaporating dish and filtered water sample

a. b.

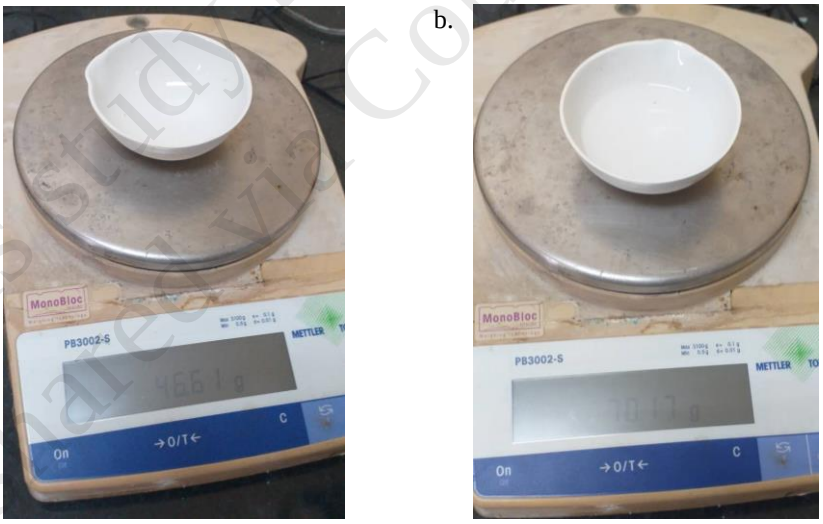

Fig. 2. (a) Mass of evaporating dish;
(b) mass of evaporating dish plus water

2.2.1.2 Evaporating the Water Sample

Heat the evaporating dish. Make sure not to overheat the evaporating dish in the process. When the water sample is near dry, cover the evaporating dish with watch glass. After the sample is dry, turn off the flame and let the evaporating dish cool down in room temperature. Measure the mass of the evaporating dish with the dried sample. Separate the solids fron the dish and keep it.

a. b

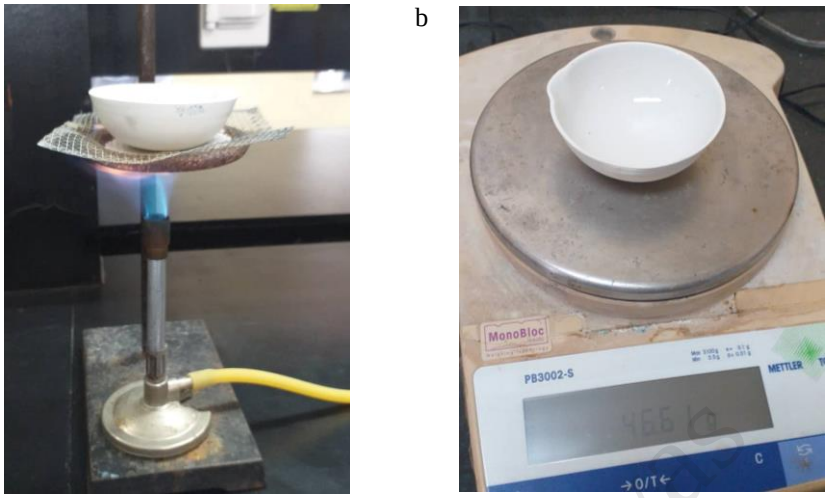

Fig. 3. (a) Evaporating water sample set up;
(b) Mass of the dried sample plus evaporating dish

2.2.2 Total Solids and Total Suspended Solids

2.2.2.1 Preparation of the Sample and Evaporating Dish

Measure the mass of the clean evaporating dish then pipette 25 mL of the raw or unfiltered sample to the evaporating dish and measure the combined mass of the evaporating dish and unfiltered water sample

Fig. 4. Acquiring raw water sample;

2.2.2.2 Evaporating the Water Sample

Heat the evaporating dish. Make sure not to overheat the evaporating dish in the process. When the water sample is near dry, cover the evaporating dish with watch glass. After the sample is dry, turn off the flame and let the evaporating dish cool down in room temperature. Measure the mass of the evaporating dish with the dried sample. Scrape of the solid from the dish and keep it.

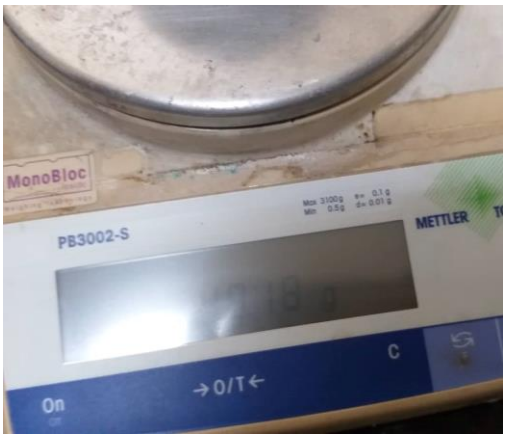

Fig. 5. Mass of the dried sample plus evaporating dish

2.2.3 Testing for Carbonate and Bicarbonate, Halides, and Calcium ions

2.2.3.2 Testing for Carbonate and Bicarbonate

Placed the scraped metal from part A to the inside of watch glass and add 1 drop of nitric acid (HNO_3) and observe for any reaction.

a. b.

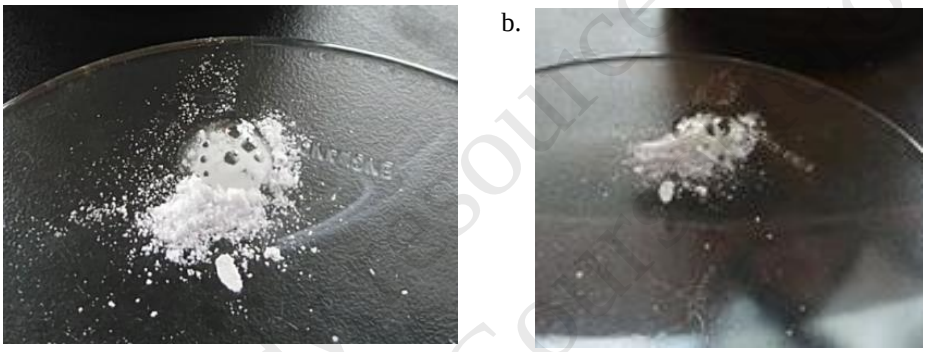

Fig. 5. (a) Bubble reaction after a drop HNO_3 using from filtered water;
(b) Bubble reaction after a drop HNO_3 using from raw water

2.2.3.3 Testing for Halides

Get a new scrape part sample from part A, add one drop of water then agitate. After, add 1 – 2 drops of Silver nitrate ($AgNO_3$) and observe any reaction

a. b.

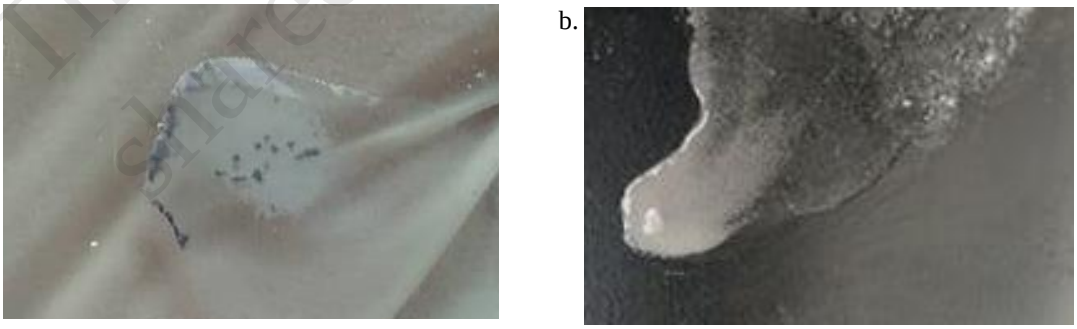

Fig. 6. (a) Reaction after a drop $AgNO_3$ from filter water;
(b) Reaction after a drop $AgNO_3$ from raw water

2.2.3.4 Testing for Calcium Ion

Using another part of sample from part A, add one drop of water then agitate. After add 1 drops of 1 *M* Potassium oxalate ($K_2C_2O_4$) and observe any reaction

a. b.

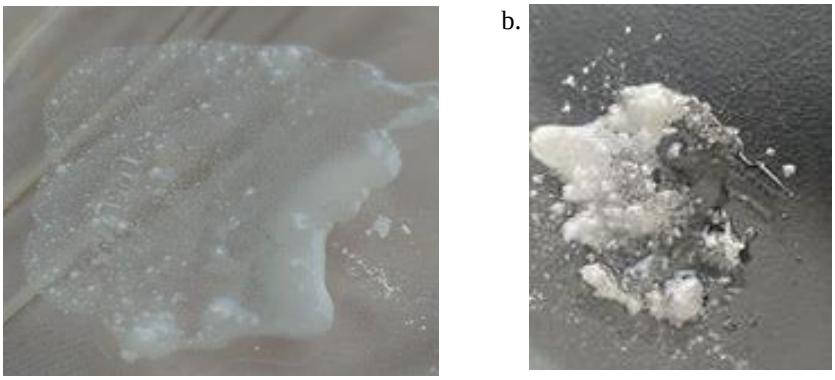

Fig. 7. (a) Reaction after a drop $K_2C_2O_4$ from filtered water;
(b) Reaction after a drop $K_2C_2O_4$ from raw water

3. Results and Discussions

3.1 Results

Table 1 Total Dissolved Solids (TDS)

	Trial 1
Mass of evaporating dish (*g*)	46.59
Mass of water sample plus evaporating dish (*g*)	70.17
Mass of water sample (*g*)	23.58
Mass of dried sample plus evaporating dish (*g*)	46.84
Mass of dissolved solids in 25 mL aliquot filtered sample (*g*)	0.2500
Mass of dissolved solids per total mass of sample (*g solids/g sample*)	0.01060
Total dissolved solids (TDS) or salinity (*g solids/kg sample, ppt*)	10.60

Calculations:

Trial 1

a.) Mass of water sample

$$mass_{water} = mass_{water\ sample\ +\ Evap\ dish} - mass_{evap\ dish} = 70.17\ g\ -\ 46.59\ g\ =\ 23.58\ g \quad (3)$$

b.) Mass of dissolved solids in 25 mL aliquot filtered sample

$$mass_{dissolved\ solid} = mass_{dried\ sample\ +\ evap\ dish} - mass_{evap\ dish} = 46.84\ g\ -\ 46.59\ g\ =\ 0.2500 \quad (4)$$

c.) Mass of dissolved solids per total mass of sample (*g solids/g sample*)

$$mass_{dissolved\ solid/\ total\ mass\ sample} = \frac{mass_{dissolved\ solid}}{mass_{water}} = \frac{0.2500\ g}{23.58\ g} = 0.01060\ \frac{g\ solid}{g\ sample} \quad (5)$$

d.) Total dissolved solids (TDS) or salinity (*g solids/kg sample, ppt*)

$$mass_{dissolved\ solid/\ total\ mass\ sample} = \frac{mass_{dissolved\ solid}}{mass_{water}} = \frac{0.2500\ g}{0.02358\ kg} = 10.60\ \frac{g\ solid}{kg\ sample} \quad (6)$$

Table 2 Total solid (TS) and Total Dissolved Solids (TSS)

	Trial 1
Mass of evaporating dish (*g*)	46.61
Mass of water sample plus evaporating dish (*g*)	69.81
Mass of water sample (*g*)	23.20
Mass of dried sample plus evaporating dish (*g*)	47.18
Mass of dissolved solids in 25 mL aliquot unfiltered sample (*g*)	0.5700
Mass of total solids per total mass of sample (*g solids/g sample*)	0.02457
Total solids (TS) (*g solids/kg sample, ppt*)	24.57
Total suspended solids (TSS) (*g solids/kg sample, ppt*)	13.97

Trial 1

e.) Mass of water sample

$$mass_{water} = mass_{water\ sample\ +\ Evap\ dish} - mass_{evap\ dish} = 69.81\ g - 46.61\ g = 23.20\ g \quad (7)$$

f.) Mass of dissolved solids in 25 mL aliquot filtered sample

$$mass_{dissolved\ solid} = mass_{dried\ sample\ +\ evap\ dish} - mass_{evap\ dish} \quad (8)$$

$$= 47.18\ g - 46.61\ g = 0.5700\ g$$

g.) Mass of dissolved solids per total mass of sample (*g solids/g sample*)

$$mass_{dissolved\ solid/\ total\ mass\ sample} = \frac{mass_{dissolved\ solid}}{mass_{water}} = \frac{0.5700\ g}{23.20\ g} \quad (9)$$

$$= 0.02457\ \frac{g\ solid}{g\ sample}$$

h.) Total dissolved solids (TDS) or salinity (*g solids/kg sample, ppt*)

$$mass_{dissolved\ solid/\ total\ mass\ sample} = \frac{mass_{dissolved\ solid}}{mass_{water}} = \frac{0.5700\ g}{0.02320\ kg} \quad (10)$$

$$= 24.57\ \frac{g\ solid}{kg\ sample}$$

Table 3. Chemical Test

Test	Observation	Conclusion
CO_3^{2} , HCO_3^{-} (TDS)	Bubble formation	Bubbles indicated carbon dioxide therefore carbonates are present
CO_3^{2} , HCO_3^{-} (TS)	Bubble formation	Bubbles indicated carbon dioxide therefore carbonates are present
CL^{-}, Br^{-}, I^{-} (TDS)	Small black particles appeared; cloudiness	Positive for the presence of halides, specifically chlorine
CL^{-}, Br^{-}, I^{-} (TS)	Cloudiness	Negative for the presence of halides
Ca^{2+} (TDS)	Small white particles; cloudy	Calcium ions are present in the water sample
Ca^{2+} (TS)	Small white particles; cloudy	Calcium ions are present in the water sample

3.2 Discussions

The whole experimentation is done for only 1 trial due to the long process it takes to evaporate the sample water, therefore we only base on 1 data and no other data can be compared from one another. From the experiment, the computed total dissolve solid from the water sample is 10.60 *ppt* and the computed total solid is 24.47 *ppt*. Getting the difference of the data, this yielded a total suspended solid of 13.97 *ppt*. To test the components of the water sample given, three tests are provided which are test for carbonate and bicarbonate, test for halides, and test for calcium ion. The test for carbonate and bi carbonate using a drop of nitric acid showed a bubble reaction. The bubble reaction is carbon dioxide and indicated the presence of carbonates in the water sample. For the test of halides, the sample showed black precipitates which indicated the presence of chlorine in the sample. The black precipitates present are identified as silver chloride (AgCl) and is more seen in the first sample using filtered water while the raw water only form cloudiness without the presence of black particles. For the last test, the test for calcium ion, white particles are accumulated in the sample. These white particles show the presence of calcium ion in the water sample.

4. Conclusion

After testing the water sample, it can be deduced that solids can be determined in the contaminated source of water. The water sample is positive in containing carbonate and bicarbonate, halides and calcium ion. Despite of the one trial, the reaction for the three test is evidently seen after dropping the three agents used in the sample. However, for the measure meant of total dissolved solid, total suspended solid and total solid, the data acquired may not be accurate and precise due to one trial given, where no other data can be compared. Furthermore, the experimentation we've done reflects how water facilities treats contaminated water and further examine the components it has.

References

Agnew, H. (2018, November 25). *Acis-Base and Gas Evolution Reaction*. Retrieved from LibreTexts: https://chem.libretexts.org/Courses/Lubbock_Christian_University/LCU%3A_CHE_1305_-_Introductory_Chemistry/16%3A_Reactions_of_Acids_and_Bases/16.3%3A_Acid%E2%80%93Base_and_Gas_Evolution_Reactions

Clark, J. (2019, June 6). *Testing for Halides Ions*. Retrieved from Chemistry LibreTexts: https://chem.libretexts.org/Bookshelves/Inorganic_Chemistry/Supplemental_Modules_(Inorganic_Chemistry)/Descriptive_Chemistry/Elements_Organized_by_Block/2_p-Block_Elements/Group_17%3A_The_Halogens/1Group_17%3A_General_Reactions/Testing_for_Halide_Ions

Friedl, S. (2019). *What is Salinity* . Retrieved from Study.om: https://study.com/academy/lesson/what-is-salinity-definition-effects-quiz.html

Weiner, C. L. (2019). *What is surface water and what affects its availability?* Retrieved from American Geosciences Institue`: https://www.americangeosciences.org/critical-issues/faq/what-is-surface-water-and-what-affects-its-availability