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: Solids

Tricczia Karlisle Chavez*, Josh Angelo Averion, Alliyah Mae Borebor, Pol Vincent Ace Keh, Allen Anthony Yap

**Experiment Leader*
CM011L-B12 Group No.1

Abstract
Nowadays, different water treatment facilities remove myriad of impurities from surface water in order to make it safe as a drinking water for the consumers. The impurities that are removed from water are the dissolved solids and suspended solids. Accordingly, for this experiment, water analysis was done by evaporating the filtered and unfiltered water sample into dryness. The contents of the water sample were then analyzed by dropping different chemicals into the dried samples. These were done in order to satisfy the following objectives: to determine the total, dissolved, and suspended solids in a water sample, and to determine the ions present in the solids of a water sample. After performing the experiment and obtaining all the needed values, the results indicated that the total dissolved solids was 21.14 g solids/kg sample, the total solids was 60.81 g solids/kg sample, and the total suspended solids was 39.68 g solids/kg sample. Furthermore, it was also reported that the water contained carbonates and bicarbonates, chlorine, and calcium.

Keywords: Total Suspended Solids; Total Dissolved Solids; Total Solids; Water Analysis

1. Introduction

Water is one of the basic needs of humans. With that said, it is important to ensure that the water we drink is clean since the purity of water impacts the health of consumers. Accordingly, several water treatment facilities remove impurities from surface water in order to supply people with clean drinking water.

Several tests can be done in order to determine the quality of water. These tests can identify the contents of the water being tested. Different types of solids, such as dissolved solids and separated solids, may emerge from the analysis of water. Dissolved solids are usually cations like sodium, calcium, magnesium and potassium, or anions like chloride, sulfate, bicarbonate, carbonate, bromide, and fluoride. Suspended solids, on the other hand, are particles that stay in water because of the exhibited turbulence of the liquid. The difference between the two is that the former is soluble while the latter is insoluble. The dissolved solids and suspended solids, when combined, result to the total solids that are contained in a water sample.

Normally, 500 ppm or 0.5 g/kg is the maximum acceptable amount of total solids contained in a drinking water. A water that exceeds this value cannot be classified as appropriate to be consumed as drinking water.

Correspondingly, for this experiment, the objectives needed to fulfil were the following: to determine the total, dissolved, and suspended solids in a water sample, and to determine the ions present in the solids of a water sample.

2. Methodology

In order to satisfy the objectives of the experiment, the following materials were used for the procedure: digital weighing scale, graduated cylinder, beaker, funnel, filter paper, evaporating dish, iron stand, iron clamp, iron ring, Bunsen burner, wire gauze, stirring rod, spatula and watch glass. Further, the following substances were also used: water sample, HNO_3, $AgNO_3$, and $K_2C_2O_4$.

The experiment was divided into two parts. The first part of the experiment intended to determine the total dissolved solids in the water sample. 20 mL water sample was obtained in a graduated cylinder and was filtered by pouring it into a funnel that has a filter paper on its opening. 15 mL of filtered water sample was poured into the evaporating dish, and their mass was measured. The mass of the evaporating dish was also measured in the digital weighing scale before pouring in the sample. The Bunsen burner, iron stand, iron clamp, iron ring, and wire gauze were then set up. The evaporating dish containing the water sample was put into the heat in order to evaporate the liquid. After all the liquid had evaporated and only the solids remained in the evaporating dish, it was cooled down so that the solids that adhered to the sides of the dish can be scraped off. Afterwards, the mass of the dish with the dried sample was quantified. The second part of the experiment followed the same procedure as the first part, but the 15 mL water sample that was used for this part was not filtered since what was needed to determine was the total solids in the water sample.

Fig. 1. (a) water filtration; (b) evaporation of the water sample.

The third part of the experiment focused in determining the ions that are present in the water sample. The dried sample from the first part of the experiment was transferred into the watch glass and was divided into three parts. One drop of each chemical – HNO3, AgNO3 (with water), and K2C2O4 (with water) was poured into a single portion. The physical changes in the dried sample were observed and recorded. This procedure was again repeated for the dried sample from the second part of the experiment.

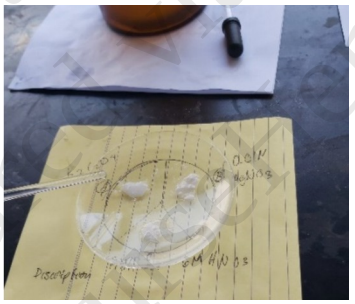

Fig. 2. chemical testing.

In order to calculate the total, dissolved and suspended solids, the following formulas were used:

$$mass_{water\ sample} = mass_{water + evaporating\ dish} - mass_{evaporating\ dish} \quad (1)$$

$$mass_{dissolved\ solids/\ total\ solids}(grams) = mass_{dried\ sample + evaporating\ dish} - mass_{evaporating\ dish} \quad (2)$$

$$mass_{dissolved\ solids/\ total\ solids}\left(g\ solids/\ g\ sample\right)=\frac{mass_{dissolved\ solids/total\ solids}}{mass_{water\ sample}} \quad (3)$$

$$\frac{TS}{TDS}=\frac{mass_{dissolved\ solids/\ total\ solids}}{kg\ water\ sample} \quad (4)$$

$$TSS=TS-TDS \quad (5)$$

3. Results and Discussions

Table 1. Total Dissolved Solids (TDS)

	Values
Mass of evaporating dish (g)	56.4 g
Mass of water sample plus evaporating dish (g)	70.6 g
Mass of water sample (g)	14.2 g
Mass of dried sample plus evaporating dish (g)	56.7 g
Mass of dissolved solids in 15 mL aliquot of filtered sample (g)	0.3 g
Mass of dissolved solids per total mass of sample (g solids/g sample)	0.021 g solids/g sample
Total dissolved solids (TDS) (g solids/kg sample)	21.13 g solids/kg sample

Table 1 exhibits the values obtained from the first part of the experiment and the calculated values for the total dissolved solids.

Supporting Calculations for Table 1

$$Mass\ of\ the\ water\ sample=70.6\,g-56.4\,g=14.2\,g$$

$$Mass\ of\ dissolved\ solids\in 15\,mL\ aliquot\ of\ filtered\ water=56.7\,g-56.4\,g=0.3\,g$$

$$Mass\ of\ dissolved\ solids\ per\ total\ mass\ of\ sample=\frac{0.3\,g}{14.2\,g}=0.021\,g\,solids/g\,sample$$

$$Total\ Dissolved\ Solids\left(TDS\right)=\frac{0.3\,g}{14.2\,g\times\frac{1\,kg}{1000\,g}}=21.13\,g\,solids/kg\,sample$$

The first part of the experiment focused on determining the total dissolved solids in water. In order to do so, during the experiment, the mass of the evaporating dish, filtered water sample plus the evaporating dish, and dried sample plus evaporating dish were recorded. These were then used to calculate for the mass of the water sample and the mass of the dissolved solid in 15 mL aliquot of filtered water sample. The mass of the dissolved solids and mass of the water sample were then used to determine the total dissolved solids in the water sample. Upon doing the calculations, the results indicated that the total dissolved solids in the water sample was 21.13 g solids/kg sample.

Table 2. Total Solids (TS) and Total Suspended Solids (TSS)

	Values
Mass of evaporating dish (g)	51.4 g
Mass of water sample plus evaporating dish (g)	66.2 g
Mass of water sample (g)	14.8 g
Mass of dried sample plus evaporating dish (g)	52.3 g
Mass of total solids in 15 mL aliquot of unfiltered sample (g)	0.9 g
Mass of total solids per total mass of sample (g solids/g sample)	0.061 g solids/g sample
Total solids (TS) (g solids/kg sample)	60.81 g solids/kg sample
Total suspended solids (TSS) (g solids/kg sample)	39.68 g solids/kg sample

Table 2 shows the values obtained from the second part of the experiment and the calculated values for the total solids and total suspended solids in the water sample.

Supporting Calculations for Table 2

$$Mass\ of\ the\ water\ sample = 66.2\,g - 51.4\,g = 14.8\,g$$

$$Mass\ of\ total\ solids \in 15\,mL\ aliquot\ of\ unfiltered\ water = 52.3\,g - 51.4\,g = 0.9\,g$$

$$Mass\ of\ total\ solids\ per\ total\ mass\ of\ sample = \frac{0.9\,g}{14.8\,g} = 0.061\,g\ solids/g\ sample$$

$$Total\ Solids\ (TS) = \frac{0.9\,g}{14.8\,g \times \frac{1\,kg}{1000\,g}} = 60.81\,g\ solids/kg\ sample$$

$$Total\ Suspended\ Solids\ (TSS) = 60.81\,g - 21.13\,g = 39.68\,g$$

The second part of the experiment focused on determining the total solids and total suspended solids present in the water sample. For this part, the water sample was not filtered since what was needed to be obtained is the total solids in the water sample. During the experiment, the mass of the evaporating dish, water sample plus the evaporating dish, and dried sample plus evaporating dish were taken note of as well. These recorded values were used to determine the mass of the unfiltered water sample and mass of total solids in 15 mL aliquot of the sample. Using these values, the total solids present in water resulted to be 60.81 g solids/kg sample.

To calculate for the total suspended solids in the water sample, the measured values of TDS and TS were used. The total suspended solids for this experiment resulted to be 39.68 g solids/kg sample.

Normally, the acceptable total solids in drinking water must not exceed 0.5 g/kg (500 ppm). Evidently, the obtained TS exceeded this level, which was justifiable by the appearance of the water sample since the sample used was of slight turbidity.

Table 3. Chemical Tests

Test	Observation
HNO_3 (TDS)	Appearance of bubbles

$AgNO_3$ (TDS)	Appearance of white color
$K_2C_3O_4$ (TDS)	Appearance of white color; Not completely dissolved
HNO_3 (TS)	Appearance of bubbles
$AgNO_3$ (TS)	Appearance of white color
$K_2C_3O_4$ (TS)	Appearance of white color; Not completely dissolved

Table 3 shows the observations made from the chemical testing of the solids that remained after the process.

For the last part of the experiment, different chemicals were dropped into the dried samples to determine the ions present in the sample. The first solution dropped in the dried sample of both the filtered and unfiltered water was HNO_3. When HNO_3 was put into the two separate dried samples, bubbles appeared. Adding HNO_3 solution tests the presence of carbonates and bicarbonates in the water, which should result to the evolution of carbon dioxide. The appearance of bubble signified the evolution of carbon dioxide. Thus, this confirms the presence of carbonates and bicarbonates in the water sample. $AgNO_3$ was the second solution that was dropped into the dried samples. Adding silver nitrate to a sample determines the presence of halides in the water. This combination should result to a silver halide precipitate. For this experiment, when $AgNO_3$ was dropped into the samples, a white precipitate appeared. Having a white precipitate indicates the presence of Cl^-, light brown indicates the presence of Br^-, and dark brown indicates the presence of I^-. Hence, this verifies the presence of Chlorine ion in the water sample. The last solution that was added is $K_2C_3O_4$, which determines the presence of calcium in water. Adding this should result to the formation of insoluble calcium oxalate. Accordingly, when the solution was added into the dried samples, the mixture produced a white appearance that is not completely dissolved. On that account, this as well confirms the presence of calcium in the water. Upon doing the last part of the experiment, it was determined that the water sample contained the following ions: carbonates and bicarbonates, chlorine, and calcium.

4. Conclusion

Generally, the objectives of the experiment, which were to determine the total, dissolved and suspended solids in a water sample, and to determine the ions present in the solids of a water sample, were accomplished. After executing the procedures for the experiment, the total dissolved solids resulted to be 21.14 g solids/kg sample, the total solids resulted to be 60.81 g solids/kg sample, and the total suspended solids resulted to be 39.68 g solids/kg sample. The total solids present in the water sample indicates that the water has a slight turbidity. Also, this is not appropriate for drinking since the acceptable value of TS should not exceed 0.5 g/kg. Furthermore, carbonates and bicarbonates, chlorine, and calcium were determined as the ions that were present in the water sample.

Acknowledgements

This experiment would have not been possibly completed without the guidance and assistance of our subject professor, Mr. Rommel Galvan. We would like to extend our deep and sincere gratitude to our professor for carefully guiding us throughout the course of the experiment.

References

[1] Beran, Jo Allan (2013) *Laboratory Manual for Principles of General Chemistry.* Retrieved from https://bookshelf.vitalsource.com