© 2018 IJSRST | Volume 5 | Issue 3 | Print ISSN: 2395-6011 | Online ISSN: 2395-602X
Themed Section: Science and Technology

Determination of Dissolution of Plastic by Using Ostwald's Viscometer

Disha Anil[1], Manavi Pai[1], Anjali Deshpande[1], Revanasiddappa M[2]
[1]Department of Information Science and Engineering, PESIT South Campus, Bangalore, Karnataka, India
[2]Department of Engineering Chemistry, PESIT South Campus, Bangalore, Karnataka, India

ABSTRACT

This study shows the extent of decomposition of different type of plastics or polymers when used to store hot food or beverages. By using Ostwald's viscometer, we determine the difference between the viscosity coefficients of different samples stored in polymeric substances to that of distilled water. This difference helps us assess the degree of dissolution of many polymeric materials and likely impact the choices that we make towards the betterment of our health.

Keywords: Ostwald's viscometer; viscosity coefficients;

I. INTRODUCTION

Plastic is by far the most valued invention made by man. It has become one of the most popular materials and has played an important role in the modern human society because of its many benefits. Being economical and cheap, it is preferred in manufacturing various products. Because of its lightweight and resistance to corrosion, it has replaced many other materials. Although plastic has its many advantages we tend to blindside its disadvantages. It not only harms the environment but often leaches itself indirectly into the human body. It affects both the consumers as well as the workers involved in the manufacture of it. As we reuse and recycle these materials, simultaneous degradation of the polymer occurs to very small extent. Our work aims to scientifically prove that the so called 'harmless plastic' could lead to catastrophic problems in humans and can have a gradual effect on our health.

II. EXPERIMENT

a. INSTRUMENT: Ostwald's Viscometer

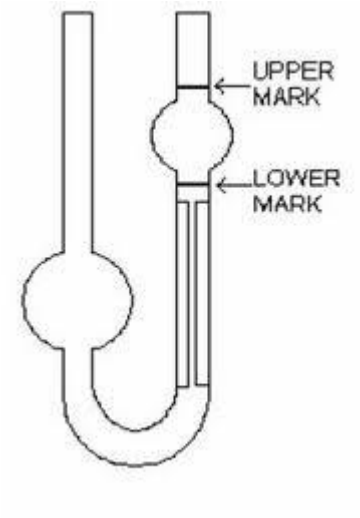

Figure 1

b. PROCEDURE:

- ✓ Heat the water 80°C and transfer it into different polymer containers whose capacity to withstand at any kind temperature is to be determined.
- ✓ Leave the water in the different polymer containers overnight.

- ✓ Now, take the viscometer, beaker and a 10cm cube pipette and clean it with water, followed by acetone. Dry these apparatus in the hot oven for 5-10 mins.
- ✓ Take them out and let it cool till room temperature.
- ✓ Take distilled water in the beaker and pipette out 10 ml of it into the wider mouth of the viscometer.
- ✓ From the other mouth of the viscometer, suck in the water until the upper mark, A.
- ✓ Calculate the time of flow of distilled water from marking A to B.
- ✓ Meanwhile, measure the temperature of the water-bath in which the viscometer is to be placed, with the help of a mercury thermometer (in ℃).
- ✓ Take a few more readings for the same sample for accuracy and find the mean time of flow.
- ✓ Repeat the above procedure for other water samples stored in the different polymeric containers.
- ✓ Using the formula given below, the viscosity coefficient for each of them and compare them to that of the distilled water (which is the reference).
- ✓ Tabulate and compare the values of the water samples from different type of polymeric containers.

III. FORMULA

$$\eta_l = \frac{d_l t_l \eta_w}{d_w t_w}$$

Where d_l and d_w are the densities of the liquid and water respectively, $t_l$and t_w is the mean time of flow of the liquid and water, η_l and η_w are the viscosity coefficients of the liquid and water. In our experiment, the density of the sample water is assumed to be the same as the density of the distilled water.

IV. OBSERVATION TABLE

Important Measurements:

1. Temperature of the lab= 27℃
2. Viscosity coefficient of distilled water η_w = 8.545 millipoise
3. Mean time of flow of distilled water t_w= 63.18 seconds

After 12 hours of storage,

Table 1

Container Used	Mean time of flow of sample water t_l (in sec)	Viscosity coefficient of sample water (in millipoise)
Plastic Bag	64.70	8.750
Tupperware	63.2	8.547
Paper Cup	63.65	8.608
Plastic Cup	64.735	8.755

After 1 week of storage,

Table 2

Container Used	Mean time of flow of sample water t_l (in sec)	Viscosity coefficient of sample water (in millipoise)
Bisleri Bottle	66.16	8.948

V. ANALYSIS

As seen in the above observation table, we have recorded and calculated the viscosity coefficients of the water samples stored in different types of containers such as plastic bag, soda bottle, Tupperware bottle, plastic and paper cup. The water samples in plastic bag, Tupperware bottle, plastic and paper cups are stored and kept in their respective containers for

almost 12 hours, whereas the water sample in the soda bottle is stored for over a week
(Assuming that the drinks in the soda bottles are often consumed after a few days of packaging).

As reference, the coefficient of viscosity of distilled water is taken as 8.545 millipoise at 27 ℃. From the table, the water sample from plastic bag and plastic cup records the viscosity coefficient value of 8.75 millipoise (approx.), which is almost 0.205 millipoise less than the reference value.

Water sample stored in the paper cup records a viscosity coefficient of 8.608 millipoise, which is 0.063 millipoise less than the reference value.

The closest recorded value of viscosity coefficient to the reference value is that of the water sample stored in the Tupperware bottle. The water sample from the soda bottle that was kept for over a week records a viscosity coefficient value of 8.948 millipoise, this shows the highest deflection (0.403 millipoise) from the reference value.

VI. PLASTIC BAG/CUP

a. Description: Polyvinyl Chloride (PVC) or Plastic #3 is commonly used to make plastic bags. It is the second most widely used plastic resin in the world. Its use has decreased over the years due to the serious health and environmental issues being faced. The base monomer, Vinyl Chloride, can be combined with numerous chemicals to create materials whose properties include versatility, ease of blending, strength, toughness, clarity and transparency.

b. Why We Chose: Plastic is used on a day to day basis and is often used to carry hot liquids. Due to this, there could be dissolution of plastic into the liquid which could affect our health in future.

c. Toxicity: PVC is considered the most toxic and hazardous plastic. It leaches a variety of chemicals such as Bisphenol A, phthalates, lead, dioxins, mercury and cadmium. Manufacture of this plastic puts not only the workers but the surrounding communities at risk due to the carcinogens. PVC when burnt produces dioxins, commonly known as human carcinogens, which could also cause cancer. Phthalates in soft forms of PVC often are the cause for asthma and allergic symptoms in children.

d. Use: PVC is used in manufacture of toys, take-out containers, squeeze bottles, mouthwash bottles, blood bags, medical tubing etc.

VII. TUPPERWARE

a. Description: Tupperware bottles and containers are generally made of Low Density Polyethylene or Polypropylene. Low density polyethylene (LDPE) or Plastic #4 are widely used plastics. They have the simplest structures of a plastic polymer making it easy to process. It is made from low density, branching chains of polyethylene which has properties including strength, toughness, flexibility, resistivity to moisture and ease of sealing.
Polypropylene (PP) or Plastic #5 is similar to polyethylenes but is stiffer and more heat resistant. The simple chemical structure makes it versatile and its crystallinity is high, in-between LDPE and HDPE.

b. Why We Chose: Tupperware is used to store food and water in almost every household. Not only is it used for storing food but is also used as a container to heat food in.

c. Toxicity: Being relatively stable, both LDPE and PP are considered safer plastics and are used for storage of food and drinks. LDPE when exposed to ultraviolet rays can leach the endocrine disruptor nonylphenol, which is added to LDPE as a stabilizer.

In a study, heated PP is suggested to cause asthma to the workers based on their exposure to it.

d. Use: LDPE is commonly used as grocery bags, coatings for paper milk cartons, cups and can also be used for wire and cable covering. PP is used not only as food and medicinal containers but also used in disposable diapers and sanitary pads, thermal vests and appliance parts.

VIII. PAPER CUPS

a. Description: Paper cup is a disposable cup made out of paper which is often coated with plastic or wax to prevent the leaking or soaking of the liquid through the paper. Initially clay was used to coat the paper cups, but as it resulted in the drinks tasting and smelling weird. On invention of coating the paper cup with a thin layer of polyethylene or wax to the paper cups, the coating of paper cups clay stopped.

b. Why we chose: Paper cups are used to serve beverages (hot or cold).

c. Toxicity: The wax present in the paper cup coating melts when a hot beverage is poured into it. The acids in our stomach normally flushes out the small amounts of wax ingested. If ingested in large amounts accumulates and causes obstruction in the intestine.

IX. BISLERI/ SODA BOTTLES

a. Description: Polyethylene terephthalate (PET or PETE) commonly known as polyester or Plastic #1, is the most known type of polymer. It is the most widely used polymer in the world. It is known for its properties of clarity, strength, toughness, barrier to liquid and glass. It is popularly used for food and drinks packaging as it acts as a barrier between liquid and glass. In soda bottles, it makes sure that the oxygen doesn't spoil the contents inside the bottle nor does it allow the carbon dioxide that makes the drink fuzzy get out.

b. Why We Chose: This type of polymer is the most widely used for many different purposes which mainly include storing food and drinks. It is predicted that during this storage period, that a little of the container material might get incorporated into the stored food or drink.

c. Toxicity: PET is known to release or leach antimony. It releases more when the liquid is kept in the container for a long time and also, in warmer temperatures. It causes respiratory problems and skin irritation and in females, menstrual problems and miscarriages.

d. Use: Bottles (water, soft drink, juice, beer), jam jars, oven-ready and microwaveable meal trays, detergent and cleaner containers.

X. PLASTIC CONTAINERS

a. Description: Polystyrene (PS) or Plastic #6 is also known as Styrofoam as it is a foam puffs up with air. The monomer styrene is made up of benzene. Apart from being foamy and soft, the can be made clear, glassy and hard and can be used for harder applications.

b. Why We Chose: This is used to make foam containers as well as harder conditions. These containers are used as take-out food containers and hence there might be a possibility of getting dissolute or decomposed into the liquid or food stored in it.

c. Toxicity: Polystyrene food containers can leach styrene, which is considered to be a human carcinogen and a brain and nervous system toxicant. Studies have shown that this has effects on genes, lungs, liver and the immune system. The leaching of

styrene from polystyrene containers is increased when the food or liquid stored is hot or oily.

d. Use: Styrofoam food containers, egg cartons, disposable cups and bowls, take-out food containers, packaging, CDs & DVDs cases, hangers, medicine bottles, smoke detector housing.

XI. CONCLUSION

The outcome of this research has proven that every type of plastic decomposes to some extent. Tupperware and paper cups show the least dissolution when compared to plastic bags and plastic cups. The plastic materials used in the manufacture of Tupperware and paper cups have a lesser impact on our body. Bisleri bottles are often reused. Results have shown that the dissolution of Bisleri bottles that have been stored over a week is maximum and hence should be avoided. Although some plastics are proven to be safer than the others, it is best to replace these plastics with glass and steel.

XII. ACKNOWLEDGMENT

We would like to thank Mr.Chandrashekhar for providing the lab equipment to us to carry out this experiment. We would also like to thank the management of PESIT South Campus for allowing us to carry out this research and giving us this opportunity.

XIII. REFERENCES

[1]. PESIT- BSC Chemistry Lab Manual
[2]. Life Without Plastic- Common Plastics #1 to #7- https://www.lifewithoutplastic.com/store/common_plastics_no_1_to_no_7#.Wr3c4ohubIU