The Effect of Temperature on Egg Shell Decomposition and Osmosis

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Abstract

The lab report explores the change in decomposition time of an egg shell and change in osmosis between the egg membrane and vinegar solution at different temperature. The experiment was performed in room temperature, in refrigerator and in a higher temperature using a Bunsen burner to increase the temperature. Three different large brown eggs were placed into three different glass jars with vinegar and kept into three different temperature states. When the egg shell decomposed completely in higher temperature, egg was removed from the jar and rinsed with water. For the other two states, eggs were removed and rinsed with water when decomposition completed in the room temperature. The egg decomposed faster in the higher temperature state and got bigger while the egg was not even completely decomposed in refrigerator for the same time. Vinegar is acetic acid which reacted with the egg shell (calcium carbonate) and decomposed it. The more the temperature increases, the faster the decomposition completes, and osmosis happens.

Introduction

Temperature plays a vital role in all kind of chemical reactions. For more than hundreds of years, people tried to increase the speed of chemical reactions. A chemical reaction has two parts: Reactant and Product. Substances that will change after reaction is called reactant and the substances we get after reaction is called product [1][2]. When the reactants start reaction, it may absorb temperature or may release temperature. Depending on the need of the reaction, we can change the rate and direction of reaction by increasing or decreasing the temperature. If the reaction absorb temperature that is called endothermic reaction [3] [4] [5]. On the other hand, if it releases temperature, it is called exothermic reaction [5]. In endothermic reaction, if heat is provided in the reactant the rate of reaction will increase at a greater rate [6]. That means, the

reaction will be completed faster than it would be in normal temperature. Thus, it can save valuable time in chemical industry and production.

Change in temperature can affect the osmosis also. Osmosis is the result of diffusion across a semipermeable membrane from a lower concentration to a higher one [7]. It is a natural biological term. If temperature increases, osmosis happens faster. That means the movement of fluid from lower concentration to a higher concentration will be completed faster [8]. Using this knowledge, we can increase osmosis in the plant so that it can grow up faster.

. In this lab, we tried to explore the effect of temperature on decomposition of egg shells. This report also described how osmosis react in different temperature. We used brown eggs in the lab so that the decomposition can be seen easily. The experiment can be performed with white egg too.

Objective

This lab report will compare the decomposition time of an egg shell in a vinegar solution at different temperature. It will also analyze osmosis process between the egg and vinegar solution through the egg membrane.

Materials

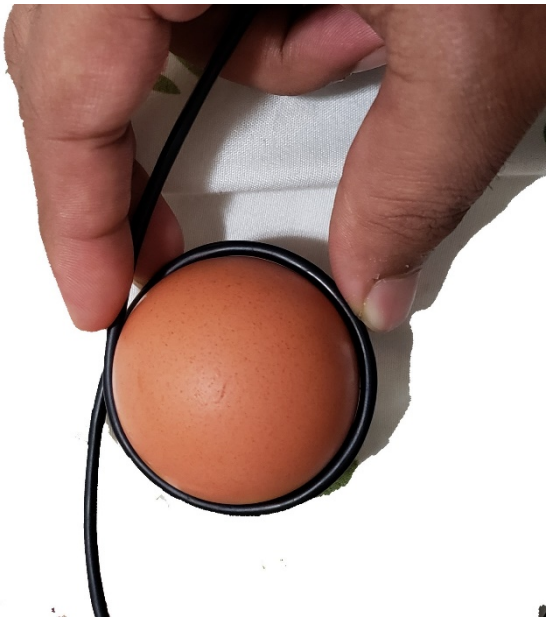
- Three large brown egg
- Three 10 cm^3 glass jars
- 30 cm^3 of 5% concentrated vinegar solution
- A refrigerator
- A flexible wire long enough to round over an egg
- Three stopwatches

- Thermometer (able to measure up to 400° Fahrenheit)
- A spirit lamp (able to produce 400° Fahrenheit)
- An iron made net
- A notebook and pen for recording data
- A meter-scale

Procedure

1. Recording the room temperature
    a. The thermometer was placed in an empty jar and the temperature was recorded 77° Fahrenheit.
    b. Then, the thermometer was taken off from the jar.
2. Measuring the circumferences of the eggs
    a. All the eggs were rounded over their center points by the wire separately.

Figure 1: Rounding egg with wire



b. The wire was marked on the point where it met its first point after rounding the eggs.

c. A meter-scale was used to measure from the first point to the marked point of the wire which determined the circumference of the eggs.

d. The data were recorded in the notebook.

3. Placing egg and vinegar into the jars

    a. Three large brown eggs were placed in the three different 10 cm^3 jar in the room temperature.

    b. The jars were filled up with 5% concentrated vinegar (acetic acid) so that the eggs were fully submerged.

4. Placing three jars into three different temperature

    a. One jar (Jar I) was kept in the refrigerator, and a stopwatch was started to record the time.

    b. Another jar (Jar II) was kept in the room temperature, and a stopwatch was started and kept by the jar.

    c. The last jar (Jar III) was placed onto the iron made net. A spirit lamp was placed under the net and turned on to heat the jar. The temperature of the burner was fixed on to 200° Fahrenheit by moving the nob of the burner. A stopwatch was used to record the time.

5. Recording the temperature while the reaction started

    a. When the bubbles were seen coming from the jar II, the thermometer was placed into the jar.

Figure 2: Bubbles begin to form on egg shell

[9]

b. The reaction temperature was recorded, and the thermometer was taken off.

6. Turning the stopwatches off

   a. For jar III, once the egg shell was decomposed completely, the burner and the stopwatch were turned off. The time was recorded in a notebook.

   b. Jar I and jar II were kept undisturbed for three days. Then, both the stopwatches were turned off and jar I was taken out of the refrigerator.

7. Draining out the vinegar
    a. After turning the Bunsen burner off, the vinegar was poured down very carefully from jar III.
    b. The vinegar was drained out carefully from jar I and jar II together.

8. Washing the egg
    a. After draining the vinegar, the eggs from jar II and jar III were rinsed with water.
    b. The egg from jar I was kept unwashed.
9. Measuring the circumferences of the eggs again
    a. The wire and the meter-scale were used as before to measure the circumferences of the eggs.
    b. The data were recorded in the notebook.

Result:

The reaction temperature measured in the step 5 was 60° Fahrenheit which was less than the room temperature. In the first case when the experiment was performed in the room temperature, the egg was found translucent, and took three days to become completely shell-less. Also, the egg got little bigger after the experiment. When the experiment was done in refrigerator, the egg shell was not decomposed completely but it got bigger. On the other hand, when a Bunsen burner was used in the third case, the egg shell was decomposed in six hours and got bigger too. These results are shown below in table I.

Table I: Egg shell decomposition time and change in circumference in different temperature

Temperature	Decomposition Time	Circumference before Experiment (cm)	Circumference after Experiment (cm)
Room Temperature (77° Fahrenheit)	3 days	15.21	16.2
Refrigerator (23° Fahrenheit)	More than 3 days	14.65	14.43
Bunsen burner (200° Fahrenheit)	6 hours	15.32	17.96

Analysis:

The egg shell is made of calcium carbonate ($CaCO_3$) whereas vinegar is a solution of acetic acid ($C2H_4O_2$). When these two compounds react together, the CO_3^{2-} group of the calcium carbonate is protonated (gets proton H^+ from acetic acid) and create carbonic acid (H_2CO_3). Simultaneously, the Ca^{2+} and $C_2H_3O_2^-$ together form calcium acetate ($Ca(C_2H_3O_2)_2$)

$2\ CH_3COOH + CaCO_3 = H_2CO_3 + Ca(CH_3COO)_2$ [10]

In the next step, carbonic acid breaks down into water (H_2O) and carbon dioxide (CO_2).

$H_2CO_3 = H_2O + CO_2$ [10]

So, the overall reaction is:

$2\ CH_3COOH\ (l) + CaCO_3\ (s) = H_2O\ (l) + CO_2\ (g) + Ca(CH_3COO)_2\ (s)$ [10]

CO_2 (g) is released into the air and the other compounds remain standing in the jar.

In the procedure (step 5), temperature was recorded when bubbles were seen coming from the egg and vinegar solution. The released CO_2 caused bubbles in the solution. The temperature decreased because it was an endothermic reaction which means the solution used

temperature to break down the reactants' (acetic acid and calcium carbonate) inner bond and form new product (water, carbon dioxide and calcium acetate).

According to Le Chatelier's principle, "If a dynamic equilibrium is disturbed by changing the conditions, the position of equilibrium moves to counteract the change" [11]. As it is an endothermic reaction, the more the temperature increases, the more the products are produced [11]. When the jar was kept inside the refrigerator, the temperature decreased. So, it took more time to complete the reaction and decompose the egg shell than in room temperature. On the other hand, when the jar was kept on the Bunsen burner, temperature increased, and the egg shell decomposed faster than in room temperature.

For all the cases, the egg became bigger than it was before the experiment. It occurred because of osmosis. By osmosis, certain kind of solvents move into a solution of higher solute concentration through a semi-permeable membrane [12] [13]. Once the egg shell is decomposed, egg membrane is the only outer surface of an egg which acts like a semi-permeable membrane. As the inner part of an egg is more concentrate than the vinegar, vinegar goes into the egg through the egg membrane and the egg became bigger [14] [15].

The experiment indicates that temperature plays a major role in all kind of reactions. The rate of reaction can be controlled by changing temperature. Even osmosis can be controlled by controlling the temperature. By increasing the temperature, many reactions can be accelerated which will save valuable time eventually. Saving time can make the world a better place.

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