**Investigating the effect the concentration of salt in water has on evaporation**

ABC123 1285 Words

Research question

How does the concentration of salt in water affect the rate of evaporation?

Evaporation is the process during which there is a substance in liquid state changing to a gaseous state due to factors including temperature and pressure. The process was first described by Swedish scientist Nils Wallerius in 1739. Liquids with an increased concentration form bonds with the salt affecting evaporation. The sodium and chloride ions are attracted to water molecules when salt dissolves in water. The internal energy of the water molecules will be reduced by the bonds, which are formed.

Hypothesis: Increasing the concentration of salt in water will reduce the rate of evaporation due to the salt creating new bonds with water, which will take more time to break for evaporation to occur.

Dependent variable. Mass of water in beakers over time.

Independent variable. Concentration of salt in water: 0 g, 1 g, 2g, 3 g, 4 g (per 50 ml of water)

Controlled variables.

* The temperature of the surroundings must stay constant for each sample to prevent any effects temperature changes could have on the evaporation rates of the samples.
* The initial mass of water must be the same for all samples due to the mass of water being responsible for the concentration of salt in it, thus affecting the rate of evaporation.
* Beakers with the same surface area of water exposed. This allows the evaporation rate to be dependent only on the concentration of salt, excluding the effect that a beaker with a different surface area could have on the evaporation rate.
* The time while to collecting the data.

Equipment and materials (Figures 1 and 2).

* Precision weighing scale to get exact masses of salt, beakers, and water
* 250 ml of water (50 ml for each sample)
* 10 g of salt (Samples with 4 g, 3 g, 2 g, 1 g, 0 g)
* 5 identical beakers to contain the 5 samples of different concentration
* Spatula to put an exact mass of salt on the scales and then to add it into the water
* Paper containing the salt to cover the scales from any salt
* Labels to put on beakers
* Pipette to accurately add needed mass of water
* Tablet to record raw data



Figure 1 Beakers with salt solution Figure 2 A balance and spatula

Experimental Setup and Procedure.

Step 1: Measure out 50 ml of water using scale, beaker, and pipette by filling in the beaker to approximately 50 ml and then adjusting the mass after weighing it using the pipette.

Step 2: Measure the required mass of salt using scale, spatula, and paper by first weighing the mass of the paper and then by weighing the paper with added salt (using spatula), before subtracting the initial mass of the paper.

Step 3: Add the salt to the water.

Step 4: Stir the solution with the spatula.

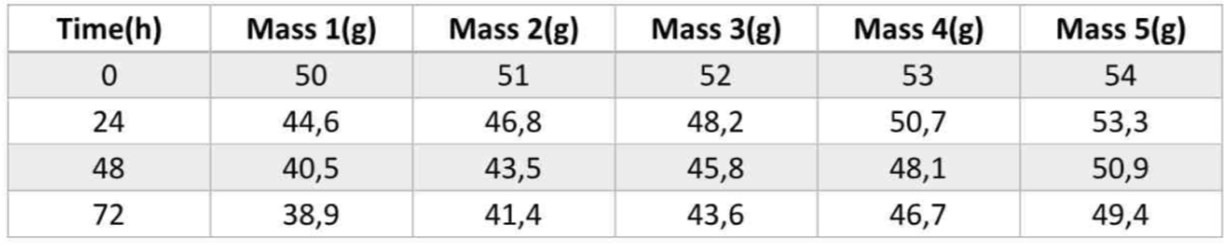
Step 5: Construct table with recordings of which numbered beaker has each salt concentration using online note file on tablet.

Step 6: Return after the specific time has passed to collect quantitative data.

Risk assessment

The experiment is quite safe, without any hazards like fire and harmful chemicals. However, goggles could be used to prevent any unlikely contact of salty water with the eyes. The glass equipment should also be handled cautiously to ensure that no glass will be broken during the experiment.

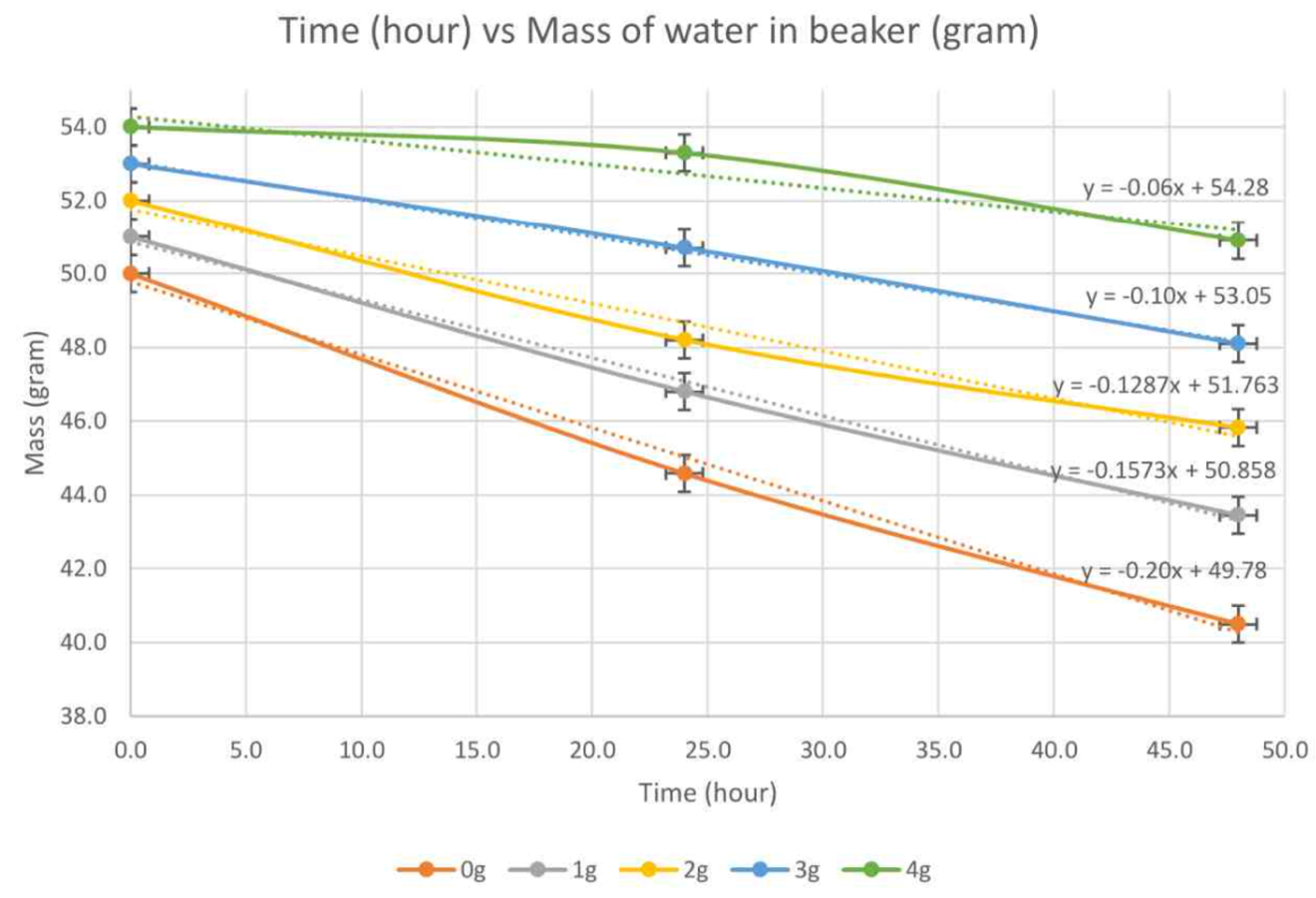
Table 1: Mass of sample over time.



The uncertainty in mass = 0,01 g.

The uncertainty in time = 0,67 h

Graph of Results



The graph above presents the relationship between the mass of the water in the sample and the time. Each line represents a different mass of salt added to the water (An

example of that is the blue line, which shows an addition of 3 grams of salt). Every sample was approximated by a straight line, which appears on the graph in the form of a dotted line. The rate of evaporation is the rate of change of the mass of the water, which is the gradient of the graph, Δ*m*/Δ*t.*

On the mass-time graph the rate of evaporation is the gradient of the line. Based on linear approximations for each sample, gradients were calculated and inserted into the table 2.

Table 2: Rates of evaporation for each sample

Table

Description automatically generated

Conclusion

The hypothesis that increasing the concentration of salt in a solution will then reduce the rate of evaporation is proven by quantitative and qualitative data.

The scientific theory also supports the results of the investigation, as the bonding between the water molecules and the sodium and chloride ions reduces internal energy, thus reducing the rate of evaporation. After analyzing the rates of evaporation for each sample we can make the following conclusions:

* The bonds created between ions in the salt and water take a longer time to break, leading for it to it taking longer to evaporation a solution with a greater salt concentration in the form of vapor.
* The data table does suggest that further addition of salt to a sample that the evaporation rate will eventually become zero if there is a linear relationship between the mass of added salt and the rate of evaporation.

Evaluation.

The investigation was successful in proving the theory in the hypothesis and graphically demonstrating and linearly approximating the results of the experiment. To make the investigation more precise preliminary experiments were conducted to minimize human error and clearly identify the correct steps needed required to collect the results.

Furthermore, the internal assessment added to my scientific knowledge through research into unique properties of the evaporation of water. Practical experiments and the methods of data collection were an essential part of the investigation and allowed me to gain further knowledge in the field explored in the investigation.

Errors and limitations.

The experiment did not include different temperatures measurements, which would affect the rate of evaporation of the five experimental samples, therefore this investigation failed to measure the effects of changing variables like temperature.

Random error: The random error could be explained as the presence of human errors in the process of investigating the hypothesis. A prime example of that is the delay to set up the next sample after one sample has been prepared. The human error also includes an uncertainty in the timing of the taken measurements caused by limited access to the lab containing samples for the investigation

Systematic error: The systematic errors mainly include the limitations of the equipment used in the investigation leading to uncertainties such as the weighing scale, which has an uncertainty ±0.01 g.

Representativeness.

A question of how representative of the real world the investigation also arises. Many of the control variables like temperature and surface area will not be constant in the real world, making the outcomes of the experiment different to ones in the environment.

Possible Improvements.

To improve the investigation more accurate measurements with less error could be made.

To reduce the time error the experiment it could have been done at home to always have access to the samples, unlike the time limitations of conducting the experiment in the school lab.

To reduce random error multiple trials of the experiment could have been conducted, which would a low for average masses of solutions, with different salt concentrations to be calculated.

Thus, we would make the data more accurate leading to more precise evaporation rates results.

In the future we could use all data and approximate it using non-linear approximation as the full data cannot be approximated using a linear function.

Bibliography.

*Physics for the IB Diploma*. Cambridge University Press, by Tsokos

“Does salt water evaporate” on Techie Scientist

<https://techiescientist.com/does-salt-water-evaporate/>

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~~29 February 2024~~