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# Thermal Conversion of Water's Adhesive Force to Cohesive Force

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***Abstract***— The study of mine was conducted to know that how water's adhesive force behave on subjecting it to different range of temperature. The primary research question that I had before starting this study was that how the physical property of water gets affected when a range of temperature is applied to it. Here in this study I have carried out **three different experiments** by subjecting water drops in a vessel which is heated at a varying range of temperature (between 20°C - 200°C) before coming to a conclusion. This research paper comprises of the physical property of water (adhesive force) which is seen to change when subjected at different range of temperature. Before conducting any research experiments I have read many research articles which have helped me in writing this research paper which I have mentioned below in my references section of this paper.

***Keywords***— water's cohesive force, adhesive force of mercury, bond angle of water, meniscus of water and mercury.

## I. INTRODUCTION

The force of adhesion or the adhesive force of water can be seen in between the glass tumbler or container in which the water molecules having a very much strong adhesive force is pulled towards the glass forming a spherical formation, thus avoiding the repulsion between like molecules [1] . This explanation may be found out in any of the science books available in the market but a need arose that what if water molecules is subjected at a varying range of temperature what could be the effect of it to it's adhesive or cohesive force was to be studied. So keeping this as the primary study of my article I have designed some few experiments which explains that water's adhesive or cohesive force is also dependent on the range of temperature it is being subjected at. Water shows its different kind of properties when different types of conditions are favorable for the property to occur likewise when water kept in a capillary tube it shows concave meniscus while mercury shows convex meniscus which is evident that water has the most adhesive force while mercury has the most cohesive force [2] **[figure 1.1].**

Fig 1.1: Showing the meniscuses of water and mercury.

The molecular forces of attraction in water or the hydrogen bonds are given in **[figure 1.2].**

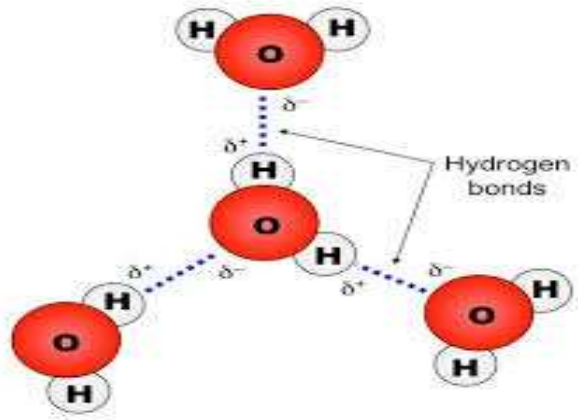



Fig: 1.2: showing the molecular forces of attraction in water or hydrogen bonds.

In this article, I had mentioned how water's adhesive force converts to cohesive force when the specific conditions like temperature and pressure is applied to it.

All modifications of this article has been made after reading the articles which are mentioned in the "references".

## II. RELATED WORK

The study of mine has been conducted after reading all the research papers mentioned in the reference section of this paper [3]. Notable works of **"A. Azoulay, P. Garzon, M.J. Eisenberg, Comparison of the mineral content of**

**tap water and bottled waters, Journal of General Internal Medicine, Vol.16, Issue.3, pp. 168–175, 2001"** has been proved very much helpful for my research [4].

## III. METHODOLOGY

**Three experiments** were done by using the same apparatus as shown in the diagram given aside (Fig. 1.3) before coming to any conclusion [5]. Note that, experiment 3 becomes a control setup for this study since experiments 1 and 2 have their temperature either being lowered or being heated when 110 degree Celsius is reached, such that deriving conclusion from the experiments become a lot more easy task to do.

**Requirements to do the experiments:**

- 30ml of tap water.
- A Bunsen burner or a normal gas oven used at home.
- An aluminium vessel or a hard-glass beaker.
- A beaker to keep the 30ml water.
- A dropper to drop the water droplets on the aluminium vessel or the hard-glass beaker.
- A stop watch.
- A barometer.

It is advised to do the experiment on the aluminum vessel for a better observation of the experiment.

**Experimental Setup:**

Pour 7ml of water from the beaker using the dropper in the aluminum vessel. Place the aluminum vessel on the top of the burner and start heating till the whole of the water evaporates. Then using a dropper pour an ml of water in the aluminum vessel. Repeat this process in each of the three experiment as mentioned above in the "discussion".

I did this experiments when barometric reading shows 1 atmospheric pressure as the boiling point of water increases or decreases with an increase or decrease in atmospheric pressure [6].

The schematic diagram of the experimental setup is given in [figure 1.3].

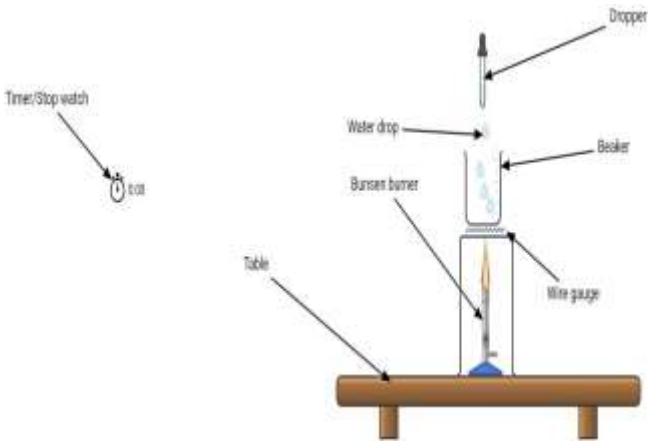
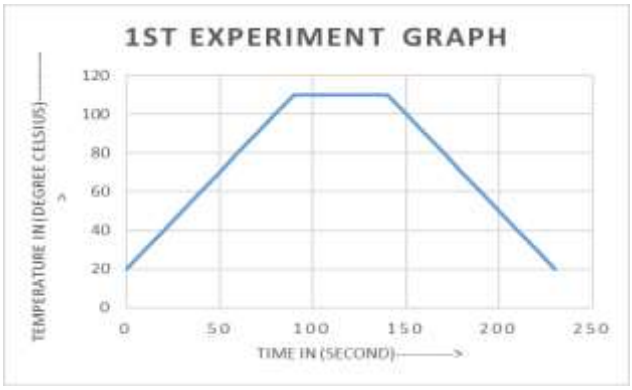



Fig: 1.3: Showing the schematic diagram of the experimental setup.

## IV. RESULTS AND DISCUSSION

In each of the three experiment 1ml of water is being taken which shows us the following results:-

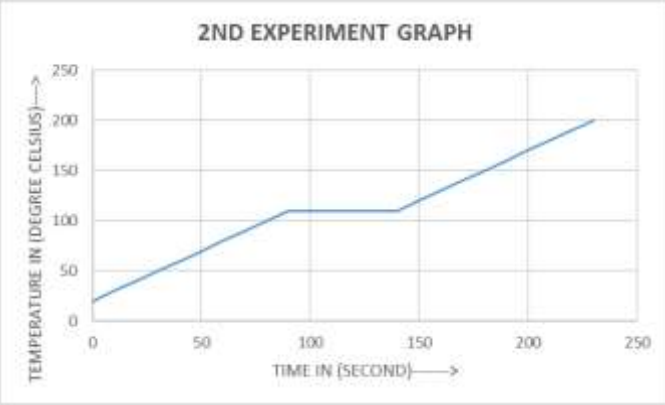
- In the 1st experiment the aluminium vessel is heated till 110 degree Celsius and is maintained the same temperature of 110 degree Celsius for a minute, and then it is set to cool down to see the effect on the water drops subjected in it. Its graph and average temperature reading on a given time period are given below:




| Time (In Second) | Temperature (In Degree Celsius) |
|---|---|
| 0 | 20 |
| 10 | 30 |
| 20 | 40 |
| 30 | 50 |
| 40 | 60 |
| 50 | 70 |
| 60 | 80 |
| 70 | 90 |
| 80 | 100 |
| 90 | 110 |
| 100 | 110 |
| 110 | 110 |
| 120 | 110 |
| 130 | 110 |
| 140 | 110 |
| 150 | 100 |
| 160 | 90 |
| 170 | 80 |
| 180 | 70 |
| 190 | 60 |
| 200 | 50 |
| 210 | 40 |
| 220 | 30 |
| 230 | 20 |

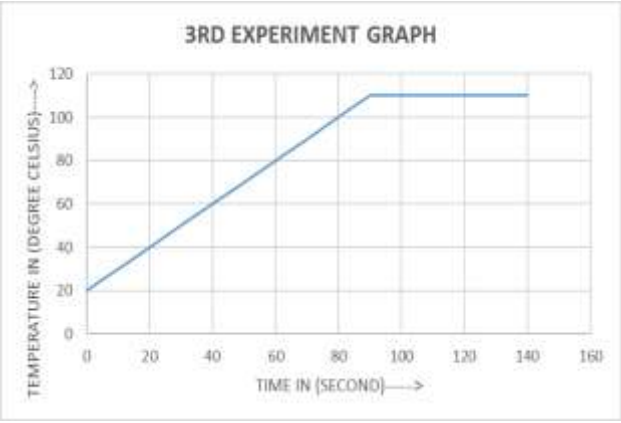
- In the 2nd experiment the aluminium vessel is heated till 110 degree Celsius and is maintained the same temperature of 110 degree Celsius for a minute, and then it was heated more to see the effect on the water drops subjected in it. Its graph and average temperature reading on a given time period are given below:




| Time (In Second) | Temperature (In Degree Celsius) |
|---|---|
| 0 | 20 |
| 10 | 30 |
| 20 | 40 |
| 30 | 50 |
| 40 | 60 |
| 50 | 70 |
| 60 | 80 |
| 70 | 90 |
| 80 | 100 |
| 90 | 110 |
| 100 | 110 |
| 110 | 110 |
| 120 | 110 |
| 130 | 110 |
| 140 | 110 |
| 150 | 120 |
| 160 | 130 |
| 170 | 140 |
| 180 | 150 |
| 190 | 160 |
| 200 | 170 |
| 210 | 180 |
| 220 | 190 |
| 230 | 200 |

- In the 3rd experiment the aluminium vessel is heated till 110 degree Celsius and is maintained the same temperature of 110 degree Celsius for nearly 1 minute unless the whole water evaporates. Its graph and average temperature reading on a given time period are given below:




| Time (In Second) | Temperature (In Degree Celsius) |
|---|---|
| 0 | 20 |
| 10 | 30 |
| 20 | 40 |
| 30 | 50 |
| 40 | 60 |
| 50 | 70 |
| 60 | 80 |
| 70 | 90 |
| 80 | 100 |
| 90 | 110 |
| 100 | 110 |
| 110 | 110 |
| 120 | 110 |
| 130 | 110 |
| 140 | 110 |

It is seen **that water's cohesive force gets stronger** like that of mercury rather than its adhesive force in each of the experiments on giving an average temperature of **"110 degree Celsius".**

## V. Conclusion and Future Scope

**As, mentioned in the methodology section of this paper, Experiment 3 becoming our control setup, helps to prove that when the water droplets were either cooled or heated in Experiments 1 and 2 above or below 110 Degree Celsius the water droplets vaporizes which indicates that neither below nor the above temperature of 110 Degree Celsius is suitable to see this phenomenon.** On having a close review to all the inferences driven from the experiments one could conclude that 110 Degree Celsius may be considered as a point when water drops changes its adhesive force to that of the cohesive force. Although, this conclusions also derive to the conclusion that the surface in which the experiments were done in this case the aluminum vessel becomes hydrophobic in nature at this temperature [7]. Limitations to this research study includes areas like contact angle between the aluminum vessel and the water droplets to be studied such that the aim to prove the hypothesis that water drops changes it's adhesive force to that of the cohesive force is proved. Also, more appropriate measurements to this study and using more analytical approach to this experiments can prove this hypothesis to be true.

## Acknowledgment

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## AUTHORS PROFILE

Mr. APARUP ROY has been doing research in Physical & Bio-Chemistry in ST. Peter's School. He had published two books namely "Problems in General Chemistry and Master ICSE Chemistry Semesters (I & II) [Class - X]". He had also been awarded with the "India Book Of Records *in 2021". He is also doing research with some of the MIT Harvard Scientist since 2020. The author also have published a research paper in the International Journal Of Science and Research named "*Development of Cow Dung using Herbal Ingredients Based Mosquito Repellent*".*

 