

# Water temperature and evaporation rate



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This report details the scientific method used to investigate the effects of water temperature on the rate at which the water will evaporate.

Project design plan:

Problem statement - The purpose of this experiment was to compare the effect of temperature on the evaporation rate of water.

The vision was to establish three containers of water. Each container contains the same amount of water. Surrounding air and humidity are kept consistent. One container is kept at a consistent room temperature; one container is kept at a heated consistent temperature; one container is kept at a cooled consistent temperature.

The issue being examined is how the three different water temperatures impacts the rate at which the water evaporates from the container.

The experiment was conceived as part of an effort to learn more about Global Warming. Since the world is made up of approximately 75% water, there is a desire to understand how increases in water temperature impacted the evaporation of water and if Global Warming could impact the world's water base.

Relevance of the question - evaporation is the scientific process where a liquid is converted to a gas state by increasing the speed of its molecules which causes a release in energy.

Water evaporates faster at higher temperatures although any amount of heat resulting from the release of this energy will cause water to evaporate.

## Literature review –

[http://www. engineeringtoolbox. com/evaporation-water-surface-d\\_690. html](http://www.engineeringtoolbox.com/evaporation-water-surface-d_690.html)

- this site provides a detailed process and mathematical equations for calculating the amount of evaporated water from a water surfaces. The amount of evaporation depends on the temperature in the water and in the air, and the humidity and velocity of the air above the surface. This site can be used as a reference to determine the level at which evaporation will occur in the experiment.

[http://www. usc. edu/CSSF/History/2002/Projects/J0615. pdf](http://www.usc.edu/CSSF/History/2002/Projects/J0615.pdf) – this site

provides the results of an experiment that measured which factor had the greatest effect on the rate of evaporation of water. The factors tested were surface area, wind speed, air temperature and water temperature. The results of this experiment validated the hypothesis for this experiment.

## Experimental design –

The constants in this experiment were:

- The type of water (tap)
- The amount of water
- The location where the water is placed
- The size of the container
- The number of test conducted
- The type of the container

<https://assignbuster.com/water-temperature-and-evaporation-rate/>

- The length of time the water has to evaporate

Materials Used -

Quantity

Item Description

1

Small home humidifier

1

Gallon jug of tap water

1

Graduated measuring cup

1

Digital wall mounted temperature and humidity gauge

3

8 ounce glass glasses

1

Digital thermometer

1

4 foot square, 3 foot high table

1

4 inch circular electrical heating plate

1

Thermos

1

Digital timer

1

12×12 terry cloth cooling towel

Steps executed in the experimental procedure –

1. Collect all required materials
2. Stabilize and maintain the humidity in testing room using a small home air humidifier. For the testing, the humidity was stabilized at 40%.
3. Stabilize and maintain the temperature in testing room using the home HVAC system. For the testing, the room temperature was stabilized at 70°.
4. Stabilize and maintain the air speed in testing room using isolated room. For the testing, the air speed was essentially “ dead calm”. Note: no special equipment was used to stabilize the air speed. The test was conducted in an isolated room. There was some air movement introduced into the room

through stabilizing the room temperature and humidity but was considered not significant enough to impact the tests.

5. Place a gallon jug of tap water in the testing room for 3 days so it adjusts to the room temperature and humidity.

6. Pour 100 ml. of tap water from the gallon jug stabilized to testing room temperature into each of 3 identical 8 ounce glass glasses using a graduated measuring cup.

7. Place the glasses into the center of the room on a table 3 feet off the floor so they are being equally affected by room temperature, humidity, and air movement.

8. Using a 4 inch, circular heating plate, place one of the glasses on the heating plate. The heating plate will raise the temperature of the water in the glass to 140 degrees. Note: it takes 30 minutes for the heating plate to heat the water in this glass to the 140 degree mark. Once this consistent temperature is reached, the volume of the water in this glass is rechecked to make sure the testing starting point is 100 ml.

9. Using a thermos, cooled via keeping it in a refrigerator for 24 hours, insert one of the glasses inside the thermos. The thermos will lower the temperature of the water in the glass to 35 degrees. Note: it takes 30 minutes for the thermos to cool the water in this glass to the 35 degree mark. Once this consistent temperature is reached, the volume of the water in this glass is rechecked to make sure the testing starting point is 100 ml.

10. Place a glass on the table and let it stabilize to the room temperature.

Note: it takes 30 minutes for the water in this glass to stabilize to the room temperature degree mark. Once this consistent temperature is reached, the volume of the water in this glass is rechecked to make sure the testing starting point is 100 ml.

11. Using the timer, let the water sit in the testing room at the 3 different temperatures for 180 minutes.

12. Using a graduated measuring cup, measure the remaining water in milliliters from each glass.

13. Record how many milliliters remained after evaporation for each temperature for each test.

14. Repeat steps 11-12 for 2 more cycles. Total evaporation time is 9 hours.

15. Wait 24 hours from the start of the test. Repeat steps 1-14.

16. Repeat steps 14 one more time.

Reason for choosing this particular experimental design plan - the reason for this particular experimental design plan was to provide 3 water sources maintained at 3 different temperatures kept in a controlled humidity, room temperature and air rate environment. This environment was expected to provide a static environment to allow water evaporation to progress solely based on the temperature of the 3 water sources. Using identical starting water amounts and a graduated measuring cup to measure the resulting water amounts was expected to provide the most accurate results.

Sequence of events used to collect quantitative data -

1. Using the timer, let the water sit in the testing room at the 3 different temperatures for 180 minutes.
2. Using a graduated measuring cup, measure the remaining water in milliliters from each glass.
3. Record how many milliliters remained after evaporation for each temperature for each test.
4. Repeat steps 1-3 for 3 more cycles. Total evaporation time is 9 hours.
5. Wait 24 hours from the start of the test. Repeat steps 1-4.
6. Repeat steps 5 two more times.

Tools, technologies, and measurement units used to collect quantitative data

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The recorded variable was the amount of water in milliliters that remained after evaporation was allowed to occur over in 180 minutes. The water in the 3 glass glasses was measured in milliliters using a graduated measuring cup before and after the evaporation occurred.

Dependent, independent, and controlled variables -

Dependent variables - the observed result of the independent variable being manipulated was the resulting water amount in each glass after evaporation has occurred



Independent variables - the value being manipulated or changed in this experiment was the water temperature of the water contained in the 3 glass glasses.

Controlled variables - the controlled variables were the air humidity, the air speed, the room temperature, the type of water (tap), the amount of water, the location where the water was placed, the size of the containers used, the number of tests conducted, the type of the containers used, and the length of time the water had to evaporate.

Threat reduction to internal validity -

To reduce the threats to internal validity the following steps were taken:

1. Stabilize and maintain the humidity in testing room using a small home air humidifier. For the testing, the humidity was stabilized at 40%.
2. Stabilize and maintain the air speed in testing room using isolated room. For the testing, the air speed was essentially "dead calm". Note: no special equipment was used to stabilize the air speed. The test was conducted in an isolated room. There was some air movement introduced into the room through stabilizing the room temperature and humidity but was considered not significant enough to impact the tests.
3. Stabilize and maintain the room temperature in testing room using the home HVAC system. For the testing, the room temperature was stabilized at 70°.

4. Stabilize the water used by placing a gallon jug of tap water in the testing room for 3 days so it adjusts to the room temperature and humidity.

5. Stabilize the test environment by placing the glasses into the center of the room on a table 3 feet off the floor so they are being equally affected by room temperature, humidity, and air movement.

Hypothesis -

The hypothesis was that the temperature of the water would affect the evaporation rate of the water the most and that the higher the water temperature, the more evaporation that would occur.

The hypothesis proposed that the warmer the water, the more molecules escaped as vapor, and thus evaporated. The hypothesis theorized that the warmer the water's molecules were the more energy that would be produced and the amount of molecules escaping as vapor would occur at a much faster pace than molecules at lower temperatures.

### **Process of data collection:**

At the end of each evaporation cycle of 180 minutes, the contents of each glass were poured into the graduated measuring cup and the resulting water in milliliters was measured and recorded.

The data below shows the resulting milliliters for each sample for each test cycle as well as the percentage of evaporation that occurred which was determined by subtracting the resulting value from the original 100 milliliters and dividing by 100 to result in a percentage.

## **Evaporation Test #1**

Sample

Resulting

milliliters

Sample

Percentage

of water

evaporation

Hours

3

6

9

3

6

Heated water

70

42

5

Heated water

0.3

0.58

Room temperature water

99

98

97

Room temperature water

0.01

0.02

Cooled water

91

80

68

Cooled water

0.09

0.2

## Evaporation Test #2

Hours

3

6

9

3

6

Heated water

73

48

10

Heated water

0.27

0.52

Room temperature water

98

97

96

Room temperature water

0.02

0.03

Cooled water

99

98

97

Cooled water

0.01

0.02

### **Evaporation Test #3**

Hours

3

6

9

3

6

Heated water

78

48

11

Heated water

0.22

0.52

Room temperature water

99

98

97

Room temperature water

0.01

0.02

Cooled water

96

88

86

Cooled water

0.04

0. 12

### **Results of experiment:**

The original purpose of this experiment was to compare the effect of temperature on the evaporation rate of water.

The results for the heated sample were as hypothesized. The highest rate of evaporation occurred in the heated sample. Also as the amount of water source decreased from previous evaporations, the subsequent evaporations were larger. The room temperature sample had marginal evaporation as expected.

The results of the cooled sample were somewhat surprising, especially in the first test. It was assumed that the rate of evaporation would have been slowed down due to the cooler temperature and it would take longer for the evaporation to occur since the water source would have to warm over time for the molecules to excite and turn into vapor and evaporate.

In researching this, it was discovered that these results might have been caused by the perspiration effect on cold water. It was noticed that there was a great deal of perspiration on the outside of the glass when the measurements were taken. After the first test, in an attempt to control this perspiration factor, the thermos was wrapped in the cooling towel. This did have an effect of the readings but the cooled sample results were still inconsistent and not what was expected.

The results of the 3 separate tests showed consistency in the rate of evaporation across the both the heated and room temperature sources. This



satisfies my goal of having a controlled environment in which to perform the tests.

## **Conclusion:**

The results of the experiment confirmed the hypothesis in terms of heat having the largest impact on the evaporation rate of water. The heated sample had the greatest rate of evaporation.

The hypothesis was that the temperature of the water would affect evaporation rate most.

The results indicate that this hypothesis should be accepted, because the heated water source had the greatest rate of evaporation.

The experimental design was a key factor in the success of the scientific inquiry. By

controlling the air humidity, the air speed, the room temperature, the type of water (tap), the amount of water, the location where the water was placed, the size of the containers used, the number of tests conducted, the type of the containers used, and the length of time the water had to evaporate variables, enabled a controlled environment and allowed the focus of the experiment to be on the variable being manipulated which was the resulting water amount in each glass after evaporation has occurred.

If the experimental design was faulty and the controlled environment was not established, other variables may have impacted the results. Humidity, air rate and air speed are factors in the rate of evaporation. If they were not

controlled, the results of the experiment would have most likely been inconsistent.

This experiment is valid since the test environment was controlled and only one variable was impacted by the test. Having multiple uncontrolled variable can invalidate an experiment in most cases.

The experimental design and execution steps listed above would allow anyone to execute this experiment. If the tests were to be re-executed, the perspiration effect of the cooled sample needs to be taken into account and included in the measurements.

Re-execution of the experiment described above and resulting similar results validates the experiment.