TED ANKARA COLLEGE FOUNDATION HIGH SCHOOL

HEAT ISOLATORS ON A VACUUM FLASK

Name of the Candidate: Utku ÖZGÜR

Candidate Number: D1129016

Supervisor: Özay Atay

Word Count: 3986

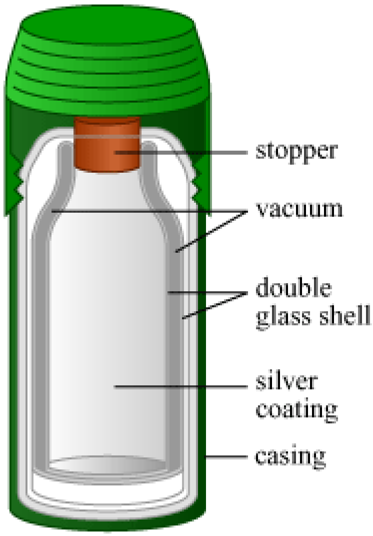
ABSTRACT

The thing which makes the vacuum flask system useful is the vacuum between the two bottles. Producers of the vacuum flask try to create a perfect vacuum between the two bottles, but it is impossible. Little air goes inside, too. This situation creates my experiment and research question. There are many heat isolators so can there be any material that can be more successful in conserving the temperature of the liquid added than the vacuum flask system? To find an answer to my question, I chose 3 heat isolators (perlite, fire brick and silicone) and put them into the flasks instead of the vacuum. In order to investigate their performance and compare with the vacuum flask system, I planned four experiments. I added to the flasks different liquids, water at the different temperature and water at different amounts and measured the temperatures of the added liquids in different times. According to the results from these 4 experiments, I reach to a conclusion that these isolators couldn’t perform a better performance than vacuum in conserving the temperature of the liquid.

(Word Count: 180 words)

CONTENTS

INTRODUCTION



A vacuum flask is a storage vessel or insulated shipping container which keeps its contents hotter or cooler than their environment without the need to modify the pressure, by interposing an evacuated region to provide thermal insulation between the contents and the environment.[1] Vacuum flask is invented by Sir James Dewar in 1892 for experimental needs, but after the invention vacuum flask became popular and nowadays people are using vacuum flasks in their daily lives. They are conserving their coffee's warmth or their cold water's coldness in a long travel. Vacuum flask system is very simple. It contains 2 bottles which is telescoped and the air between the outer bottle and the inner bottle is taken. Inner bottle is mostly made from stainless steel and glass. Outer bottle is also made from stainless steel and glass. The air between the two bottles isn't taken fully. Because of this, temperature of an item in the vacuum flask doesn't stay constant. This situation creates my experiment. Can heat isolators be more successful in keeping the temperature of the liquid added than vacuum flask? To answer this research question I changed the vacuum with three heat isolators which

[1] http://en.wikipedia.org/wiki/Thermos

are perlite, fire brick and silicone. The reason for this choice of heat isolators is their conductivity of heat is really small.

Perlite is an amorphous volcanic glass that has relatively high water content, typically formed by the hydration of obsidian.[2] Although perlite is a solid rock, its thermal conductivity is smaller than many gases and items used in isolation of the buildings which is 0.031 *W/mK*[3]. Because of its form, perlite is mainly used as an industrial material for isolation. In this experiment, perlite is crushed into very small pieces by the help of hammer and grinder and big pieces are sieved.

A fire brick is a block of refractory ceramic material used in lining furnaces, kilns, fireboxes, and fireplaces[4]. As we can see from its places of usage, we can say that fire brick must withstand high temperatures and to be an effective item it must have a small thermal conductivity which is 0.24 *W/mK*[3]. In this experiment, brick is crushed into very small pieces by drill and big pieces are sieved.

Silicones are largely inert, man-made compounds with a wide variety of forms and uses. Typically heat-resistant, nonstick, and rubber like, they are commonly used in cookware, medical applications, sealants, adhesives, lubricants, and insulation.[5] Its thermal conductivity is between 0.146 and 0.314 *W/mK*[3]**.** In this experiment, silicone is squeezed into the flask by the silicone gun.

PLANING OF THE EXPERIMENT

In order to find the most effective item which can be used in flasks, an experiment had to be done. As flasks' main objective is to keep the temperature of the added item, experiment must

---

[2] http://en.wikipedia.org/wiki/Perlite
[3] http://www.engineeringtoolbox.com/thermal-conductivity-d_429.html

[4] http://en.wikipedia.org/wiki/Firebrick
[5] http://en.wikipedia.org/wiki/Silicone

be about the temperature loss in the flasks. In order to investigate these losses, 4 experiments had been planned. First experiment is planned to show the effect of time on temperature loss, second experiment is planned to show the effect of the temperature of the liquid which is added into the flasks, third experiment is planned to show the effect of the amount of the liquid added to the flasks and fourth experiment is planned to show the effect of the different liquids added to the flasks. Liquids which are planned to use in experiments are tea, coke and water. 500 mL bottle is used to see the effect of the direct air connection on the temperature on the temperature of the liquid and compare the results with the other heat isolators. Bottle's cap was opened. Initial temperatures of the coke and cold water is planned to be 13 ºC. Initial temperatures of the hot water and tea is planned to be 65 ºC.

EXPERIMENTS

1. **Time Experiment**

Every person has a different usage of a vacuum flask. As I said at the beginning of the essay, one person put his coffee or cold water into the vacuum flask at long journey. This requires the vacuum flask to conserve the temperature for longer hours. In this first part of the experiment, I will add some water to the flasks and record the temperature of the water after 1, 2, 4, 6, 8 and 12 hours. In this experiment, independent variable is the time that the liquid is kept in the flasks, dependent variable is the temperature of the liquids in the flasks and the controlled variable is the mass of the liquids, initial temperature, container and kind of liquid. Materials required for this experiment is:

- 4 same flask with different isolations (Vacuumed, Perlite added, Fire brick added and Silicone squeezed flasks)
- 500 mL bottle
- 5 L tap water
- Digital Thermometer
- 500 g ice cube
- Container (3 L capacity)
- 4 bolts
- Drill
- Stop watch

Procedure followed in the experiment:

1. Open holes in the caps of the flasks with the help of the drill and close the caps with the bolts to avoid the temperature loss.
2. Pour 2.5 L tap water to the container. Temperature of the tap water is bigger than the planned temperature of the cold water (mostly 16 ºC), so make the tap water colder with the help of the ice cubes.

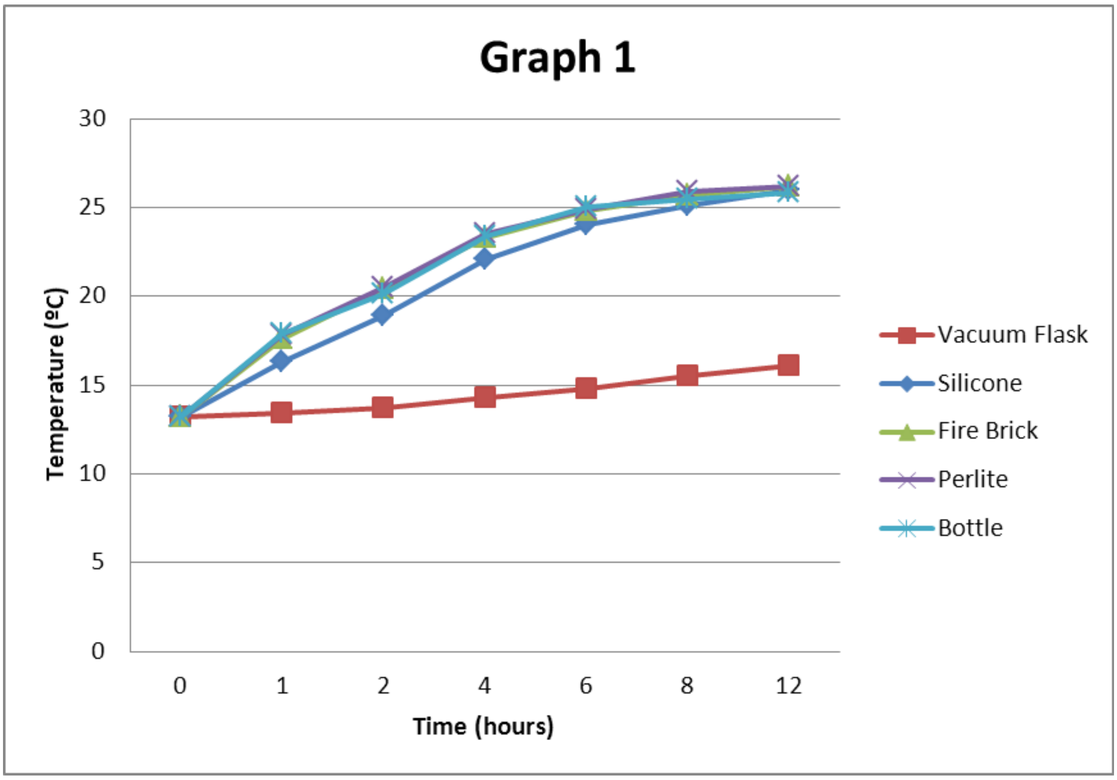
3. Before pouring the cold water to flasks, clean the flasks with a little amount of water to have the best result from the systems.
4. Pour 500 mL cold water to the flasks when it is near 13 ºC with the help of the bottle.
5. After pouring water to 4 flasks and 500 mL bottle, open bottle's cap.
6. Start the stop watch.
7. Record the temperatures of the water in the 4 flasks and one bottle after 1, 2, 4, 6, 8 and 12 hours. For flasks, take the bolt and put the thermometer into the flask from the open hole.

Temperature of the medium=26,3 ºC [6]

Hours After/Temperature of the water in flasks and bottle	Temperature of the water in vacuum Flask (**ºC**) (±0.1 **ºC)**	Temperature of the water in silicone squeezed flask (**ºC**) (±0.1 **ºC)**	Temperature of the water in fire brick added flask (**ºC**) (±0.1 **ºC)**	Temperature of the water in perlite added flask (**ºC**) (±0.1 **ºC)**	Temperature of the water in bottle (**ºC**) (±0.1 **ºC)**
0 Hour After	**13,2**	**13,2**	**13,2**	**13,2**	**13,2**
1 Hour After	**13,4**	**16,3**	**17,6**	**17,8**	**17,9**
2 Hours After	**13,7**	**18,9**	**20,4**	**20,5**	**20,1**
4 Hours After	**14,3**	**22,1**	**23,3**	**23,5**	**23,4**
6 Hours After	**14,8**	**24,0**	**24,8**	**24,9**	**25,0**
8 Hours After	**15,5**	**25,1**	**25,7**	**25,9**	**25,5**
12 Hours After	**16,1**	**26,0**	**26,2**	**26,2**	**25,8**

Table 1: Data of the 1st trial in detail.

[6] All measurements were made with the digital thermometer.



Graph 1: Temperature-Time Graph for the cold water.

2. Temperature Experiment

Hot water is always an important element for tea. Because of this, hot water is carried with vacuum flasks as much as cold water so vacuum flasks must also conserve the temperature of the items added at high and low temperatures. In order to find the flasks effectiveness in different temperatures, I will add same amount of hot and cold water and record the temperature changes in 1, 2, 4, 6, 8 and 12 hours. In this experiment, independent variable is the temperature of the liquids added to the flasks, dependent variable is the temperature of the liquids in the flasks and the controlled variable is the mass of liquids, kind of liquid, initial temperature and containers. Materials needed for this experiment is:

- 4 same flask with different isolations (Vacuumed, Perlite added, Fire brick added and Silicone squeezed flasks)
- 500 mL bottle

- 2.5 L of hot water and 2.5 L cold water
- Digital Thermometer
- 500 g ice cube
- Container (3 L capacity)
- Oven

Procedure followed in the experiment for cold water:

1. Pour 2.5 L tap water to the container. Temperature of the tap water is bigger than the planned temperature of the cold water (mostly 16 ºC), so make the tap water colder with the help of the ice cubes.
2. Before pouring the cold water to flasks, clean the flasks with a little amount of water to have the best result from the systems.
3. Pour 500 mL cold water to the flasks when it is near 13 ºC with the help of the bottle.
4. After pouring water to 4 flasks and 500 mL bottle, open bottle’s cap.
5. Start the stop watch.
6. Record the temperatures of water in the flasks and one bottle after 1, 2, 4, 6, 8 and 12 hours. For flasks, take the bolt and put the thermometer into the flask from the hole.

Procedure followed in the experiment for hot water:

1. Pour 2.5 L tap water to the container. Temperature of the tap water is smaller than the planned temperature of the hot water (mostly 16 ºC), so make the tap water hotter with the help of the oven.
2. Before pouring the hot water to flasks, clean the flasks with a little amount of hot water taken from the container to have the best result from the systems.
3. Pour 500 mL hot water to the flasks when it is near 65 ºC with the help of the bottle.
4. After pouring water to 4 flasks and 500 mL bottle, open bottle’s cap.
5. Start the stop watch.

6. Record the temperatures of the water in the 4 flasks and one bottle after 1, 2, 4, 6, 8 and 12 hours. For flasks, take the bolt and put the thermometer into the flask from the open hole.

Temperature of the medium=26,2 ºC

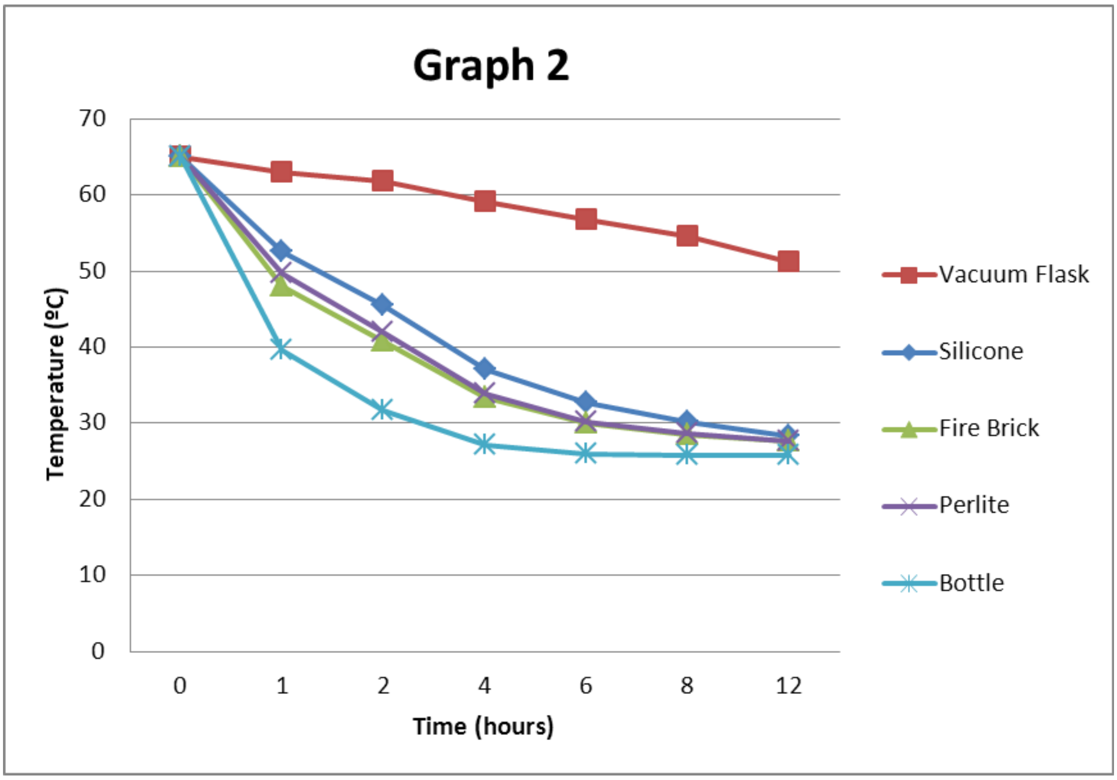
Hours After/ Temperature of the systems	Temperature of water in vacuum Flask (**ºC**) (±0.1 **ºC)**	Temperature of water in silicone flask (**ºC**) (±0.1 **ºC)**	Temperature of water in fire brick added flask (**ºC**) (±0.1 **ºC)**	Temperature of water in perlite added flask (**ºC**) (±0.1 **ºC)**	Temperature of water in bottle (**ºC**) (±0.1 **ºC)**
0 Hour After	**13,2**	**13,2**	**13,2**	**13,2**	**13,2**
1 Hour After	**13,4**	**16,3**	**17,6**	**17,8**	**17,9**
2 Hours After	**13,7**	**18,9**	**20,4**	**20,5**	**20,1**
4 Hours After	**14,3**	**22,1**	**23,3**	**23,5**	**23,4**
6 Hours After	**14,8**	**24,0**	**24,8**	**24,9**	**25,0**
8 Hours After	**15,5**	**25,1**	**25,7**	**25,9**	**25,5**
12 Hours After	**16,1**	**26,0**	**26,2**	**26,2**	**25,8**

Table 2: Data for the cold water.

Temperature of the medium=23,5 ºC

Hours After/Temperature of the water in flasks and bottle	Temperature of the water in vacuum Flask (**ºC**) (±0.1 **ºC)**	Temperature of the water in silicone squeezed flask (**ºC**) (±0.1 **ºC)**	Temperature of the water in fire brick added flask (**ºC**) (±0.1 **ºC)**	Temperature of the water in perlite added flask (**ºC**) (±0.1 **ºC)**	Temperature of the water in bottle (**ºC**) (±0.1 **ºC)**
0 Hour After	**65,0**	**65,0**	**65,0**	**65,0**	**65,0**
1 Hour After	**63,0**	**52,5**	**47,9**	**49,7**	**39,5**
2 Hours After	**61,7**	**45,4**	**40,8**	**41,9**	**31,7**
4 Hours After	**59,1**	**37,1**	**33,3**	**33,8**	**27,1**
6 Hours After	**56,8**	**32,6**	**30,0**	**30,2**	**25,9**
8 Hours After	**54,5**	**30,1**	**28,5**	**28,6**	**25,8**
12 Hours After	**51,1**	**28,3**	**27,6**	**27,6**	**25,8**

Table 3: Data for the hot water.



Graph 2: Temperature-Time graph for hot water.

3. Amount Experiment

I put the same amount of water into the vacuum flask all the time so results of the first two experiments couldn't reach us to a certain conclusion. In order to find the effectiveness of the flasks at different amounts of liquid added, I will add flasks different amount of water. In the 1st trail I will add 300 mL of water, in the 2nd trail I will add 400 mL of water and in the 3rd trail I will add 500 mL of water to the flasks. Cold water will be used in the experiment. In this experiment, independent variable is the amount of the liquid added to the flasks, dependent variable is the temperature of the liquids in the flaks and the controlled variable is the kind of liquid, initial temperature and containers. Materials needed for this experiment is:

- 4 same flask with different isolations (Vacuumed, Perlite added, Fire brick added and Silicone squeezed flasks)

- 500 mL bottle
- 6 L cold water
- Thermometer
- 500 g ice cube
- Container (3 L capacity)

Procedure followed in the experiment for 500 mL cold water:

1. Pour 2.5 L tap water to the container. Temperature of the tap water is bigger than the planned temperature of the cold water (mostly 16 ºC), so make the tap water colder with the help of the ice cubes.
2. Before pouring the cold water to flasks, clean the flasks with a little amount of water to have the best result from the systems.
3. Pour 500 mL cold water to the flasks when it is near 13 ºC with the help of the bottle.
4. After pouring water to 4 flasks and 500 mL bottle, open bottle's cap.
5. Start the stop watch.
6. Record the temperatures of the water in the 4 flasks and one bottle after 1, 2, 4, 6, 8 and 12 hours. For flasks, take the bolt and put the thermometer into the flask from the open hole.
7. Repeat the first 6 steps for the 400 mL water and 300 mL water, but for 400 mL water, pour 2 L water to the container and fill the flasks and bottle with 400 mL water. For 300 mL water, pour 1.5 L water to the container and fill the flasks and bottle with 300 mL water.

Temperature of the medium=26,8 ºC

Hours After/Temperature of the water in flasks and bottle	Temperature of the water in vacuum Flask (ºC) (±0.1 ºC)	Temperature of the water in silicone squeezed flask (ºC) (±0.1 ºC)	Temperature of the water in fire brick added flask (ºC) (±0.1 ºC)	Temperature of the water in perlite added flask (ºC) (±0.1 ºC)	Temperature of the water in bottle (ºC) (±0.1 ºC)
0 Hour After	**13,2**	**13,2**	**13,2**	**13,2**	**13,2**
1 Hour After	**13,4**	**16,3**	**17,6**	**17,8**	**17,9**
2 Hours After	**13,7**	**18,9**	**20,4**	**20,5**	**20,1**
4 Hours After	**14,3**	**22,1**	**23,3**	**23,5**	**23,4**
6 Hours After	**14,8**	**24,0**	**24,8**	**24,9**	**25,0**
8 Hours After	**15,5**	**25,1**	**25,7**	**25,9**	**25,5**
12 Hours After	**16,1**	**26,0**	**26,2**	**26,2**	**25,8**

Table 4: Data for the 500 mL cold water.

Temperature of the medium=26,8 ºC

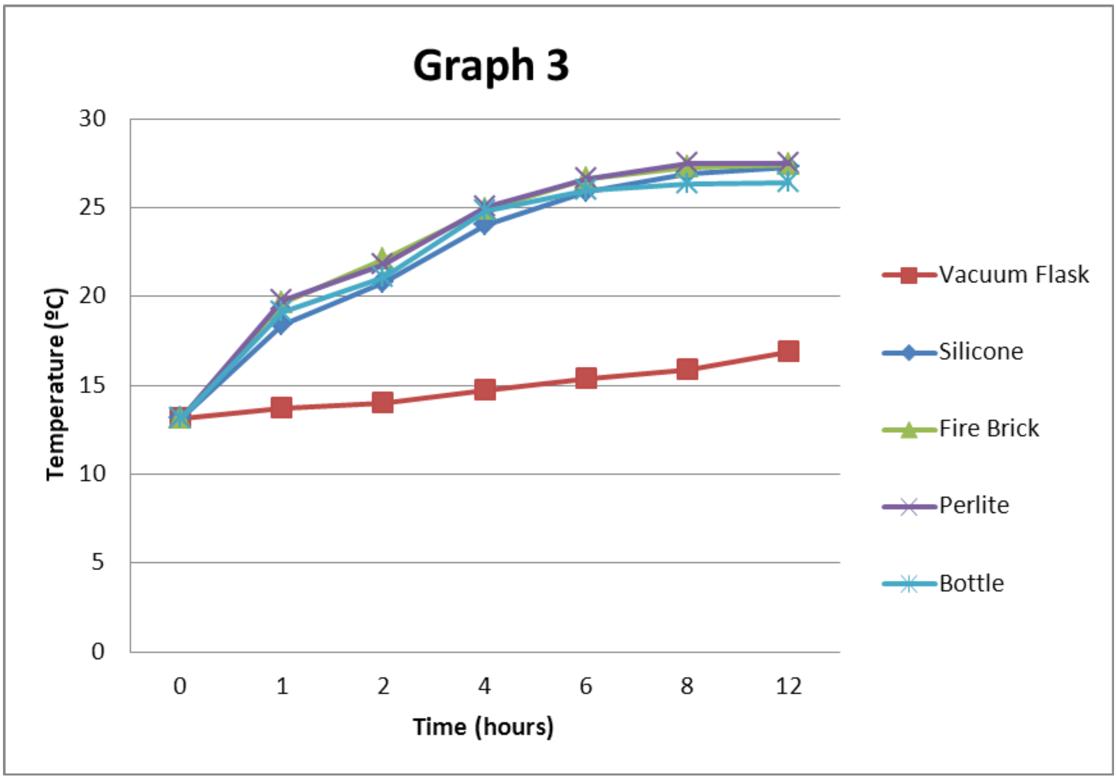
Hours After/Temperature of the water in flasks and bottle	Temperature of the water in vacuum Flask (ºC) (±0.1 ºC)	Temperature of the water in silicone squeezed flask (ºC) (±0.1 ºC)	Temperature of the water in fire brick added flask (ºC) (±0.1 ºC)	Temperature of the water in perlite added flask (ºC) (±0.1 ºC)	Temperature of the water in bottle (ºC) (±0.1 ºC)
0 Hour After	**13,2**	**13,2**	**13,2**	**13,2**	**13,2**
1 Hour After	**13,7**	**18,4**	**19,6**	**19,8**	**19,1**
2 Hours After	**14,0**	**20,8**	**22,1**	**21,8**	**21,1**
4 Hours After	**14,7**	**24,0**	**24,9**	**25,0**	**24,8**
6 Hours After	**15,4**	**25,0**	**25,6**	**25,6**	**26,0**
8 Hours After	**15,9**	**25,9**	**26,3**	**26,5**	**26,3**
12 Hours After	**16,9**	**26,3**	**26,4**	**26,5**	**26,4**

Table 5: Data for the 400 mL cold water.

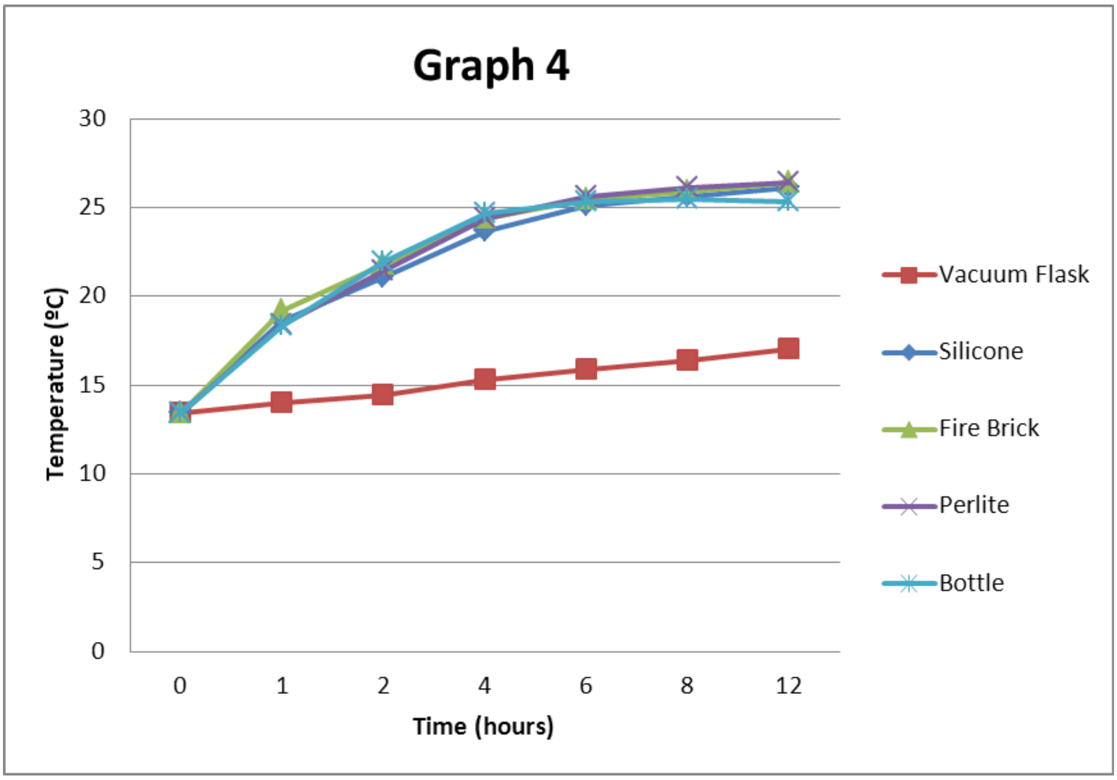
Temperature of the medium=26,8 ºC

Hours After/Temperature of the water in flasks and bottle	Temperature of the water in vacuum Flask (ºC) (±0.1 ºC)	Temperature of the water in silicone squeezed flask (ºC) (±0.1 ºC)	Temperature of the water in fire brick added flask (ºC) (±0.1 ºC)	Temperature of the water in perlite added flask (ºC) (±0.1 ºC)	Temperature of the water in bottle (ºC) (±0.1 ºC)
0 Hour After	**13,2**	**13,2**	**13,2**	**13,2**	**13,2**
1 Hour After	**14,0**	**18,6**	**19,2**	**18,4**	**18,3**
2 Hours After	**14,4**	**21,1**	**21,8**	**21,4**	**21,9**
4 Hours After	**15,3**	**23,7**	**24,4**	**24,4**	**24,7**
6 Hours After	**15,9**	**25,1**	**25,5**	**25,6**	**25,3**
8 Hours After	**16,4**	**25,6**	**25,9**	**26,1**	**25,5**
12 Hours After	**17,0**	**26,1**	**26,4**	**26,4**	**25,3**

Table 6: Data for the 300 mL cold water.



Graph 3: Temperature-Time graph for 400 mL cold water.



Graph 4: Temperature-Time graph for 300 mL cold water.

4. Liquid Experiment

Water isn't the only liquid that can be carried in the flasks. Other types of liquids can be put into the flask, too. Throughout the experiments, I only tested water. I will also test the temperature conservation of tea and Coca Cola. In this experiment, independent variable is the type of the liquid added to the flasks, dependent variable is the temperature of the liquids in the flaks and the controlled variable is the containers, initial temperature and mass of liquids. Materials needed for this experiment is:

- 4 same flask with different isolations (Vacuumed, Perlite added, Fire brick added and Silicone squeezed flasks)
- 500 mL bottle
- 2.5 L of cold water
- 2.5 L of hot water

- 2.5 L Coca Cola
- 2.5 L tea
- 500 g ice cube
- Container (3 L capacity)
- Oven

Procedure followed in the experiment for cold water and coke:

1. Pour 2.5 L tap water to the container. Temperature of the tap water is bigger than the planned temperature of the cold water (mostly 16 ºC), so make the tap water colder with the help of the ice cubes.
2. Before pouring the cold water to flasks, clean the flasks with a little amount of water to have the best result from the systems.
3. Pour 500 mL cold water to the flasks when it is near 13 ºC with the help of the bottle.
4. After pouring water to 4 flasks and 500 mL bottle, open bottle's cap.
5. Start the stop watch.
6. Record the temperatures of the water in the 4 flasks and one bottle after 1, 2, 4, 6, 8 and 12 hours. For flasks, take the bolt and put the thermometer into the flask from the open hole.
7. Repeat these steps with coke instead of water for the coke experiment.

Procedure followed in the experiment for hot water and tea:

1. Pour 2.5 L tap water to the container. Temperature of the tap water is smaller than the planned temperature of the hot water (mostly 16 ºC), so make the tap water hotter with the help of the oven.

2. Before pouring the hot water to flasks, clean the flasks with a little amount of hot water taken from the container to have the best result from the systems.
3. Pour 500 mL hot water to the flasks when it is near 65 ºC with the help of the bottle.
4. After pouring water to 4 flasks and 500 mL bottle, open bottle's cap.
5. Start the stop watch.
6. Record the temperatures of the water in the 4 flasks and one bottle after 1, 2, 4, 6, 8 and 12 hours. For flasks, take the bolt and put the thermometer into the flask from the open hole.
7. Repeat these steps with tea instead of water for the tea experiment.

Temperature of the medium=26,4ºC

Hours After/Temperature of the water in flasks and bottle	Temperature of the water in vacuum Flask (**ºC**) (±0.1 **ºC)**	Temperature of the water in silicone squeezed flask (**ºC**) (±0.1 **ºC)**	Temperature of the water in fire brick added flask (**ºC**) (±0.1 **ºC)**	Temperature of the water in perlite added flask (**ºC**) (±0.1 **ºC)**	Temperature of the water in bottle (**ºC**) (±0.1 **ºC)**
0 Hour After	**13,2**	**13,2**	**13,2**	**13,2**	**13,2**
1 Hour After	**13,4**	**16,3**	**17,6**	**17,8**	**17,9**
2 Hours After	**13,7**	**18,9**	**20,4**	**20,5**	**20,1**
4 Hours After	**14,3**	**22,1**	**23,3**	**23,5**	**23,4**
6 Hours After	**14,8**	**24,0**	**24,8**	**24,9**	**25,0**
8 Hours After	**15,5**	**25,1**	**25,7**	**25,9**	**25,5**
12 Hours After	**16,1**	**26,0**	**26,2**	**26,2**	**25,8**

Table 7: Data for the cold water.

Temperature of the medium=26,4 ºC

Hours After/Temperature of the coke in flasks and bottle	Temperature of the coke in vacuum Flask (ºC) (±0.1 ºC)	Temperature of the coke in silicone squeezed flask (ºC) (±0.1 ºC)	Temperature of the coke in fire brick added flask (ºC) (±0.1 ºC)	Temperature of the coke in perlite added flask (ºC) (±0.1 ºC)	Temperature of the coke in bottle (ºC) (±0.1 ºC)
0 Hour After	**13,2**	**13,2**	**13,2**	**13,2**	**13,2**
1 Hour After	**14,2**	**19,0**	**20,6**	**20,7**	**20,8**
2 Hours After	**14,4**	**20,5**	**21,8**	**21,8**	**21,8**
4 Hours After	**15,0**	**22,9**	**23,9**	**23,8**	**23,9**
6 Hours After	**15,5**	**24,2**	**25,0**	**25,1**	**24,7**
8 Hours After	**16,0**	**25,1**	**25,6**	**25,7**	**25,0**
12 Hours After	**16,9**	**25,9**	**26,2**	**26,2**	**26,2**

Table 8: Data for the coke.

Temperature of the medium=23,5ºC

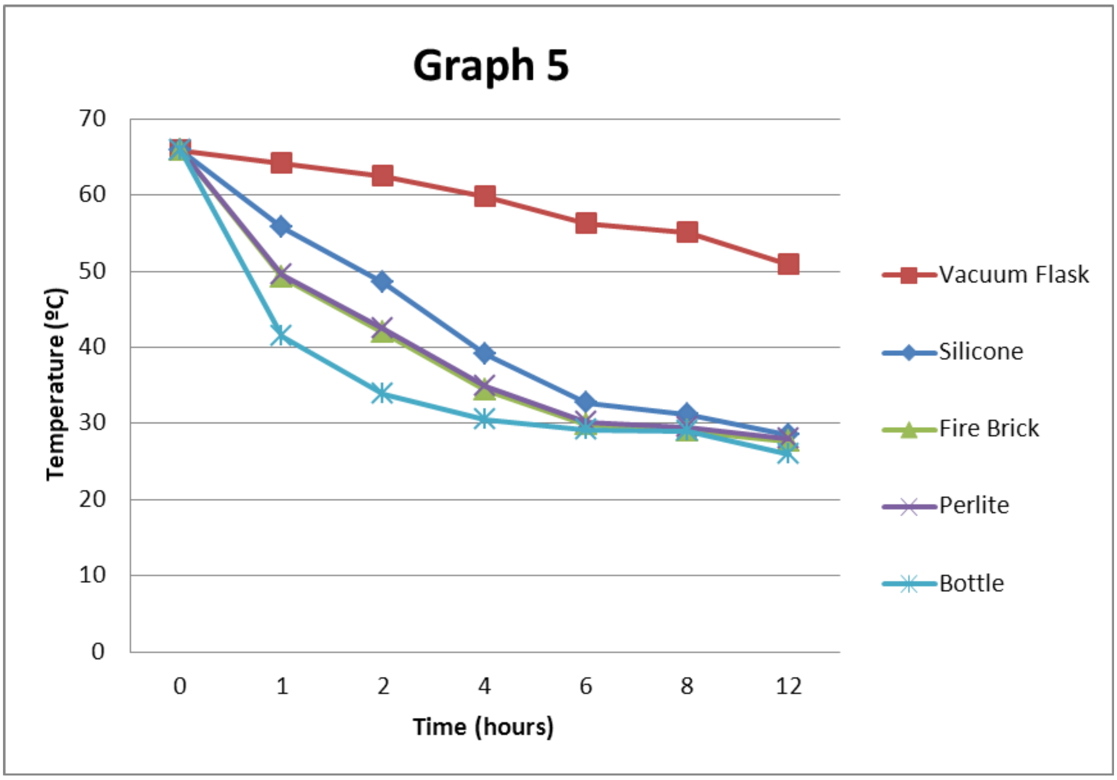
Hours After/Temperature of the tea in flasks and bottle	Temperature of the tea in vacuum Flask (ºC) (±0.1 ºC)	Temperature of the tea in silicone squeezed flask (ºC) (±0.1 ºC)	Temperature of the tea in fire brick added flask (ºC) (±0.1 ºC)	Temperature of the tea in perlite added flask (ºC) (±0.1 ºC)	Temperature of the tea in bottle (ºC) (±0.1 ºC)
0 Hour After	**65,0**	**65,0**	**65,0**	**65,0**	**65,0**
1 Hour After	**64,1**	**55,8**	**49,1**	**49,5**	**41,4**
2 Hours After	**62,4**	**48,5**	**42,0**	**42,4**	**33,9**
4 Hours After	**59,8**	**39,1**	**34,3**	**34,8**	**30,4**
6 Hours After	**56,2**	**32,6**	**29,8**	**30,1**	**29,1**
8 Hours After	**55,1**	**31,1**	**29,0**	**29,5**	**29,0**
12 Hours After	**50,9**	**28,5**	**27,7**	**27,9**	**25,9**

Table 9: Data for the tea.

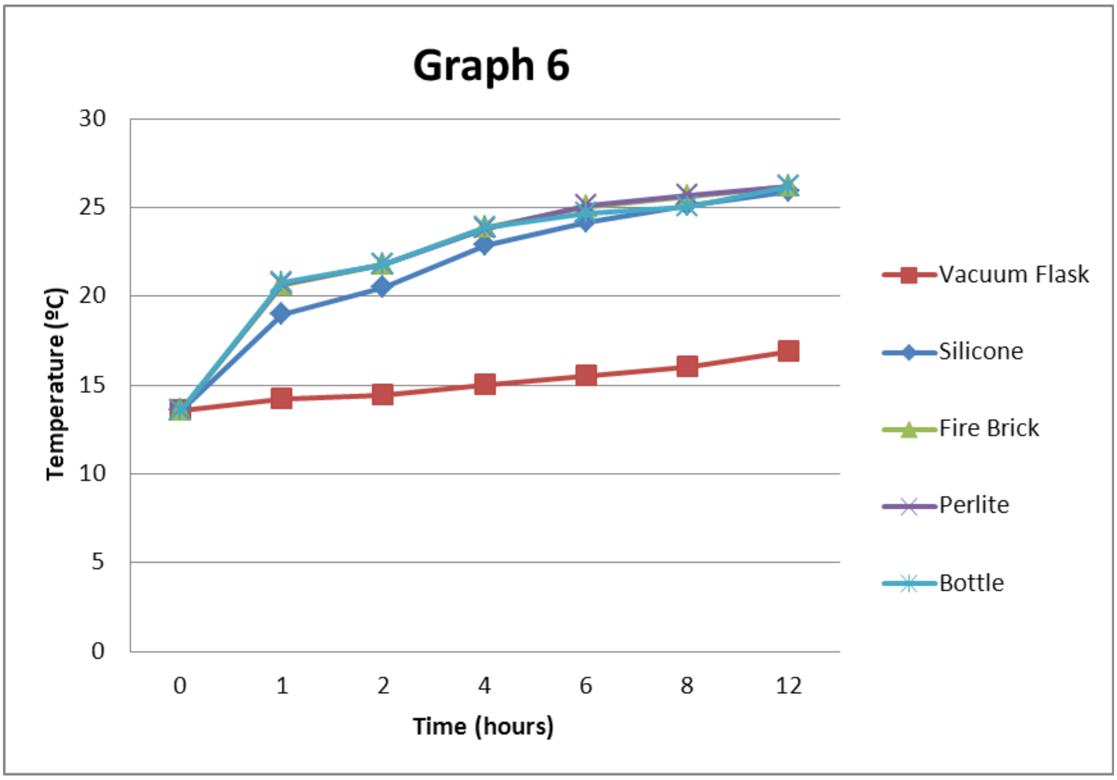
Temperature of the medium=23,5 ºC

Hours After/Temperature of the water in flasks and bottle	Temperature of the water in vacuum Flask (ºC) (±0.1 ºC)	Temperature of the water in silicone squeezed flask (ºC) (±0.1 ºC)	Temperature of the water in fire brick added flask (ºC) (±0.1 ºC)	Temperature of the water in perlite added flask (ºC) (±0.1 ºC)	Temperature of the water in bottle (ºC) (±0.1 ºC)
0 Hour After	**65,0**	**65,0**	**65,0**	**65,0**	**65,0**
1 Hour After	**63,0**	**52,5**	**47,9**	**49,7**	**39,5**
2 Hours After	**61,7**	**45,4**	**40,8**	**41,9**	**31,7**
4 Hours After	**59,1**	**37,1**	**33,3**	**33,8**	**27,1**
6 Hours After	**56,8**	**32,6**	**30,0**	**30,2**	**25,9**
8 Hours After	**54,5**	**30,1**	**28,5**	**28,6**	**25,8**
12 Hours After	**51,1**	**28,3**	**27,6**	**27,6**	**25,8**

Table 10: Data for the hot water.



Graph 5: Temperature-Time graph for tea.



Graph 6: Temperature-Time graph for coke.

GENERAL CONCLUSION and EVALUATION

Considering the graph 1, we can say that perlite, silicone and fire brick couldn't be successful in keeping the temperature constant in shorter and longer times. After 12 hours, temperature of the water in these flasks comes to the medium's temperature. Perlite and fire brick had a similar performance with bottle in conservation of temperature of the liquid added. This situation created a question about these 2 flasks: "Do these flasks make the water in the flasks warmer? ".

Considering the graph 2, we can say that temperature affects the flasks' system. Perlite, fire brick and silicone were more successful in hot water than cold water.

Considering the graph 3 and 4, we can say that vacuum flask showed same performances for different amounts of water. However, other 3 flasks and bottle were more successful in lower amounts of water.

Considering the graph 5 and 6, we can say that flasks had the same performance despite the change in liquids.

Considering all of the experiments, perlite, silicone and fire brick aren't successful in keeping the temperature of a liquid added to the flask constant. If we compare the performance of the isolators, silicone was a bit effective than fire brick and perlite. This situation shows that the thermal conductivity doesn't have an effect on the materials' effectiveness on keeping the temperature constant.

Temperature losses at the measurement were the main source of error. When bolts are taken out from the hole and the thermometer is put into the hole, air also reaches to the water in the flask. This resulted in little changes on the temperature of the water.

In the experiment, only one thermometer is used. If there are 3 more thermometers, then there won't be any temperature loss in the measurement.

The experiment can be carried out again with different heat isolators.

BIBLIOGRAPHY

- http://www.engineeringtoolbox.com/thermal-conductivity-d_429.html
- http://en.wikipedia.org/wiki/Perlite
- http://en.wikipedia.org/wiki/Firebrick
- http://en.wikipedia.org/wiki/Silicone
- http://en.wikipedia.org/wiki/Thermos
- http://www.perlite.net/
- http://www.consolidatedrefractories.com.au/insulating.htm
- http://www.efunda.com/materials/polymers/properties/polymer_datasheet.cfm?MajorID=SI&MinorID=1
- Knight, Jones, and Stuart Field. College Physics. San Francisco: Pearson, 2007.