DANCING COIN

Parsa Ghalibaf Khorasani, Arman institute , Mashhad/Iran

ARTICLE INFO

Presented in ICYS 2018, Belgrade, Serbia

Accepted in country selection by Ariaian Young Innovative Minds Institute , AYIMI

ABSTRACT

In this research parameters that are effective on a dancing coin which is on the neck of a strongly cooled bottle have been investigated. The noise of the jumping coin and its jumping depend on the bottle's volume , temperature difference between inside and outside of the bottle, bottle's material and coin's mass that they will change the results of balance time, number of coin's jumping, height of jumping and the amount of exiting gas (air). Concepts such as perfect gas law, molar specific heat, Fourier heat transfer law and Transient thermal conductivity have been studied to justify the coin's behavior.

1 Introduction

The heat transfers from the heat source to the bottle. As the heat increases, based on perfect gas law the pressure of the air inside the bottle increases too. Therefore, the air tries to escape through the mouth of the bottle, and push the coin out. If the air's force is more than atmosphere pressure and coin's mass, the coin starts jumping.

As the bottle is put inside the hot water we will hear a noise and we will see the coin's jumping. After putting the bottle inside the cold water , the temperature of the air inside it decreases and after putting it inside the hot water it goes up. High temperature will make more molecular movement and it rises the pressure.

2 Theory

Hot water makes the bottle warm and increases inner energy which makes some vibrations in coin [1].

$$sin\theta = \theta, \cos\theta = \theta \quad (1)$$

$$x \cong d = 2R\theta \quad (2)$$

$$w = F.x = Fx\,cos\beta = F2R\theta$$

$$Q + \Delta U = W \quad (3)$$

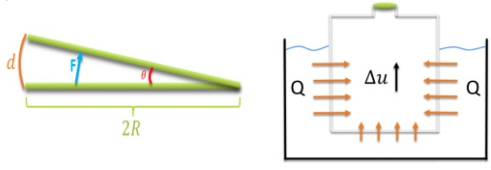

Fig. 1: Thermal conductivity and vibration

$$mc\Delta T + nC_v = W \quad (4)$$

$$\Delta T(mc + nC_v) = 2FR\theta \quad (5)$$

$$\frac{\Delta T(mc + nC_v)}{2R\theta} = F \quad (6)$$

$$Mg\,cos\theta = F \quad (7)$$

$$\frac{\Delta T(mc + nC_v)}{2RMg} = \theta \quad (8)$$

Q = heat
m = water mass
C = thermal capacity
n = Number of molar
C_v = Molar thermal heat in constant volume
ΔU = inner energy
M = coin's mass

3 Experiments

As the general description of the experiment , some effective factors have been studied to find coin's behavior.

Bottle's volume : which takes longer time to get heated if it has more air inside . Then number of jumping will be more because more air molecules inside the bottle want to be excited to go outside and more jumps will happen.

Bottle's wall diameter: it affects on conduction as: when L increases the thermal conductivity will decrease and the interval will increase too.

Bottle's type: We have different types of bottles like metal, glass and plastic which their thermal conductivities are different. Metal has more conductivity than the other two types. Thermal conductivity of these three types are:
Metal = 72.7, 71.8
Glass = 0.8, 0.9, 1.2, 1.4
Plastic = 0.42, 0.52
The time between jumps is less in higher thermal conductivity so time to reach balance will be earlier.

Coin's mass: When coin has more mass , more force is needed then time of the first jump will be longer . Also more air molecules exit in each jump and the number of jumps will decrease too.

Liquid temperature: When the temperature around the bottle is higher , it can make more force and because of that the amount of air molecules exit in each jump and then the number of jumps , will increase .

Reason for the sounds: Existence of surface tension (Bubbles) and collision with edge of the bottle make sound.

4 Conclusion

In this research, thermodynamic processes were studied and different factors, such as:_Bottle's volume, Bottle's wall diameter, Bottle's type, Coin's mass, Liquid temperature (most effective factor), were investigated which have the effective roles in the experiment.

References

[1] Halliday & Resnick, "Fundamentals of physics". file:///C:/Users/user/Desktop/Halliday-Fundamentals-of-Physics-Extended-9th-HQ.pdf