정전기장 높이와 면적에 따른 용매의 증발 현상 관찰

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The evaporation phenomena under an electrostatic plate

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Introduction

In this experiment, the purpose of this experiment is to understand electrostatic filed and electrostatic energy by investigating the effect of the electrostatic field on the vapor. If the electrostatic field is exerted on the water, the vapor on the water will be affected by the electrostatic energy of Coulomb's law. The vapor on the water is charged and transferred to the metal plate of electrostatic generator. Then, the vapor pressure drops instantly and the evaporation is facilitated because of disrupted kinetic equilibrium state.

To verify these phenomena, some assumptions are made to this experiment.

First, It is assumed that the evaporation will be facilitated as the intensity of the electrostatic filed is increased.

Second, It is assumed that the rate of the evaporation will be accelerated as the area of the electrostatic plate widened.

That is, the changes to the vapor pressure will be increased as the intensity of the electrostatic filed is increased and as the area of electrostatic plate is widened.

These hypotheses will be verified from experiment. In this experiment, an amount of the vapor pressure's changes are measured by using Clausius-Clapeyron equation. Assume that the electrostatic charge is distributed to the surface of the plate evenly.

Vapor pressure

The vapor pressure of the liquid is the pressure exerted by its vapor when the liquid and vapor are in dynamic equilibrium. If we were to place a substance in an evacuated, closed container, some of it would vaporize. The pressure in the space above the liquid would increase from zero and eventually stabilize at a constant value, the vapor pressure. It is important to specify the temperature when stating a vapor pressure because vapor pressures increase with temperature. Also, be aware that there are several different units for pressure. Finally, recognize that liquids that aren't in a closed container still have a vapor pressure. However, the material will eventually evaporate or vaporize (turn into a gas) completely.

The Clausius-Clapeyron Equation.

The vaporization curves of most liquids have similar shape. The vapour pressure steadily

increase as the temperature increases. A good approach is to find mathematical model for the pressure increase as a function of temperature. Experiments showed that the pressure P, enthalpy of vaporization, DH_{vap}, and temperature T are related, $P = A \exp(- DH_{vap} / R T)$ where R (= 8.3145 J mol^{-1} K^{-1}) and A are the gas constant and unknown constant. This is known as the Clausius- Clapeyron equation. If P_1 and P_2 are the pressures at two temperatures T_1 and T_2, the equation has the form:

$$\ln\frac{P_1}{P_2} = \frac{DH_{vap}}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right) \quad (1)$$

The Clausius-Clapeyron equation allows us to estimate the vapor pressure at another temperature, if the vapor pressure is known at some temperature, and if the enthalpy of vaporization is known.

Equipments

Thermostat, Static electricity generator, Digital thermometer, Timer, petri dish (D=2.25cm, 4.25cm), Electric radar, Aluminum plate (d=1㎝, 2㎝, 3㎝, 4㎝, 5㎝)

Procedures

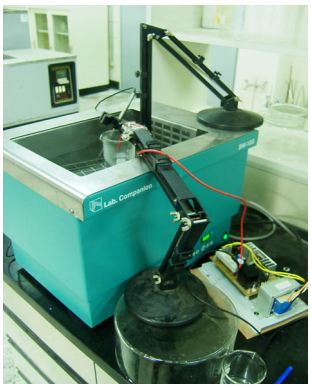

Fig. 1.
Experimental installation.

Maintain the temperature of Thermostat at 80℃

3.1 Electrostatic force by the distance between water surface and electrostatic field.
Put petri dish which is put into 2ml of water on Thermostat, Set Static electricity generator away 0.5cm from the surface of water and then measure the time 2ml of water is completely evaporated. Measure the time of evaporation with changing distance from the surface of water such as 0.5, 1.0, 2.0, 3.0.cm

3.2 The effect of an area of the charged plate.
Put 5ml of the water into a petri dish and then get charged squared metal plate to be equipped at the distance of 1.5cm from the surface of water. Here, the metal plate has an area of $1cm^2$ measure the time till all the water in petri dish is vaporized. Repeat the above procedures without electrostatic field to find the temperature of water bath at which the vaporization occurs applied as much time as Electrostatic field to check out. The area of the plate repeat the above experiment with the metal plates of $4cm^2$, $9cm^2$, $16cm^2$, $25cm^2$.

3.3 The effect of the distance between the charged plate and initial surfaced of distilled water. Use the difference of the two temperatures to find the effect of an electrostatic field on the vapor pressure of the distilled water. According to the result of experiment 3.1, repeat the experiment with the distances between the plate and the surface of water such as 1.5cm, 2.5cm, 3,5cm and 4.5cm

Results

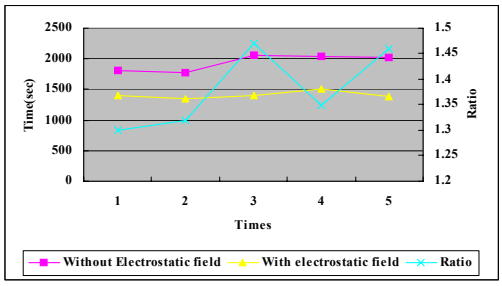

Fig. 2. The evaporation time under the existence and non existence of electrostatic field.

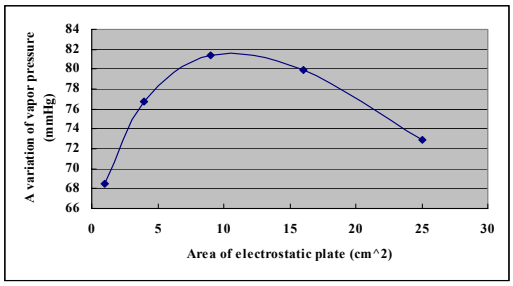

Fig. 3. The variation of vapor pressure with the area of electrostatic plate.

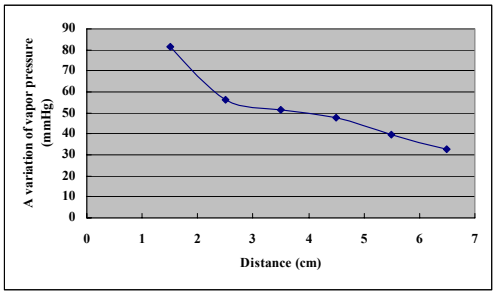

Fig. 4. The variation of vapor pressure with the distance between the plate and the surface of the water.

Discussion

This experiment data show the effects of the electrostatic field on the vapor.

First, Fig 2 shows the evaporation rate under the existence and non existence of electrostatic field. In the non existence of electrostatic field, the evaporation time is about 1400sec. But in the existence of electrostatic field, the evaporation time is about 1900sec. In other word, the evaporation is increased by the electrostatic field.

Second, Fig 3 shows the evaporation rate as the area of the electrostatic plate widened. In the graph, the evaporation rate be accelerated as the area of the electrostatic plate widened. But the area of the electrostatic plate be excessive an optimum area, the evaporation rate decreased. Because Static electricity generator capacity is limited. So the area of the electrostatic plate over $9cm^2$, an electric charge range decreased as the area of the electrostatic plate widened and the evaporation rate decreased.

In the Fig 4, the evaporation rate be accelerated as the distance between the plate and the surface of the water get near. This is why that the changes to the vapor pressure increased as the intensity of the electrostatic filed is increased.

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