정전기장에서 용매의 증발속도 관찰

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The evaporation Phenomena under an electrostatic field

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Introduction

The solvent's evaporation time depends on environmental conditions such as a temperature, a humidity and a wind. When such conditions are controled, change physical elements has an effect evaporation Phenomena. In this experiment, an electrostatic intensity, a form of electric charge, a properties of solvent has been changed for finding out power of influences.

Evaporation means phenomena to change from a liquid state to a gas with breaking molecular attraction by a heat. If we apply electronic force into it, by Coulomb's law, a solvent receives as much force as the square of the amount of electrical charges. therefore, breaking the molecular attraction is accelerated, and evaporation proceed faster. And also a nonpolar solvent as well as polar solvent is influenced by an electrostatic producer. If the area of electrostatic field increases, an electrostatic energy total amount that the solvent is affected by the equipment increases so that the solvent evaporates rapidly.

Theory

The basic law of electrostatic was formulated by Coulomb' law. Assuming that we have very charged particles which can be treated as points, Coulomb's law say:
The force between two charged particles is directly proportional to the product of the charges on these particles and inversely proportional to the square of the distance between them.

$$F = k\frac{Q_a Q_b}{r^2}\text{[N]} \tag{1}$$

If the international system of units (SI system) is used, then Q is measured in coulombs (C), r in meters, and the force should be in newtons (N). In this case, the constant of proportionality k will be

$$k = \frac{1}{4\pi\epsilon_0} \quad [\mathrm{Nm^2/C^2}] \tag{2}$$

where ε_0 is called the permittivity of vacuum and $\varepsilon_0 = 8.85\ x10^{-12}$ $\mathrm{C^2/Nm^2}$. And the value of the permittivity of dry air is so close to that of vacuum. So, for the vacuum and for the air we will use the same numerical value $k = 8.99x10^9$ $\mathrm{Nm^2/C^2}$.

A point charge in the surface charge distribution was formed by electric charge on a very little *ds* face.

A very little point charge of the *ds* surface is

$$dQ = \rho s\ ds \ [\mathrm{C}] \tag{3}$$

A very small electrostatic field intensity E is computed.

$$\mathbf{E} = \int_s dE = \int_s \frac{\rho_s ds}{4\pi\epsilon_0 R^2} a$$

$$= \frac{\rho_s}{4\pi\epsilon_0} z\hat{z} \int_0^{\infty} \int_0^{2\pi} \frac{r_{c'}'}{(r_c^2 + z^2)^{3/2}} d\phi' dr_c' \quad [\mathrm{V/m}] \tag{4}$$

Procedures

In this experiment, An electric generator, a beaker(100ml) are prepared for measuring an evaporation phenomena.

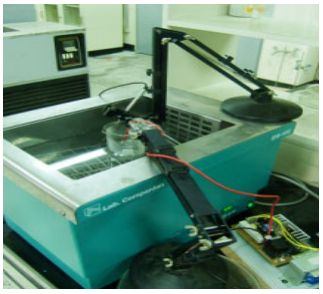

Figure 1 The experiment equipment.

The thermostat is used to boil the volume of 4ml water in two beakers until the resonable temperature point(62.8 ℃). And the electrostatic generator was installed to influence on the water, as seen in Fig. 1.

At first experiment, the evaporation rate is observed in accordance with the intensity of electrostatic field by controlling distances between the surface of water and the cable connected with the electric generator (Fig.2).

At second, forms of the charge are changed the point charge to the surface charge. The surface charge are made into a aluminum plat board. And the evaporation phenomena is observed under the nonexistence of electrostatic field, point charge, and surface charge (Fig.4).

At last, as the solvent is changed water to benzene (Fraction=95%, Duksan Pure Chemicals CO., LTD), we has founded out a point of different between the polar and a nonpolar in the electrostatic field (Fig.5).

In all of the experiments, evaporation rates is measured without electrostatic field and it is used a comparison group.

Results

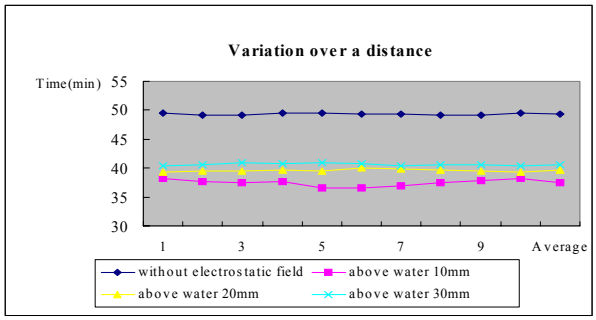

Figure 2 Intensity of electrostatic field.

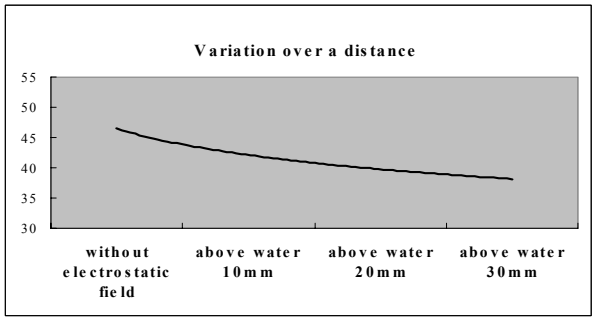

Figure 3 Intensity of electrostatic field.

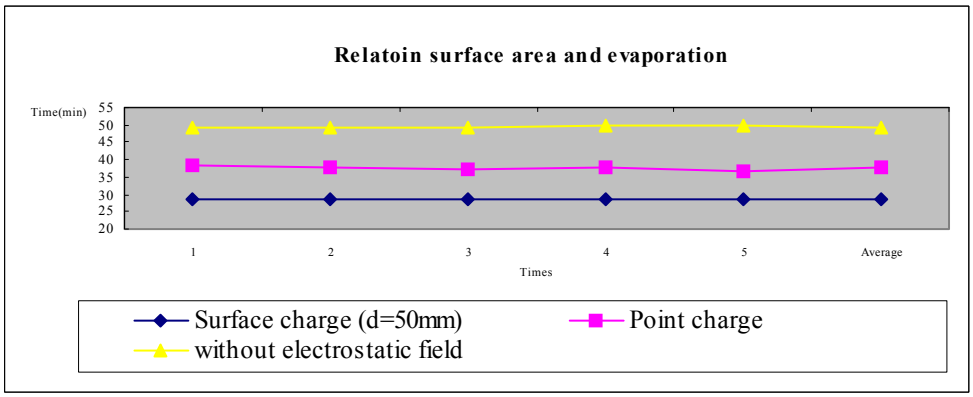

Figure 4 The relation between forms of charge.

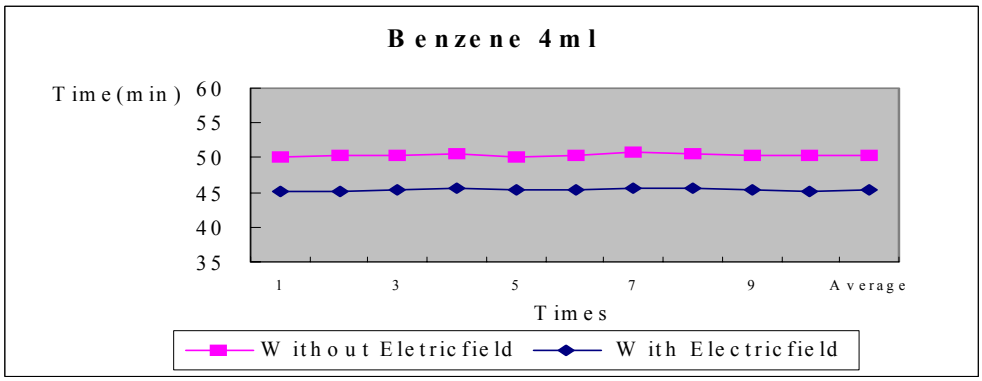

Figure 5 An example of benzene 4ml case results.

Conclusions

A rate of evaporation had some connection with a intensity of electrostatic field. Here the temperature and the volume of the water controlled. A force between two charged particles is directly proportional to the product of the charges on these particles and inversely

proportional to the square of the distance between them (Fig.2).

There is different between the surface charge used a aluminum plat board (D=50mm) and the evaporation rate. The intensity of electrostatic field and the volume of the water and temperature controlled. As a result there is the rate different (about 21min) between the beaker with electrostatic field and the beaker without that. The area of electrostatic field increases, total electrostatic energy amount that the solvent is affected by the equipment increases so that the solvent evaporates rapidly (Fig.4).

For the comparison of effectiveness polar and non-polar molecule in the electrostatic field, benzene and water have been used. Evaporation rate for water has increased 22.6% with electrostatic, and increased 9.8% for benzene. However, it is not recommended to compare polar and non-polar directly because volatility, boiling point are not correspond (Fig.5).

But it has been observed that non-polar molecule affected by electrostatic field, too. We could analogize that non-polar molecule which is great volatility evaporate easily by instantaneous electrostatic induction.

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