STRANGE MOTION

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ABSTRACT

Sprinkle small floating particles on the surface of water in a bowl. Bring a strong magnet above and near to the water surface. Explain any observed motion of the particles. The main purpose of the problem is explaining any observed motion of the particles. Experiments on this project show that in paramagnetic fluids, first adsorption and then excretion occur.This phenomenon also occurs if the liquid changes to alcohol, because alcohol is also diamagnetic, so it shows the same behavior as water.

Key Words : *Moses effect, particles, diamagnetic, laser*

1. Introduction

Normally there are three types of material in terms of magnetism: ferromagnetic, diamagnetic and paramagnetic. Different liquids and materials exhibit different behaviors in the presence of magnets. Water is one of these materials that shows an interesting behavior in the presence of a magnet because it is one of the diamagnetic materials that is repelled against the magnet. Temperature has no effect on this material because in general, unlike para-magnetic materials, temperature has no effect on diamagnetic materials (Fig.1).

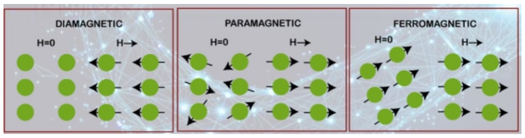

Fig.1: Three types of material in terms of magnetism

Deformation of the surface of a diamagnetic liquid by a magnetic field is called the "Moses Effect". This deformation in water attracts particles and create a current in the direction of the magnetic field. By calculating this deformation, we can also measure the magnetic energy density and the gravitational potential energy density, which according to the law of conservation of energy must be equal.

Due to the behavior of water, which is related to its non-bonding electrons, a Moses effect is created when a magnet is held above or below a container containing a liquid, the liquid will show different magnetic behaviors depending on its type. If it is diamagnetic, a dome is created inward and if it is paramagnetic, it is created upward.

In this question water is diamagnetic so a semicircle is created downward. This phenomenon helps us to justify the behavior of particles (Figs. 2).

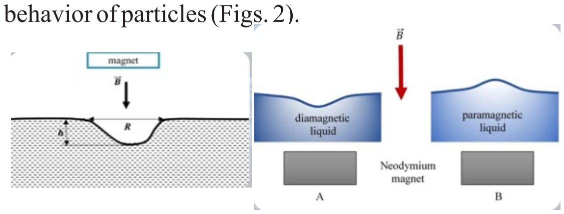

Fig 2. Comparison of phenomena in diamagnetic and para-magnetic fluids and their deformation

Moving and positioning small particles and low liquid volumes are important tasks in miniaturized bio-analytical and biomedical systems, where decreased sample sizes can reduce analysis costs and times.

Water is a diamagnetic fluid because it has no unpaired electrons. Also, the specific locations of water molecules are regular due to the orientation of water molecules in the presence of an induced magnetic field.

Due to the above reasons and the diamagnetic nature of water, it can be said that it is expelled from the magnet.

By measuring the depth of water created, we can calculate the magnetic energy density and the gravitational potential energy density.

2. Experiments and Theory

To measure the water level, we measure the laser to the water level once in the presence of a magnet and once without the presence of a magnet, and measure the maximum water depth by using the height difference created by the reflection of the laser light on the screen (Figs. 3 & 4) (Eqs. 1-8).

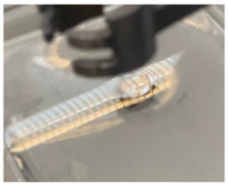

Fig. 3. Deformation created in the water surface in the presence of Neodymium magnets

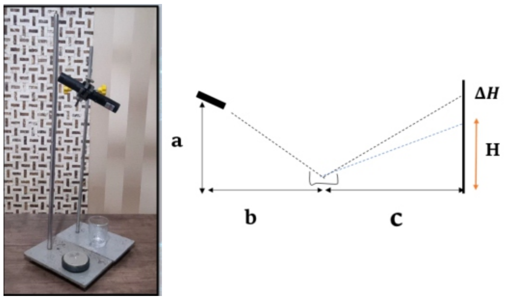

Fig 4. Experimental Setup and Laser test simulation

$$\frac{a+\Delta h}{b}=\frac{?}{c}\rightarrow\ ?=\frac{c}{b}(a+\Delta h)=H+\Delta H\rightarrow \tag{1}$$

$$\Delta h=\frac{H+\Delta H}{c}\times b-a\rightarrow\downarrow\Delta\theta\rightarrow\Delta H<0\rightarrow \tag{2}$$

$$\frac{a}{b}=\frac{H}{c}\ \rightarrow(H+\Delta H)/C=tg(\alpha-2\Delta\theta) \tag{3}$$

$$tg\alpha=\frac{a}{b} \tag{4}$$

$$\frac{\text{Distance of laser to water surface}}{\text{The distance from the curtain to the water surface}}\times\Delta H=\text{Maximum water surface displacement} \tag{5}$$

$$\frac{360mm}{1540mm}\times 7mm=\ 1.4\ \text{mm} \tag{6}$$

Gravitational Potential Energy Density :

$$\mu=\rho g\Delta h \tag{7}$$

$$\mu=997\frac{kg}{m^3}\times 9.8\frac{m}{s^2}\times 0.0014m=13.7\ \text{kg/ms}^2 \tag{8}$$

Magnetic Energy Density (Eqs. 9-10):

$$\mu=\frac{B^2}{2\mu_0} \tag{9}$$

$$\frac{0.006^2}{2\times 1.2566\times 10^{-6}}=14.32\ \text{kg/ms}^2 \tag{10}$$

By the law of conservation of energy, the two energies should be equal.

3. Results and Relevant Parameters

1. With the change of fluid, the performance of the system also changes. If the liquid is diamagnetic (residual alcohol that has been tested), it behaves like water and the particles absorb the magnet. If the liquid is para-magnetic, it is first excreted and then absorbed.

2. If the particles are denser than water, they will settle and the phenomenon will not be observed. Otherwise, the smaller its size and mass, the faster their movement will increase.

3. If the strength of the magnet changes, the stronger the magnet, the clearer and faster the particles move towards the magnet. Also, the strength of the magnet affects the shape of deformation .

4. Conclusions

Due to the diamagnetic nature of water and the effect of Moses, a deformation is created in water and attracts particles, and due to the movement of water molecules and the induction magnet, a current is created.

This phenomenon occurs similarly in diamagnetic fluids. By measuring the maximum depth of water, we can also calculate the magnetic energy density and the gravitational potential energy density, which according to the law of conservation of energy must be approximately equal .

$$13.7\ \text{kg/ms}^2 = 14.32\ \text{kg/ms}^2$$

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