ASSEMBLING DIFFUSION CLOUD CHAMBER

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ABSTRACT

This paper presents construction of a simple cloud chamber used to detect charged particles. Three types of dimensions of the chamber have been used to observe the quality of saturated vapor and timing of the vapor to be formed. Different types of dry iced also been manipulated to overcome long and short time delay of vapor formation. Solution to some errors occurred while assembling the chamber also been discussed. The visible tracks and the pictures taken from the experimental tracks from the chamber been used to analyze the properties and the charged of the particle tracks.

Keywords – Wilson Cloud Chamber; Diffusion Cloud Chamber

INTRODUCTION

There are several types on earlier detector to detect charged particles. Since there are certain countries just started to study about charged particles, the idea was to study regarding the earliest detector that later on triggered much advanced idea and technologies of much advanced detector. Cloud chamber is one of the most earlier instruments used to detect particles. This instrument has been constructed after carefully combine the theory, principal and ideas about the particle at that time. Cloud chamber can be divided to two types; expansion chamber and diffusion chamber. The cloud in the chamber functioned to visible the track of the particle meanwhile the magnetic force are used to see the curvature of the particles thus to find the new or existing charged of the particles. Evaporation mechanism has been used to detect and make visible of the track particle in the chamber by evaporating the nearly pure alcohol to become cloud. The mechanism works when there is evaporation from the alcohol by a very cold source such as dry ice, thus lowering the temperature and pressure in the closed container. This event will trigger supersaturated volume of air inside it.[1] Thermocouple been used to capture the negative temperature of dry ice. When there is any of the charged particle pass through the chamber, the ionization occur which changing the alcohol vapor into the tiny droplets.[2] From this event, the trail of the charged particle will then can be seen clearly with the help of the high luminosity light in the dark area.

The main objective now is to assembling an easy diffusion cloud chamber and to observe the rate of diffusion, and also to find a solution to any problem occurs during assembling of the detector. As a bonus, tracks found and curvature of the visible particle track in the experimental diffusion cloud chamber can be used for further analysis.[3]

METHODOLOGY

This chamber operates when there are two different temperature which helps to execute a supersaturated condition inside a sealed chamber. To begin with, a predetermined size of a chamber been used and a felt soaked with a high purity of alcohol such as isopropanol was glued to the top of the chamber. A grooved metal plate was sealed under the chamber. Next dry ice was put below the metal plate in a box sized much bigger than the plate. Dry ice was contacted with the surface of metal plate to make sure the plate chill as same as the temperature of dry ice. Roughly the experiment setup will be look alike in Figure 1. Since there are two temperatures in the chamber, a diffusion of a cold and a room temperature were diffused together to formed a cloud mist. A certain amount of time was needed to allow the reaction take place. This amount of time was measured to observed differences when using different types of dry ice. The experiment was conducted in a dark room and a high luminosity light was used to allow bare eyes to see the track from the cloud mist. Sources of radiation for particle alpha (Polonium 210), beta (Caesium 137, Talium 204) and gamma (Cobalt 60) been put near or inside the chamber to see the track of the charged particles, and a strong magnet or electromagnet can be installed beside the wall of the chamber like in Figure 2 to observed the type of charge of the charged particles.[4] The experiment was undergone using different sizes of container and different types of dry ice.

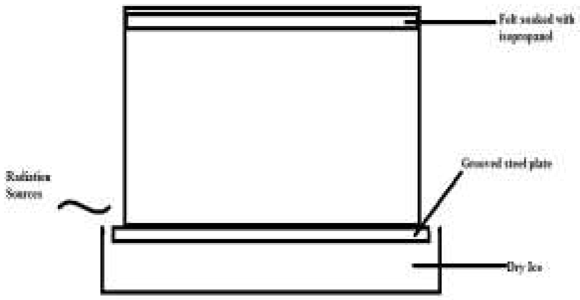

Figure 1

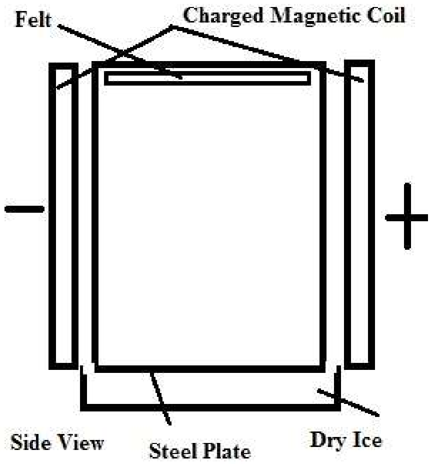

Figure 2

RESULTS AND TRACK ANALYSIS

Since all of these detectors yield tracks of charged particles, there are some methods to interpret and to extract the data from the track formed. One of the common methods is by using radiation transport codes and Monte Carlo track-structured codes. Track structured codes was used to simulate the track of the charged particles and also to imagine the movement of the charged particles. Monte Carlo 3D and 4D are also applicable to see random track dimension and their angular momentum. Commonly there are 3 types of tracks that can be observed in a cloud chamber. Figure 3, Figure 4, and Figure 5 respectively shows an incoming cosmic rays, decay of Muon and also multiple scattering. Meanwhile diffusion occurs between point A and B while taking the area of chamber surface C. From the study, calculation of condensation rate is quite complicated to be presented in formula. Condensation rate in this experiment was taken from the time experiment started until the first formation of visible cloud in the chamber.

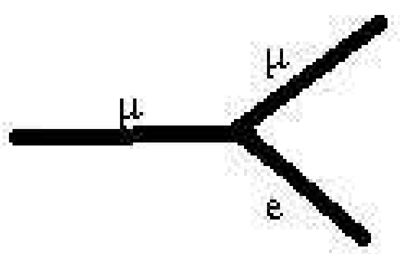

Figure 3

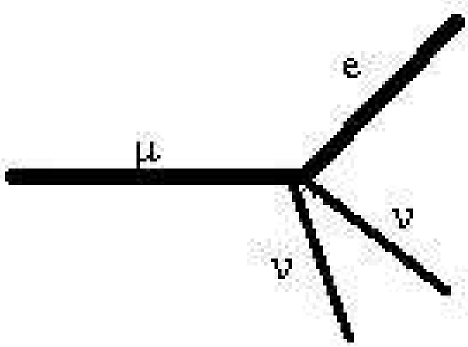

Figure 4

Figure 5

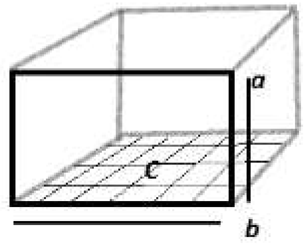

Figure 6

Results of the experiment was taken and recorded into a data box as shown in Table 1.

Table 1

Dimension of chamber in LxWxH	Top Temperature °C	Bottom Temperature °C		Diffusion Rate	
		Dry Ice	Reusable Dry Ice	Dry Ice, s	Reusable Dry Ice, s
30x15x15 cm	25	-78	-47	1020	1740
30x15x10 cm	25	-78	-47	910	1520
30x15x5 cm	25	-78	-47	840	1330

CONCLUSION

There are times when no cloud formation been formed. The experiment done shows that the chamber must be sealed correctly to prevent inside vapor from leaked out. The temperature difference also need to be monitored because if much higher temperature difference, diffusion process become much faster until no observation can be done. Next the height and dimension of the chamber plays crucial parts in formation of the vapor. Much smaller the chamber, rate of diffusion will hasten. The rate of the diffusion also can be controlled by manipulating temperature difference.

ACKNOWLEDGEMENT

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Appendix

Three sizes of chamber

Steel plate with groove

Industrial Dry Ice

Experimental equipment

Experiment in progress

Radiation sources