Al-Mustaqbal University College
Radiological Techniques Department

RADIATION PROTECTION

Characteristics of a Geiger-Muller Tube

Third Stage

First Lecture

Practical

By
Assistant lecturer

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Characteristics of a Geiger-Muller Tube

The purpose of the experiment:

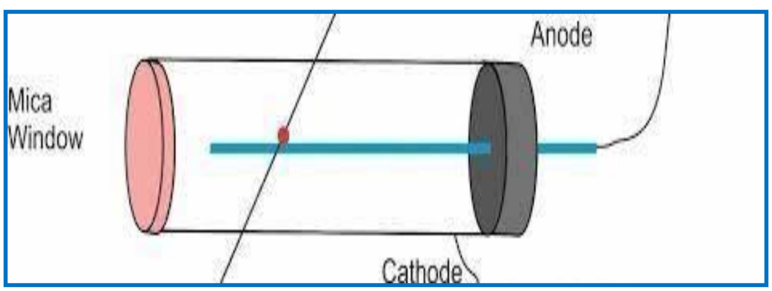
1. Find the plateau for the counter.

2. Find the length and the slope of the plateau.

3. Finding the operating voltage of the meter.

Theory:

Geiger-Müller (G-M) tube consists of a wire anode surrounded by a metal cathode, the space between them being filled with a mixture of gases (often argon or neon with a little bromine or chlorine) at low pressure. There is usually a small glass bead on the end of the wire anode to prevent discharge from a point.



When radiation enters the tube via the thin (and fragile) mica window it ionizes the enclosed gas, and a large potential difference (e.h.t.) maintained between the electrodes causes the ions produced to accelerate sufficiently rapidly to produce further ionization of the gas by collision. Thus, the effect of a single ionizing event is quickly magnified, resulting in an avalanche of electrons along the whole length of the wire, and the resulting pulse of current is fed to a counting apparatus.

If the counting apparatus is a scaler each randomly distributed ionization event and resulting current pulse is recorded as a unit on an electrical counting device, and a stop-watch or clock is required in order to calculate the mean rate of received pulses, i.e. the mean ionization current measured in counts per minute.

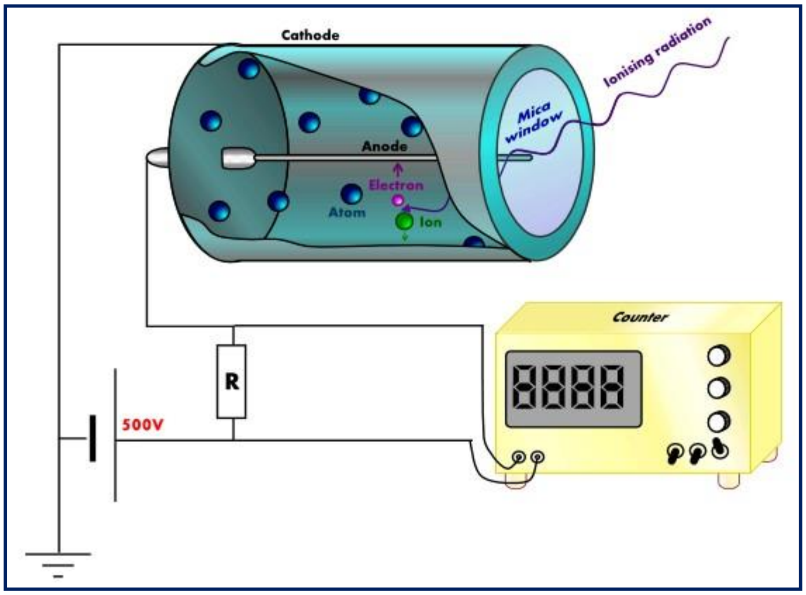
If the counting apparatus is a rate meter the mean rate of occurrence of the ionization events in the G-M tube (in counts per minute) is recorded on the rate meter output dial.

The advantage of a rate meter over a scaler is that it dispenses with the need for a stop-watch and gives the count-rate directly. It is not, however, satisfactory for very low count-rates, when a scaler and stop- watch are needed. In most experiments either a scaler or a rate meter may be used as the counting device, and the experiments described refer to the count-rate (in counts per minute) whether measured directly by the rate meter or indirectly by the scaler and stop-watch. In the G-M tube, lest the process of ionization by collision continues indefinitely, thus rendering the tube insensitive to a subsequent ionization event from the incident radiation, the discharge caused by any ionizing event must be 'quenched' as soon as possible. This is the purpose of the trace of halogen gas added to the main inert gas in the tube. For the G-M tube to be in its optimum condition, i.e. capable of detecting any and all ionizing events, however small, occurring in its enclosed gas, as well as being independent of any variations in the applied Voltage, it is necessary that its sensitivity should be independent of the applied voltage.

Experimental Work:

Apparatus:

1. Radioactive source
2. Geiger-Muller Counter
3. GM Tube
4. Computer with STX software
5. Power supply
6. Forceps for handling



Safety Precautions:

Although only sealed radioactive sources are provided from which radiation hazards are negligible , it is good (and accepted) practice never to handle radioactive sources except with forceps , and they should be returned to their containers whenever they are not actually in use . See that the high voltage (e.h.t.) supply is switched off while the apparatus is being assembled or adjusted or dismantled .

Action Steps :

1. Place the gamma source approximately 2 cm away from the window of the Geiger tube
2. Increase the counter voltage until it registers this point is called the Starting Voltage
3. Choose the time period (1 minute) and count for 1 minute Increase the high voltage by 20 volts and count for 1 minute Minutes
4. Keep making measurements every 20 volts until you have data to draw the relationship between voltages and the number of pulses per minute, as shown in the drawing.

   Caution (use values for high voltage less than 27). Usually, the area between V_1 and V_2 is equal to 300Volt. If you increase the voltage more than V_2, a large increase will occur in the count. If this happens, it means that you have reached the continuous discharge area, then reduce the high voltage directly to V_2.
5. Retake the readings for the same voltage differences recorded previously, starting with the highest voltage and ending with the starting voltage
6. Remove the radioactive source from the front of the detector and store it in the designated place
7. Find the count rate of the background radiation without a radioactive source

8. Find the net count rates i.e. the count rate Subtract the count rate for the background radiation
9. Set the standard deviation in the count rates
10. Draw a Geiger counter curve (Plot a graph between the voltage on the x-axis and the number of meters on the y-axis).

We calculate the operating voltage through the graph and the operating voltage is:

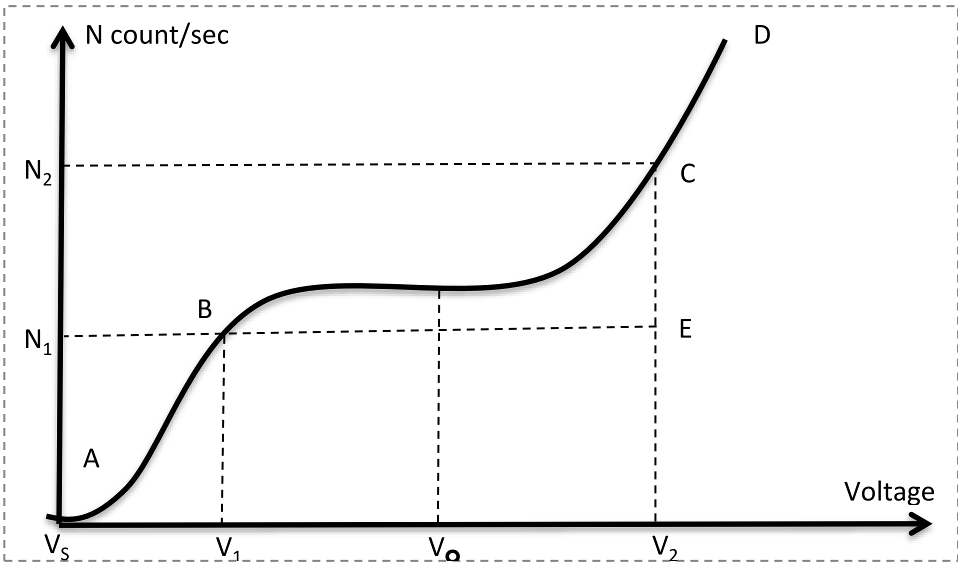
$$\mathbf{V_{0P} = \frac{V_1+V_2}{2}}$$

We calculate the slope of the plateau area through the following law:

$$\textbf{Slope} = \frac{N_2-N_1}{N_1(V_2-V_1)} 100\%$$

We calculate the length of the plateau by the following law:

$$\mathbf{L = V_2 - V_1}$$



The Geiger-Muller counter is characterized by several areas, as shown in the figure:

1. **Low voltage region (V < Vs):** at low operating voltages, fan the count is of no value and thus the counter cannot work in this area.

2. **Starting voltage region Vs:** It is the lowest value of the voltage applied to the tube in which the device can detect the counting pulses in a specific and distinctive way.

3. **The threshold voltage region (VT > Vs):** The counting ratio increases rapidly between two values for the two voltages (50 - 100) volts.

4. **The plateau region (V1> V> V2):** It is the region in which the change is small the working area of the meter is approximately (100) volts in length, and the greater the length of this area and the shorter its steeper the higher the stability of the radiation readings.

5. Continuous electrostatic discharge area: the continuous increase in voltage leads to the continuous discharge state of the charge it can damage the tube, and then the device must be turned off.

Questions:

1. Why the rate-meter doesn't work at the beginning of the experiment even though a little effort is shed, when does the count start?
2. Can the voltage difference in the Geiger counter be increased to any value without any condition and why?
3. Why is it preferable to use the Geiger counter in nuclear measurements?
4. How can we increase the effectiveness of the Geiger counter