

## EXP.NO. ( 4 )

### **X-ray Detection by using ionization chamber**

#### The aim of experiment

-To investigate the relationship between the saturation ionization current and the tube high voltage  $V$  at constant emission current  $I$

#### Theory:-

X-ray is an ionizing electromagnetic radiation with approximate wavelength range (0.001nm-10 nm) and photon energies range of( 100ev – 1Mev) . In this experiment , the photons energy range of ( 5Kev -35 Kev ).

The most frequent method of generating X-ray radiation is based on the use of " hot cathode "X-ray tube . Which is vacuum device containing two electrodes the positive electrode is the anode and the negative electrode is cathode and a high voltage applied between the two electrodes . the cathode is heated to emit electrons from its surface . The emitted electrons are accelerated by the mentioned voltage and strike the surface of the anode . The interaction of the fast electron with the material of anode which is ( Molybdenum Mo ) in this experiment causes the emission of X-rays from the anode .

The X-ray beam passes through the capacitor plates ionizing part of the air volume in the capacitor , when we apply voltage  $V_c$  to the capacitor the electron or ions are collected at its plates . the current generated at the capacitor correspond to an ionization current  $I_c$  in the outer circuit that can be measured using a measuring amplifier. At low voltages  $V_c$  ,fewer and fewer charges recombine in the gas volume as  $V_c$  increases more charge carries and collected at the capacitor plates . Thus the ionization current  $I_c$  increases with the voltage  $V_c$  .

When  $V_c$  is increased beyond a certain point , $I_c$  ultimately reaches a saturation value , as all of the charges carries formed by the incident radiation per unit of time are captured .

This saturation value is an indicator for the intensity of the incident X-radiation.

The capacitor function is storing charges onto its plates , the amount of electrical charges known as its capacitance value and depends upon three main factors

-The surface area , of the two conductive plates, the larger surface area the greater the capacitance.

-The distance (d ) between the two plates the smaller the distance the greater capacitance.

-Dielectric material the type of material separates the two plates , the higher permittivity of the dielectric the greater the capacitance

### Apparatus:-

-X-ray unit consist of

-control panel contains number of key to set the parameters such as X-ray tube voltage ,emission current which appear on adisplay filed , adjust knob enables you to set the desired values , select the operating mode and on/off switch .

-Tube chamber with X-ray tube Mo .

-Experimental chamber

-Plate capacitor , which is connected to electrometer amplifier , power supply

-Electrometer amplifier , fitted with resistor  $1\text{ G}\Omega$  to measure ionization current , because the amplitude of ionization current in the capacitor  $I_c$  is too small to be measured by stander galvanometer, an electrometer amplifier (which is high sensitive electronic voltmeter ) indirectly measure current by sensing the voltage drop a cross the resistor .

-Voltmeter  $V \leq 300\text{ V}$  , Voltmeter  $V \leq 10\text{ V}$

## Method:-

- 1- Set the emission current  $I = 1 \text{ mA}$
- 2- Set the capacitor voltage  $V_c \geq 150 \text{ V}$ .
- 3- Increase the tube high voltage  $V$  in steps from 5 Kv to 35 Kv and determine the corresponding ionization current  $I_c$  write down your measurement results as shown in the table .

$V_{\text{tube}} \text{ (Kv)}$	$V_r \text{ (V)}$	$I_c = V/R \text{ (A)}$

- 4- plot the graph between  $I_c$  on Y axes and  $V_{\text{tube}}$  on X axes .
- 5-Discuss the results .

Note : the value of the resistance  $R = 10^9 \Omega$



## Medical application

- 1-For checking Broken bone (fracture) , bone cancer and osteoporosis (DXA) device .
- 2-Mammography technique which is use to look for Breast cancer .
- 3-Chest X-ray which is used for detecting conditions affecting the lungs .
- 4-To view some swallowed item