Dielectrics :-

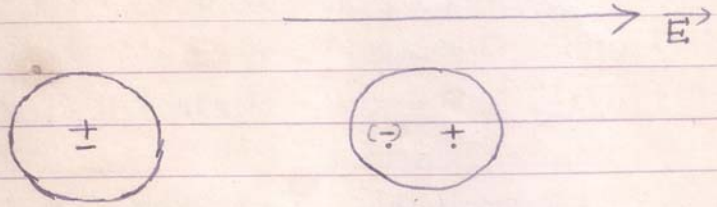
We have two types of atoms and molecules known as ① Polar molecules.
② Non-polar molecules.

An atom consists of a central +vely charged nucleus round which electrons rotate in circular orbits. The total positive charge of all the protons can be thought of as concentrated at a point, known as centre of inertia or the centre of gravity of the positive charge. Similarly the total negative charge of all the electrons in the orbit can be represented by an electron cloud and the total negative charge can be assumed to be concentrated at a point known as centre of inertia or the centre of gravity of the negative charge.

If for a molecule; the C.G of the +ve charge and C.G of the (-)ve charge coincide the molecule is said to be a non-polar molecule.

If for a molecule the C.G of the +ve and -ve charge do not coincide; the molecule possesses a permanent dipole moment and is said to be a polar molecule.

Polarization :-



Unpolarized atom Polarized atom.

Dipole moment developed $p = (Ze)\delta$

If there are N atoms per unit volume of the substance. The dipole moment induced per unit volume of the substance $= Np = N\delta(Ze)$

This dipole moment induced per unit volume is known as Polarisation $\vec{P}$.

[Thus Polarization vector $\vec{P}$ in ~~electrostatics~~ dielectrics is analogous to the magnetization vector $\vec{M}$ in ferromagnetics].

$\vec{P} = N\delta q$ where $q = Ze$.

= columbic.

In case of non-polar molecule; when the non-polar molecule is placed in an electric field; the molecule gets polarized in the direction of the field; and the induced dipole moment (p) is proportional to the strength ie intensity of the applied electric field. $[p \propto E]$

$\therefore p = \alpha \epsilon_0 E$

where α is constant of proportionality and which depends on the nature of the dielectric and is known as molecular polarizibility of the dielectric.

ϵ_0 = The permitivity of air and has been introduced just for historical Importance.

If there are 'n' such molecules per unit volume of the dielectric. Then induced dipole-moment per unit volume of the dielectric is known as polarization vector and is given by

$$\vec{P} = n\alpha\epsilon_0\vec{E} \quad \text{---------}$$

The polarisation process always involves a rapid type of polarization which is mostly electronic polarization i.e the displacement of electrons w.r to the nuclei. Some times the polarization procen also involves a relatively slow type of polarization, namely atomic polarization i.e the displacement of atoms w.r to one another. This type of polarization exist when different atoms constituting the molecule contain different effective charges i.e HCl. The polarization process involving displacement of charged entities

w.r.t one another is known as distortion polarization and that involving orientation of dipoles in the field is known as orientational polarization.

The phenomenon of polarization may be illustrated as shown in the figure. In the absence of an electric field the molecules will either be neutral non-polar molecules or polar molecules which will be oriented at random as shown in the fig. 2.

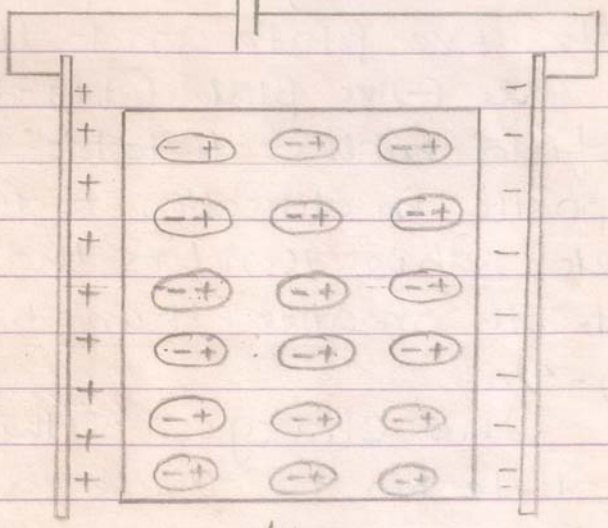


fig-1

fig-2.

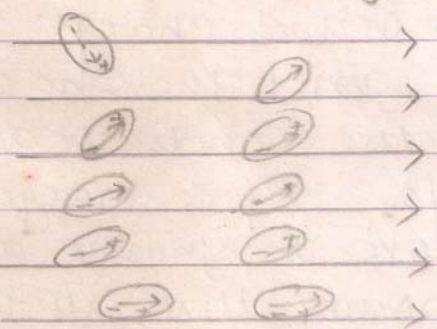
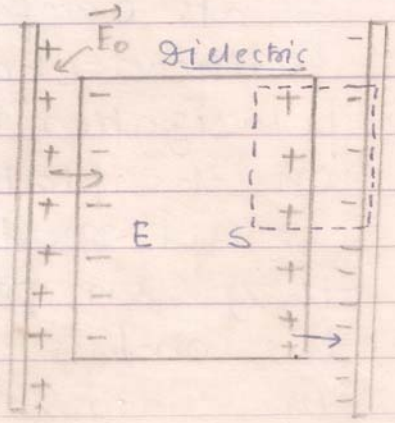


fig-3



and will be such a large number that there resultant electric effect is zero. When a P.d is applied between the plates of the condenser with dielectric filling the space between them (fig-1) induced dipoles will be created. The induced dipole or permanent dipole will be oriented along the electrostatics lines of force the degree of orientation depending on the strength of the applied field fig ③. The negative portion of the molecules +ve plate and the +ve portion will face (−)ve plate (fig-1). The induced field in the dielectric is therefore opposite in direction to the applied field. This renders the field in the dielectric smaller than in free space (fig-4).

The charges within the polarized dielectric for those appearing at its surfaces are known as fictitious charges or bound charges or polarization charges and the charges on the plates of the condenser are called real charges or free charges as they can freely move anywhere on the condenser. We assume that all the the charges are polarized to the same extent. The net charges within the main body of the dielectric will neutralise

One another because the negative side of one polarized minute structure (such as a molecule) is adjacent to the positive side of its neighbour. However at the surface of the dielectric in incontact with the plates the bound or polarization charges are not neutralised. This causes the field in the dielectric to become smaller than in the free space.