Clausius Mosotti relation , lec -2

The change in surface density of charge

$$\sigma - \sigma' = E_{vac} / 4\pi - E /4\pi$$

Or , $$\sigma - \sigma' = \varepsilon_S E / 4\pi - E /4\pi$$

Or , $$\sigma - \sigma' = (\varepsilon_S - 1) E /4\pi \qquad (2)$$

Or , $$P = (\varepsilon_S - 1) E /4\pi \qquad (3)$$

After introducing the substance between the plates is to decrease the field strength E_{vac} to E

Where $E_{vac} / E = \varepsilon_S$

P = Dielectric polarisation

Now we consider the case $P_a = P_d = 0$

The substance for which the polarisation is due to electronic displacement .

We Know that

$$P = (\varepsilon_S - 1) E / 4\pi$$

But $P_e = P_d = 0$, hence

$\alpha_a = 0$ and $\alpha_d = \mu^2 / 3KT = 0$ and after

putting $E = E_i$ = Internal field ,

Now the form becomes $P_e = N \alpha_e E_i$ (4)

Comparing eq (3) and (4)

$(\varepsilon_S - 1) E / 4\pi = N \alpha_e E_i$

$(\varepsilon_S - 1) = 4\pi N \alpha_e E_i / E$ (5)

We know that the internal electric field

$E_i = E + \gamma P$

Where $\gamma = 4\pi / 3$

Therefore , $E_i = E + 4\pi P / 3$

Or , $E_i = 2E + E + 4\pi / 3$ (6)

We know that

$P = (\varepsilon_S - 1) E / 4\pi$

Or , $4\pi P = \varepsilon_S E - E$

So $E + 4\pi P = \varepsilon_S E$ (7)

Using eq(7) and (8)

We get

$$E_i = 2E + \varepsilon_S E / 3 = E (2+ \varepsilon_S) /3$$

So , $E_i / E = (2+ \varepsilon_S) /3$ (8)

Using eq(8) in (5), we have

$(\varepsilon_S - 1) = 4\pi N \alpha_e (2+ \varepsilon_S) /3$

Or , $(\varepsilon_S - 1) / (2+ \varepsilon_S) = (4\pi/3) N \alpha_e$ (9)

This is Known as Clausius – Mosotti relation .

This can predict dielectric constant of new substance if the atomic polarizability is known .