Electrical double layer
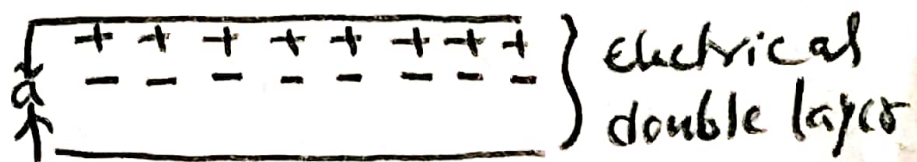
It is formed due to set up potential when particles are moved in a resting layer means immovable layer. The opposite charged one produce because movement of colloidal particles. The effect is for the reason

1. Electrophoresis

2. Electro kinetics or electro osmosis
3. Sedimentation
4. Streaming

When liquid especially colloidal particles are forced to move through a tube under pressure, there must develop a potential that tends to make double layer due to opposite charged. This is known as Zeta potential (ξ)

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electrical double layer

First, there is a immovable layers of ions that adhere tightly to the surface of the colloidal particles

Second ___ The charged particles attract the opposite charged

and make inner and outer layers, or atmosphere which is called electrical double layer.

The potential energy of double layer having radius "a"

$$V_{repulsion} = + \frac{A a^2 \psi^2}{R} e^{-S/R_d}$$

where A → constant
       a → radius
       ψ → potential
       S → separation between the layers
       R_d → Thickness.

When double layer is thick i.e $\left(a \gg R_d\right)$

$$V_{rep} = \frac{1}{2} A \psi^2 \ln\left(1 + e^{-S/R_d}\right)$$

When attraction is developed the eqⁿ will be somewhat different

$$V_{attrac} = - \frac{B}{S}$$ where B → another constant.
                                    S → separation

At high ionic strength the ionic atmosphere is dense and the potential tends to minimum. This separation or effect is called <u>flocculation</u>

Again when flocculation materials are redispersed by agitation it is known as <u>coagulation</u>.

Role of double layer —

The primary role of electrical double layer is to confer kinetic stability. Colloiding colloidal particles break the double layer

The protective role of double layer is the reason ~~why~~ why it is important not to remove all the ions when a colloids are being purified by dialysis.

Surface Excess — Surface Active agents

For binary solution in terms of colloidal solution Gibbs Duhemn equation can be had as

$$\cancel{n_1 d\mu_1 + n_2 d\mu_2}$$

$$n_1 d\mu_1 + n_2 d\mu_2 + n \quad = 0$$

When surface area is A we have

$$n_1 d\mu_1 + n_2 d\mu_2 + A d\gamma = 0 \quad \cdots (1)$$

In standard binary solution $\Rightarrow$

$$n_1^0 d\mu_1 + n_2^0 d\mu_2 = 0 \quad \cdots (2)$$

Multiplying eq^n (2) by $\dfrac{n_1}{n_1^0}$ so that

$$\frac{n_1}{n_1^0} \times n_1^0 d\mu_1 + \frac{n_1}{n_1^0} n_2^0 d\mu_2 = 0 \quad \cdots (3)$$

$$n_1 d\mu_1 + \frac{n_2^0}{n_1^0} n_1 d\mu_2 = 0$$

$(1) - (3) \Rightarrow \quad n_2 d\mu_2 - \frac{n_2^0}{n_1^0} n_1 d\mu_2 + \cancel{A d\gamma} \; Ad\gamma = 0$

$$\left(n_2 - \frac{n_2^0}{n_1^0} n_1\right) d\mu_2 + Ad\gamma = 0$$

or $\left(n_2 - \frac{n_2^0}{n_1^0} n_1\right) d\mu_2 = - Ad\gamma$

or $\dfrac{\left(n_2 - \frac{n_2^0}{n_1^0} n_1\right)}{A} = \dfrac{-d\gamma}{d\mu_2}$

Or $\dfrac{-d\gamma}{d\mu_2} = \Gamma_2 \quad \underline{\hspace{2cm}} (4)$

But $d\mu_2 = RT d\ln a_2$

$\therefore \quad \Gamma_2 = -\dfrac{d\gamma}{RT d\ln a_2}$

$\therefore \quad \Gamma_2 = -\dfrac{d\gamma}{RT \frac{da_2}{a_2}} = -\dfrac{d\gamma}{da_2} \dfrac{a_2}{RT}$

$$= -\dfrac{d\gamma}{dc} \times \dfrac{c}{RT}$$

If a solute lowers the surface tension then $\dfrac{d\gamma}{dc}$ is negative so that Γ_2 is positive. It is called surface excess. The colloidal particles such as soap, detergent etc reduce surface tension, these are called surface Active agents. If γ does not depend on C, $\Gamma_2 = 0$

The quantity $-\dfrac{d\gamma}{dc}$ as $c \to 0$ is known as surface activity