Unit III

Surface and interfacial phenomenon

Spreading Coefficient:

When a substance such as oleic acid is placed on the surface of water, it will spread as a film if the force of adhesion between the oleic acid molecules and the water molecules is greater than the cohesive forces between the oleic acid molecules themselves.

- ✓ Oleic Acid – Spreading Liquid (L)
- ✓ Water – Sub layer Liquid (S)
- ✓ Generally spreading occurs when adhesive force is more than cohesive force.

Work of Cohesion (Wc) may be defined as the surface free energy increased by separating a column of pure liquid into two halves.

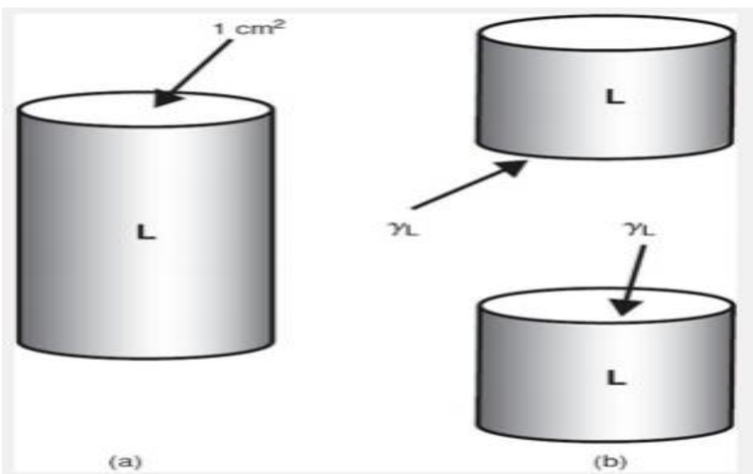

Figure: Representation of the work of cohesion involved in separating like molecules in a liquid

Surface free energy increase = γ dA

Wc = γL (dA+dA) = 2 γL dA

Here the column is of cross sectional area $1cm^2$

Wc = 2 γL

Work of Adhesion (Wa) may be defined as the surface free energy increased by separating a column of two immiscible liquids at its boundary into two sections. As two sections of immiscible liquids are already separated by a boundary, the energy requirement will be less by an amount γLS dA

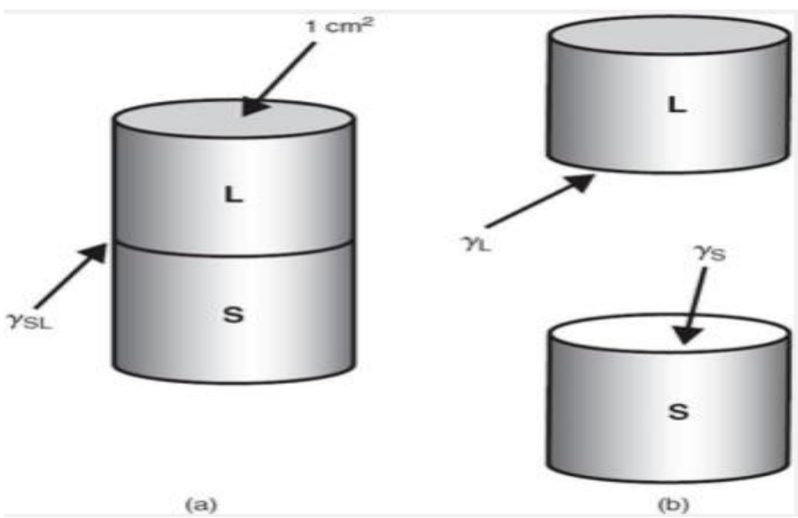

Figure: Representation of the work of adhesion involved in separating a substrate and an overlaying liquid.

Wa = γL dA + γS dA - γLS dA

Here the columns are of cross sectional area $1cm^2$

Wa = $\gamma L + \gamma S - \gamma LS$

Spreading coefficient (S) is the difference between work of adhesion and work of cohesion.

$S = Wa - Wc = (\gamma L + \gamma S - \gamma LS) - 2\gamma L$

$= \gamma S - \gamma L - \gamma LS$ S

$S = \gamma S - (\gamma L + \gamma LS)$

Where,

γL - Surface tension of spreading liquid

γS - Surface tension of sublayer liquid

γLS - Interfacial tension

Spreading occurs when spreading coefficient S is positive

i.e, $\gamma S > (\gamma L + \gamma LS)$

When spreading coefficient S is negative

ie, $(\gamma L + \gamma LS) > \gamma S$

Spreading liquid forms globules or floating lens.

That is spreading will not take place.

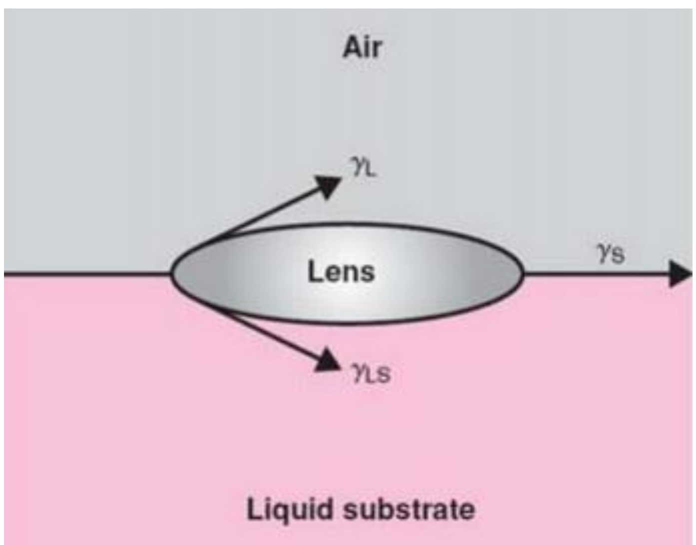

Figure: Forces existing at the surface of a lens floating in a substrate liquid.

- When free energy of the spreading liquid and the interfacial tension with the sub layer is less than that of sublayer the spreading becomes spontaneous in an attempt to reduce free energy of sublayer.
- There may be saturation of the liquid with the other and there may be change in the surface tension of the sublayer liquid.
- In that case the spreading coefficient may become negative after saturation, the spreading liquid coalesces and form a lens on the surface of the sublayer.
- In the case of a DUPLEX FILM if S becomes negative after saturation, it forms a monolayer and excess liquid remains as lens on the surface.
- Fatty acids and alcohols have high spreading coefficient.
- As non polar chain length increases in an acid or alcohol spreading coefficient decreases.
- Propionic acid and ethyl alcohol having high spreading coefficient.
- Liquid petroleum do not spread on water

Applications:

The applications of spreading coefficients in pharmacy should be fairly evident.

- The surface of the skin is bathed in an aqueous–oily layer having a polar–nonpolar character similar to that of a mixture of fatty acids.
- For a lotion with a mineral oil base to spread freely and evenly on the skin, its polarity and hence its spreading coefficient should be increased by the addition of a surfactant.
- The relation between spreading, HLB (hydrophile–lipophile balance), and emulsion stability has been studied.
- Surfactant blends of varying HLBs were added to an oil, a drop of which was then placed on water.

- The HLB of the surfactant blend that caused the oil drop to spread was related to the required HLB of the oil when used in emulsification.

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