

4.1.4. Interfacial Properties of Suspended Particles

Two important interfacial properties of suspensions are:

- 1) The surface free energy, and
- 2) The presence of electric charges on the surface of the dispersed particles.

4.1.4.1. Surface Free Energy

When solid or liquid materials are reduced in size, the surface area increases readily leading to corresponding increase in surface free energy given by:

$$\Delta F \propto \Delta A \quad \dots (1)$$

$$\Delta F = \gamma_{SL} \cdot \Delta A \quad \dots (2)$$

Where,

γ_{SL} = Interfacial tension between the liquid medium and solid surface.

This makes the system thermodynamically unstable. Thermodynamic means that the particles are highly energetic and tend to re-group in such as to decrease the total surface area thereby reducing the surface free energy. Particles in liquid suspension therefore tend to flocculate. The extent of formation of floccules can be taken as a measure of the system to thermodynamically stable state.

Increased stability can be realised by reducing the interfacial tension, decreasing the interfacial area. Interfacial tension can be reduced by the use of certain surface active agents, e.g., sodium lauryl sulphate, lecithin, etc. are adsorbed selectively at the interface thereby reducing the interfacial tension. While the particles remain dispersed or deflocculated and settle relatively slowly they may form a hard cake at the bottom of the container which is extremely difficult to re-disperse.

4.1.4.2. Surface Potential

Though suspensions consist of uncharged particles suspended in an aqueous medium, the solid particles frequently acquire a positive or a negative charge. The vehicle around it will contain the same charge (the so-called gegenion of opposite sign, so as to maintain electroneutrality).

The forces at the surface affect the degree of flocculation and aggregation. Each particle is associated with an electrical double layer which gives rise to a zeta potential. The importance of zeta potential with regard to the stability and aggregation of flocculated suspension is best appreciated by noting the forces between particles in suspension.

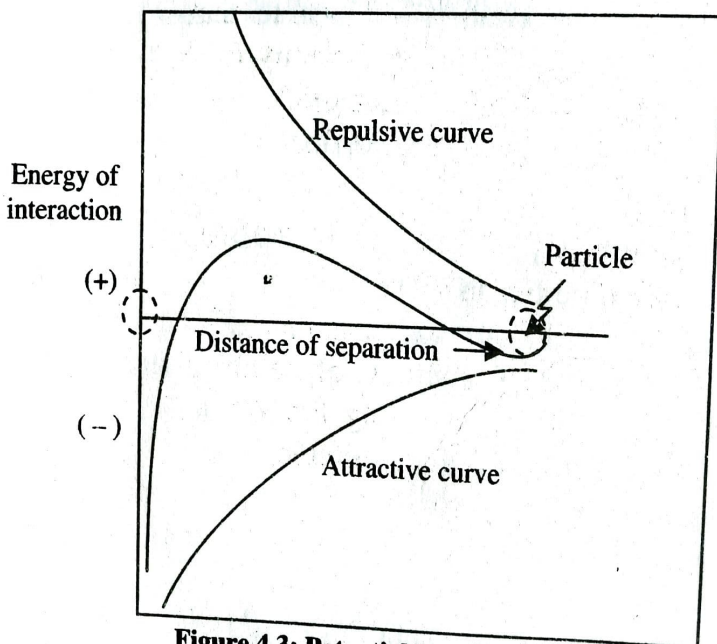


Figure 4.3: Potential Energy Curves for Particle Interactions in Suspension

The potential energy of two particles is plotted as a function of the distance of separation (figure 4.3). The curves depict the energy of attraction, the energy of repulsion, and the net energy. There will be repulsion between the particles if the net energy is positive.

attraction between particles, so that the net potential will be the sum of two curves. Equilibrium exists when the particles are very close together (primary minimum) and also at a distance of 100-200nm (secondary minimum).

The former energy E_1 is large and if those particles come this close, they are difficult to separate again and caking results. If they stay at that secondary minimum they are again in equilibrium (flocculation), but the particle aggregates are easy to break apart. Thus, flocculated suspensions are characterised by being in the secondary minimum and being voluminous they form loosely packed sediments.

However, if the particles pack into compact sediment they are close together and experience a pressure allowing them to pass the energy barrier and enter the primary minimum causing caking. Thus, caking results in either deflocculation or poorly flocculated systems.

The potential existing in the system responsible for repulsion is the zeta potential. If the zeta potential is high the particles repel one another and remain in a dispersed form for a long time, i.e., they settle slowly.

Even when brought closer during random motion or agitation the deflocculated particles resist collision due to the high surface potential. Such a system is said to be deflocculated.

If the zeta potential is low, or is lowered by the addition of preferentially adsorbed ions whose charge is opposite in sign to that on the particles, the electrical forces of repulsion are lowered sufficiently for the forces of attraction to predominate. Under such conditions, the particles may approach each other more closely to form loose aggregates termed flocs. Such a system is said to be flocculated.