CHAPTER - III

THEORETICAL BACKGROUND AND CONTROLLING FACTORS
3.1 THEORETICAL BACKGROUND AND CONTROLLING FACTORS

A colloidal suspension is an aqueous dispersion where the particles move in an electric field (84) indicating that these particles carry an electric charge. Colloidal particles such as clays, hydrous metal oxides, bacteria, pulp fibers etc. can develop such electric charge in many ways. The sign of this primary charge can be either positive or negative, though most colloidal in water and waste water develop a negative charge. A colloidal dispersion does not have a net charge, so that the primary charge on the particles must be counterbalanced in the aqueous phase, as a result an electric double layer exist at every interface between solid and water. Stability of colloidal solution is produced due to this electric double layer.

3.2 Mechanism of destablisation

Destablisation of colloidal solution (84) takes place mainly due to the following -

(i) Double layer compression
(ii) Adsorption and charge neutralisation
(iii) Enmeshment in precipitate
(iv) Adsorption and interparticle bridging
3.2.1 Double Layer Compression

Ionic layer compression is brought about by increasing the total ionic concentration. By compressing the electric double layer, the effect of the surface charge is limited to a layer around the particles. As a result, the attractive body forces become (85) larger than the repelling electrical forces, so particle growth can occur if the particles colloid during flocculation.

3.2.2 Adsorption and Charge Neutralisation

Ionisation of aluminium sulphate in water products SO$_4$~2~- and Al$^{+++}$ ions. The SO$_4$~2~- ions may remain in this form or combine with other cations. However, Al$^{+++}$ cations react immediately with water to form a variety of Al(OH)$_3$ aquametallic ions and hydrogen. The aquametallic ions have great affinity for surface and adsorbed on to the surface of colloids where they neutralise the surface charge (86). Overdosing with coagulants can result in restabilising the suspension.

3.2.3 Enmeshment in Precipitate

Insoluble Al(OH)$_3$ is formed in the hydrolyses of metal coagulants such as alum. This forms amorphous, gelatinous flocs and settle by gravity. Colloids become entrapped in the floc as it is formed or they become
enmeshed by its sticky surfaces and the floc settle (87).

3.2.4 Adsorption and Inter-particle Bridging

Interparticle bridging occurs when polymers are used as coagulant. These polymers may be linear or branched and are highly surface reactive. The polymer serves as a bridge between colloid particles resulting in a settleable mass.

The destabilisation of colloids in waste water treatment process is accomplished by adsorption of coagulant species by enmeshment with in hydroxide or carbonate precipitate. When the destabilisation is brought about by adsorption, the sorbable species are usually polymers. Cationic polymers can function as destabilising agent by bridge formation, charge neutralisation or both on negative colloids. Nonionic polyelectrolytes are generally used with inorganic flocculants, charge neutralisation is brought about by inorganic flocculant as alum or ferric chloride. Polyelectrolytes serve as bridge between neutralised particles. The combination gives excellent results (84) but the doses of non ionic polymers are generally 10 times of cationic polymers.

3.3 FACTORS AFFECTING COAGULATION AND FLOCCULATION

3.3.1 Types of Polyelectrolytes

The colloids in waste water generally carry negative
charge, hence the cationic polyelectrolytes (16) are most suitable. If water contains mineral suspended solids and organic substances, combination of inorganic flocculant, such as alum or ferric chloride with cationic polyelectrolytes gives best result. Non ionic polyelectrolytes are also used with inorganic coagulants. But the doses of nonionic polymers are 10 times than those of cationic ones. If the colloids contain positive charge, anionic polyelectrolytes would be most effective. For colloid containing negative charge, the anionic polymers are insufficient.

3.3.2 Adding Sequence of Polyelectrolytes

It is stated that the combination of inorganic coagulant like alum or ferric chloride and polyelectrolytes is economical (88). For this inorganic coagulant must be added first to neutralise the charge on the colloidal waste water. It must be thoroughly mixed at the speed of 100 rpm for 2 minutes.

3.3.3 Polyelectrolytes and Colloid Mixing

Polyelectrolytes must be mixed thoroughly with the waste water so that all the colloidal particles may come in contact (16) with polymer. Generally rapid mixing is done
at the speed of 100 rpm for 2-5 minutes.

3.3.4 Flocculation Time

If the waste water is to be filtered through sand bed, additional agitation period during the flocculation gives better results. In the laboratory flocculation at 30-50 rpm for about 15 minutes is recommended.

3.3.5 Sedimentation Time

If the flocs formed are large, strong and three dimensional, they settle quickly. Sedimentation time required is about 30 minutes.

3.3.6 Polyelectrolyte Dose

Polyelectrolytes are required in very small amount for various treatments. Polyacrylamide in combination with inorganic coagulant has been used in the concentration of 0.12 ppm (68).

3.3.7 Polyelectrolyte Molecular Weight

The higher is the molecular weight of a polyelectrolyte more effective it is (89). For cationic
polymers molecular weight has no dependence in the range of $10^4 - 10^6$, nonionic polyelectrolytes are effective when molecular weight is greater than $2 \times 10^6$ (mainly for polyacrylamide).

3.3.8 Temperature

At 21°C temperature prolonged stirring at a velocity gradient of 14/sec caused no impairment of floc sedimentation. However, at 4°C continued prolonged flocculation revealed a deterioration of the floc settling capability (88).