2.0 INFLUENT PRETREATMENT

Water from a surface source such as a river or lake contains suspended contaminants such as dirt and organic matter that will foul heat exchangers and compromise the operation of the boiler feedwater (BFW) pretreatment system, especially filters. Well water and potable water do not have suspended solids and do not require clarification. However, many well waters contain significant levels of hardness, iron, and silica that require a type of clarification called cold lime softening.

2.1 Influent Clarification

The first water treatment process on river water is to remove coarse debris. River intakes typically require annual maintenance to remove debris and ensure there is no macro-fouling by higher life forms like zebra mussels that affect the portions of the central and upper Midwest United States. Some refineries may use a settled water pond for coarse debris removal. The second water treatment process is clarification to remove suspended solids. All suspended particles in surface water have negative charges that cause particles to repel each other and remain in suspension, resulting in water that looks "cloudy" or turbid.

Clarification is a three-step process: coagulation, flocculation and settling. The first step, coagulation, occurs due to the addition of an organic or inorganic chemical that has positively-charged molecules that will neutralize the negative charge on these suspended particles (**Figure 2-1**). Coagulants are typically added at a point far upstream from the clarifier and often travel through in-line mixers because coagulation requires significant mixing time.

Flocculation occurs as the neutralized particles agglomerate, forming larger particles (**Figure 2-2**). In some systems, operators add a flocculant chemical to act as a bridge between particles, increasing the speed of this process. Flocculation occurs in the second reaction chamber of the clarifier where the water velocity is much lower than the first chamber.

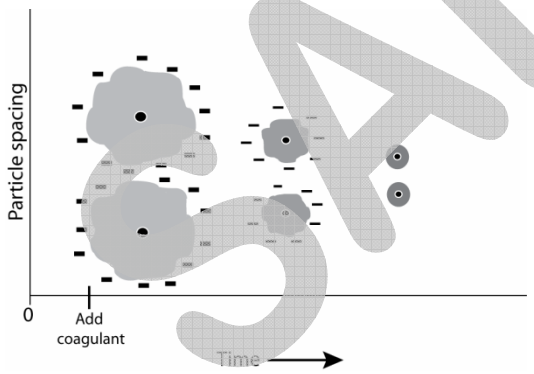

Figure 2-1 – Charge Neutralization after addition of Coagulant (*courtesy of Gulf Publishing*)

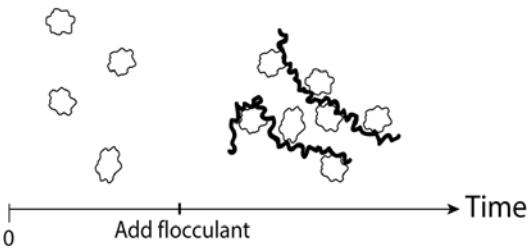

Figure 2-2 - Agglomeration of Particles (*courtesy of Gulf Publishing*)

As the size of the particles increases and the water velocity decreases, settling occurs due to the force of gravity (**Figure 2-3**). The larger the particle, the faster it will settle.

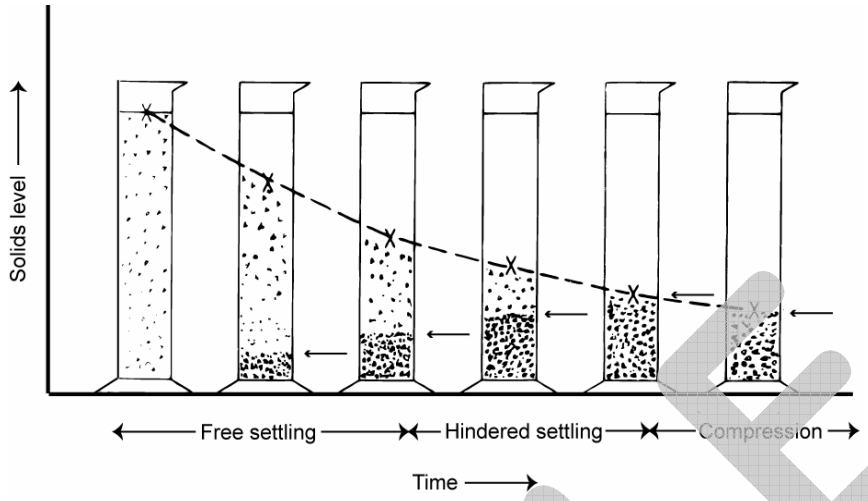

Figure 2-3 – Settling of agglomerated particles. (*courtesy of Nalco*)

Settling occurs more rapidly in warm weather because warm water is less dense than colder water. In cold weather, poor settling causes a cloudy appearance of the water in the settling zone, and close examination often shows an uneven distribution of small white particles or "pin floc." (**Figure 2-4**)

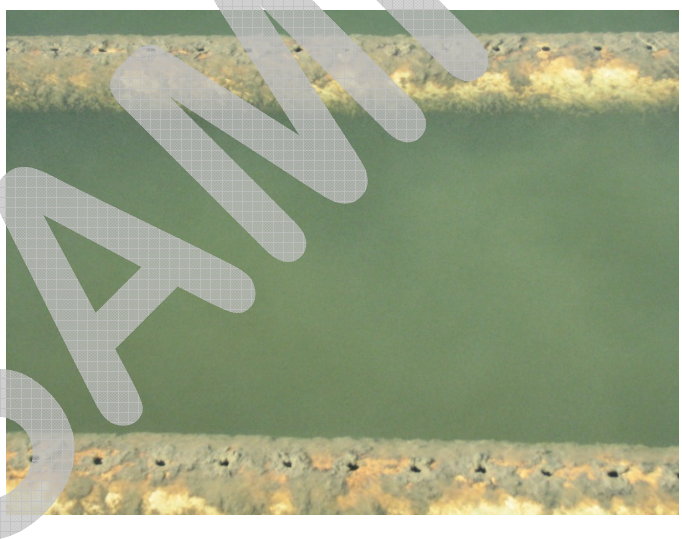

Figure 2-4 – Pin Floc in Settling Basin of SuperPulsator

Pin floc is consistent with an increased risk of carryover, especially in cold weather. Improper application or overfeed of anionic flocculants can also cause carryover, blinding downstream filters and catastrophically fouling reverse osmosis units.

As the particles settle to the bottom of the vessel, the top layer of clear water flows into collection troughs or weirs, completing the clarification process. Operators determine the clarity of this water by measuring the turbidity; the lower the turbidity measurement, the greater the clarity of the water.