From the Board

Consider the Pros and Cons of Slow Mixing


Shirish Kardile

After coagulation, the most important unit process in conventional water treatment plants is slow mixing, which is also known as *flocculation*. The coagulation-flocculation processes neutralize or reduce the zeta potential of nonsettleable solids, allowing the van der Waals force of attraction to begin pulling particles together. These particles are then able to gather into small groups called *microfloc*.

Although these particles are larger than the original colloids, they're held together rather weakly. Individual particles are invisible to the naked eye and nonsettleable. However, the gentle stirring action created by the flocculation process brings the microfloc particles together to form large and relatively heavy floc particles called *macrofloc*, which can settle or be filtered. The jellylike floc particles are usually visible and will look like small tufts of cotton in the water. Dosages of coagulants and coagulant aids must be closely monitored to ensure effective coagulation is occurring.

The most important factors in flocculation are degree of agitation and duration of agitation. However, the quality of agitation is where the experience of a treatment plant's designers and operators play a crucial role.

Mechanical flocculation is the most popular mode and generally employs vertical or horizontal paddles or turbines mounted on a shaft. The drive consists of an electrical motor and a speed-reduction mechanism.

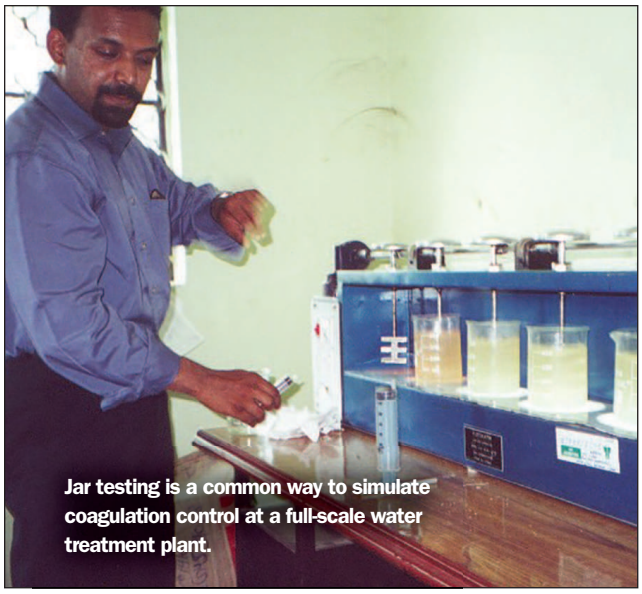
In conventional treatment plants, most flocculation basins are designed for tapered flocculation, which involves a reduction in velocity gradient as the water passes through the basin. This promotes the development of a readily settleable floc. The advantage of mechanical flocculation is that, by incorporating a speed-variation mechanism in the drive, the degree of agitation can be altered to suit changes in water quality. Of course, the disadvantage is the maintenance required for drive units, gears, pulleys, bearings, etc. The theoretical aspects are well-defined, and standard reference books give guidelines on design parameters.

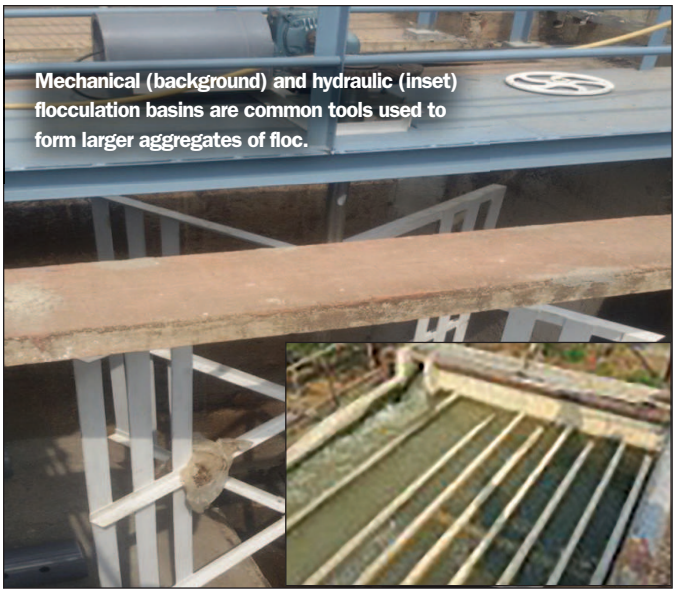
Hydraulic flocculation is another common approach in which baffled chambers provide turbulence to the water flowing over and under the baffles. "Around-the-corner" baffles are also used. Velocity gradients are generated when a change in flow direction occurs. The energy input is in the form of head required to pass the flow through the baffles. In the old days, wooden partitions were used as baffles. More recently, brick, concrete, and plastic sheets have been used.

The advantage of hydraulic flocculation is that no maintenance is required, nor is electrical power used. The disadvantage is that such a system is inflexible, as turbulence is determined by the flow rate and normally can't be controlled. Changes in flow change the velocity, making it difficult to form desirable floc. Also, silt can settle between the baffles and cause a maintenance issue. Hydraulic flocculation typically isn't used in developed countries because they have durable drives and sound maintenance programs. However, this approach is common in developing countries.

Despite all the expertise needed to design and build effective water treatment facilities, operators are key to effective execution. Their efforts to optimize coagulation and filtration processes help to ensure water treatment facilities provide safe drinking water to the public.

—Shirish Kardile,
AWWAIndia Strategic Board Chair


Jar testing is a common way to simulate coagulation control at a full-scale water treatment plant.


Mechanical (background) and hydraulic (inset) flocculation basins are common tools used to form larger aggregates of floc.

PHOTOGRAPHS: SHIRISH KARDILE