

Methodology for flocculation control

Brief description

This is a methodology developed for control and study flocculation processes based on monitoring the evolution of the particles chord size distribution in real time by means of the reflectance technique which does not require sample dilution. This methodology allows determining the optimal dosage of flocculant, to study the kinetics of the flocculation process, as well as those of the flock breakage (deflocculation) and reflocculation processes. From these studies, it is possible to determine flock properties and to propose the flocculation mechanisms model that explains the flocculant behaviour (Figures 1 and 2).

Traditional methodologies, based on the measurement of the surface charge of the particle, are only appropriate to study the aggregation process when it implies the modification of these properties, but not when the flocculation is carried out by other mechanisms as bridging with neutral polymers, for example. However, the developed methodology is appropriate to study every flocculation process, independently of the aggregation mechanism or the suspension nature.

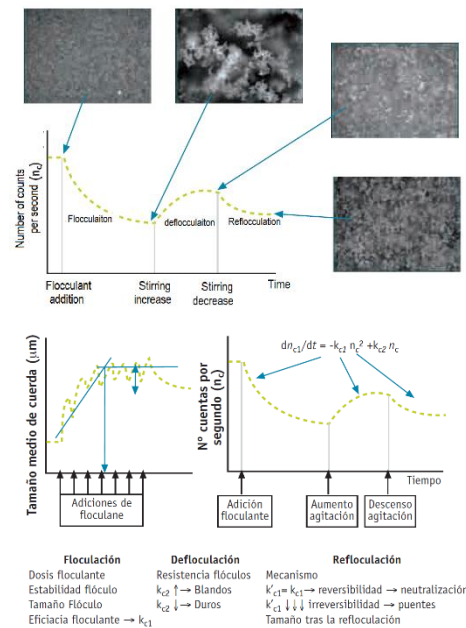
The study of the flocculation kinetics requires a technique able to measure on real time. Many of these kinds of techniques are based on measuring turbidity or on image analysis. These techniques detect or measure the intensity of the light that passes through the suspension or that is slightly deviated by the particles, because the intensity of the reflected light would be too low. However, these techniques are useful only if the suspension is diluted enough to allow the passing of the light through it, an example of these techniques is the dispersion photometric analyzer. Furthermore, the use of these techniques implies to assume that the turbidity or the colour of the suspension does not change or to assume that the particles are spheres. This introduces an error; because turbidity often decreases during the flocculation process, the colour can change and the particles are not always spheres.

Using this methodology does not require diluting the sample nor assuming any particle shape. It is not necessary to assume that the turbidity and the colour of the suspension are constant during the process. Therefore, this methodology is applicable in many different processes involving a change in the size of the particles, or droplets of the dispersed phase (emulsion) by aggregation of the same or dispersion of the aggregates.

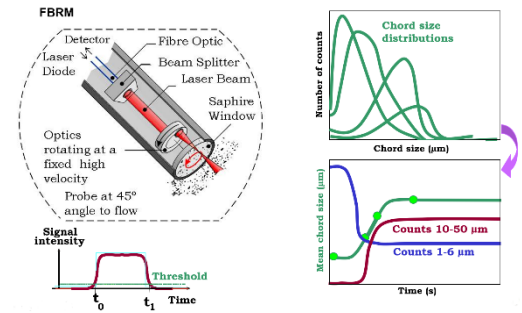
How does it work?

The study, control and optimization of the flocculation or coagulation process is carried out by monitoring the evolution of the particles chord size distribution in real time. This distribution is obtained by a focused beam reflectance measurement technique. The chord size distribution contains information about the size and number concentration of particles, whose variation is inherent to the flocculation process with independence to the mechanism through which this process takes place.

The measurement technique used by the developed methodology consists of commercial Mettler Toledo equipment with a probe, which is introduced in the suspension or in the pipe, and an electronic box with a detector. A computer system controls the equipment and receives the data. This equipment is provided with a laser diode that generates a laser beam which is split into different parallel beams. These beams are focused on a point (focal point) on the external surface of the sapphire probe window (sited in the extreme of the probe that is introduced on the suspension) through a rotating lens.



The focal point describes a circular path at high speed as a result of the rotation of the lens. When a particle intercepts the focal point path, light reflected is conducted to the detector, which receives light pulses, whose duration is proportional to the particle chord length (Figure 3). The equipment can measure thousands of particles per second and obtain a chord length distribution, representative of the particle population. The evolution of this distribution characterizes the flocculation process. The properties of the flocs can be studied by causing deflocculation and reflocculation by controlling stirring intensity.



What problem does it solve?

The incorporation of this methodology is highly valuable for industrial plants where a change in size of particles, droplets or bubbles must be controlled and for research centers aiming to study the behavior of suspensions and emulsions, the effectiveness of flocculants or coagulants, or the effects of additives on flocculation or coagulation processes. It can be a powerful tool for optimizing flocculant efficiency, determining the best way to use them and the optimal dosage—not only to maximize the degree of flocculation but also when flocs with specific properties are required.

What future products will it develop?

This methodology is applicable to a wide variety of processes that involve a change in particle size, or in the size of the droplets or bubbles of a dispersed phase, especially if it involves aggregation or dispersion of the aggregates. It is therefore applicable in the paper industry, water treatment, metal recovery, sludge thickening, and more.

Competitive advantages compared to other research

The results allow optimizing the processes of flocculation or coagulation; it can be used for the selection of flocculant to use and to optimize its dose. This reduces operating costs, avoiding the use of excessive doses of chemicals, and maximizing their effectiveness. When this methodology is used to control flocculation process, one can detect any disturbance in the process before it affects production and thus it is possible to carry out the appropriate action more effectively. This methodology has been successfully applied in water treatment plants, in wet-end control in papermaking and fibrecement production. It has been applied even in emulsions study.

Where has it been developed?

The Research Group of Cellulose, Paper and Advanced Water Treatment at the Department of Chemical and Materials Engineering of the Complutense University of Madrid (UCM) specializes in the study of colloidal systems and in flocculation, retention, and drainage processes. The group has extensive experience in the development of new methodologies based on Focused Beam Reflectance Measurement (FBRM), both at laboratory and industrial scale, in various sectors such as fibrecement, papermaking, and water treatment.

And moreover...

The research group has adapted the methodology to study other different processes, such as the monitoring of multiphasic catalytic reactions, the control of algae production, the control and optimization of dissolved air flotation, and the monitoring of the cellulose regeneration process.

Researcher in charge

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