THE BREAKUP OF FLOCS IN A TURBULENT FLOW FIELD

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CHAPTER 1

INTRODUCTION

The removal of solid impurities in water and wastewater treatment is normally accomplished by sedimentation. Since many of the impurities are too small for gravitational settling, the aggregation process is necessary as a precursor. Deaggregation, a phenomenon which inevitably accompanies the process, will obviously play an important role in the ultimate determination of floc size. Unfortunately, floc breakup is one aspect of the dynamic behavior of coagulating systems that is not well understood.

The most important physical properties of flocs in the water treatment context are size, density, structural type, and strength (or resistance to deaggregation). Size can be observed directly and the apparent density can be determined from measurements of terminal velocity; structural type and strength, on the other hand, are characteristics that are much more difficult to investigate because they are affected by a host of physicochemical parameters including: solution pH and ionic strength, surface characteristics of the colloidal solid, type of coagulant used, and the level of aggregation at which the particular agglomerate was formed.

Several breakup mechanisms have been proposed in the literature and these include: resonant breakup due to vortex shedding, rotation and deformation by viscous shear, bulgy deformation by fluctuations in dynamic pressure, primary particle erosion by shear, collisional fragmentation, and interaction between particles and impeller vortex system.

Of course, not all of these mechanisms are equally probable for a given environment and floc structure; consider the mechanical differences between flocs formed by: particle capture by enmeshment, macromolecular bridging, adsorption and charge neutralization, bioflocculation, and as a subset of each of the above, different levels of aggregation. Widely different structural types cannot be expected to respond identically to imposed stress.

In order to investigate the relationships between floc strength, size and structural type which are needed to elaborate the population balance model, experiments were conducted in a baffled, stirred tank and a two-dimensional free turbulent jet. The latter was chosen as a pertinent flow field since some similarities are evident between the jet flow and the impeller stream in the tank (compare the mean velocity profiles in Figure 6).

This study provided the following information:

1. Direct observation of the deaggregatiom of individual flocs and thus the breakage mode for flocs formed under various conditions;
2. Estimation of the critical levels of stress and dissipation required for aggregate breakup; quantitative determinations of the strength of floc;
3. The relationship between various floc parameters, including strength, density, size, and structural type;
4. A quantitative description of the distribution of daughter particle sizes and number produced;
5. Some evidence supporting the existence of multiple-levels of aggregation.