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Fractal Structures and Mechanisms in Coagulation/Flocculation Processes in Environmental Systems. Theoretical Aspects.

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Aggregation phenomena are of great importance in environmental systems but also in many areas of colloid science, chemistry and physics, and industrial processes. In natural waters and waste water treatment plants, the transport and fate of both nutrients and toxic compounds largely depends on their interactions with colloidal particles, biopolymers and the aggregates they form. The transport and elimination of vital or detrimental compounds then depends upon the kinetics of formation, structure, and sedimentation rate of these aggregates. Because of the complexity and large number of biophysical and chemical factors influencing these processes, as well as to the fact that natural colloids include several components, no rigorous analytical theory or models can directly be derived and applied to describe aggregation in environmental systems.

Nonetheless, due to the development of computers and the introduction of scaling concepts, numerical and theoretical models have been applied only relatively recently for investigating the behaviour of colloidal suspensions. These models have proved to be important and convenient tools for the systematic investigation of some of the physicochemical factors (pH, temperature, solution ionic strength, colloidal concentration and chemical surface properties) influencing the morphology of colloidal structures

induced by perikinetic aggregation (bridging flocculation by polymers, salt-induced coagulation, heteroaggregation, etc) and when addressing fundamental issues such as fractal growth.

Some of the simulation and theoretical models used to investigate aggregation processes will be discussed. The models depend upon whether the problem under consideration is defined at a microscopic or mesoscopic level and on the appropriate degree of complexity and rigour that is required to solve real practical problems of interest. Description of individual techniques and examples will be focused upon those that are, or are applicable to coagulation/flocculation processes in colloidal dispersions. Owing to the fact that such processes are now recognized to lead to the formation of fractal objects, fractal concepts will be discussed.