
Preface

Deposition and aggregation of small solid particles from a liquid dispersion are encountered in a variety of situations in manufacturing and process technologies and in natural aquatic environments. Deposition may occur onto a surface immersed into the suspension, that is of macroscopic dimensions compared with the particle, or solids may settle due to gravity to form a sediment at the bottom of the vessel containing the mixture. Aggregation involves the formation of assemblies of particles brought together by collisions, held in contact by surface forces. From a mechanistic point of view, deposition onto a macroscopic surface can be considered to be a limiting case of particle-particle aggregation in which one of the particles has an infinite dimension.

These phenomena are of significant industrial importance in the chemical, environmental, electronics, mineral and biological sectors. For instance, deposition processes are used in preparing magnetic tapes, in water purification using packed-bed filters, and in selective capture of solids, cells and macromolecular species. Aggregation to form larger particle assemblies is also an important step in enhancing the rate of gravitational settling to allow improved dewatering of suspensions, and in selective flocculation processes. It is often desirable to control the rate and extent of aggregation or deposition to control the morphology of the aggregates or deposits that are being formed. Many industrial operations involve both aggregation and deposition simultaneously.

Particle deposition and aggregation also play an important role in the transport of pollutants in aquatic environments and in the geochemical cycling of trace elements in the ocean. The transport of viruses, bacteria and particle-bound reactive pollutants in soils and ground waters is controlled by the rate of particle deposition. Aggregation in rivers, lakes and oceans is an important mechanism of modifying the size of particles, and, subsequently, in controlling their settling rates.

This book describes how such processes can be measured, modelled and simulated in a systematic manner. It brings together the necessary disciplines of colloid and surface chemistry, hydrodynamics, experimental methods, and computational methods to present a unified approach to this problem. Advances in instrumental and computational techniques are enabling the engineering of these complex colloid systems to be undertaken with greater confidence, although many problems still need to be addressed. For example, the advantages and limitations of employing computational simulation are discussed. The three aspects of *experimental measurement, modelling and simulation* are intended to

provide an introduction to the key concepts involved augmented by bibliographic recommendations.

A reasonable level of mathematical knowledge is assumed within the text, although basic concepts of physical and surface chemistry and microhydrodynamics are introduced at an appropriate level. The book should be useful to graduates working in process and environmental engineering research or industrial development at a postgraduate level, and to scientists who wish to extend their knowledge into more realistic process conditions in which the fluid hydrodynamics and other complicating factors must be accommodated.

The book is divided into four parts. Part I presents the theoretical principles governing deposition and aggregation phenomena, including a discussion of the forces that exist between particles and the hydrodynamic factors that control the movement of the particles and suspending fluid. Part II introduces methods for modelling the processes, first at a simple level (e.g. single particle-surface, single particle-single particle interactions in model flow conditions) and then describes the simulation protocols and computation tools which may be employed to describe more complex (multiple-particle interaction) systems. Part III summarizes the experimental methods of quantifying aggregating and depositing systems and concludes with a comparison of experimental results with those predicted using simple theoretical predictions. Part IV is largely based on illustrative examples to demonstrate the application of simulation and modelling methods to particle filtration, aggregation and transport processes.

A separate nomenclature is provided for each chapter. Wherever possible the use of notation is standardized throughout the text, with the same symbol being used consistently for important variables. Inevitably some conflicts are bound to arise in a multidisciplinary work and, therefore, we have chosen to adopt the nomenclature that is most commonly used within the subject area under consideration. The meaning of the symbols employed should be obvious from the context and can be confirmed by consulting the nomenclature at the front of each chapter.

The book is of multiple authorship. The principal areas of interest of the authors were characterization of particle-particle interactions (JG, RAW), hydrodynamics (XJ), experimental and theoretical behaviour of particle deposition on model collectors (ME), experimental and theoretical aspects of aggregation (JG), and simulation and computation methods (RAW, XJ). For this reason the individual chapters may differ slightly in style and approach, nevertheless we have sought to deliver a coherent text. We are particularly grateful to several colleagues who have commented on the different portions of the text, undertaken proof-reading and provided additional experimental data. These include Dr Tom Dyakowski, Professor Graham A. Davies, Dr Alec E. James, Dr Geoff Lyman and Dr Lianfa Song.

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