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# PREFACE

The dissolved air flotation (DAF) process has now been in use for more than 40 years as an important process for the clarification of drinking water. During the past 20 years it became a widely adopted alternative for sedimentation in all parts of the world, for plants large and small. A rich body of experience and fundamental understanding has steadily accumulated among researchers, designers, and manufacturers and yet there is no professional book on this subject. The authors over the last 25 years have published scholarly journal papers, conducted research, have participated as keynote speakers at international conferences on DAF, and consulted worldwide to engineering companies and water utilities. We know from our own experience and from numerous discussions with professionals in the water field that there is a great need for this book. Our primary purpose with this book is to consolidate and to interpret this knowledge, for the first time, in a single volume entirely devoted to DAF for water clarification.

The book should be of particular interest to those sectors of the water field involved with DAF including academic researchers, design engineers from consulting practices, water plant manufacturers and suppliers, and water plant managers and operators. Others who should consider this book include:

- University professors, upper-level undergraduate and graduate students who study water treatment processes. This book will serve as a comprehensive reference in courses on Water Treatment Processes, Advanced Water Treatment, Membrane Processes and Desalination, and Design of Water Treatment Systems.
- Engineers and scientists who design water treatment plants and advanced water treatment plants for water reuse and water desalination.
- Water utility managers, engineers, scientists, and operators.
- Engineers and scientists involved with industrial water and wastewater treatment processes.

The material in the book is developed along three main objectives. The first is to develop a fundamental basis for understanding how DAF works. The fundamental principles developed in the book apply to all fields that use DAF. However, discussion and evaluation of DAF for the following drinking water applications are addressed in detail: (1) clarification in conventional treatment, (2) clarification pretreatment in low-pressure and high-pressure membrane plants—for the latter especially in desalination applications, (3) clarification in water reuse, and (4) treatment of spent filter backwash waters. Therefore, a second objective is to provide guidance for process engineers and water managers toward these applications where DAF might be incorporated in the various treatment schemes. The third objective is to develop the necessary DAF design concepts and to illustrate them by descriptions of practical applications.

Chapter 1 provides background material on various methods of flotation so the reader gains an appreciation of DAF versus other methods and gives a brief description of DAF as used within a conventional drinking water treatment plant. Chapter 2 traces the evolution of DAF technology from its mining roots a hundred years ago up to its present status as a widely used and accepted clarification process.



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The next six chapters develop fundamentals of the process, Microbubbles, essential for successful DAF treatment, are covered in Chaps. 3 and 4. Chapter 3 considers the options for saturating the recycle stream with air under pressure and develops a complete set of equations for the design of common saturation systems, while Chap. 4 analyzes the manner in which the recycle flow is injected into the DAF tank and how the bubbles are formed. Chapter 5 considers breifly some general properties of air bubbles in water, and then emphasizes the forces between particles, bubbles, and particles-bubbles. The crucially important roles of appropriate pretreatment coagulation and flocculation are addressed in Chap. 6. Chapter 7 continues with our fundamental approach dealing with the contact zone of the DAF tank where bubbles and floc particles collide and attach to each other. Finally, we reach the separation zone in Chap. 8, where the floc-bubble aggregates are separated before the clarified water flows out of the DAF tank. We stress in Chaps. 3 to 8 fundamental principles pertaining to DAF, but we also provide practical and illustrative examples, provide ranges or typical values of design and operating variables, and relate the concepts to drinking water treatment practice.

The book closes with five practical chapters. Chapter 9 is devoted to methods for removing the float layer from the surface of the DAF tank. Chapter 10 addresses whether DAF is a process that should be considered for a water treatment plant. It starts with the presentation of a clarification process selection guide based on raw water quality, moves to what information bench-scale DAF studies provide, and then considers pilot-scale DAF studies and the kind of design and operating criteria generated from these studies. Supplementary and complementary measurements and tests are also addressed. Chapter 11 discusses and evaluates DAF in conventional drinking water plants. We begin with the presentation of different DAF configurations including discussion of conventional-rate and high-rate plants. DAF treatment experience for various type raw water qualities are presented and evaluated. The discussion according to raw water quality is supplemented with several case studies, each demonstrating different aspects of DAF. Chapter 12 explores additional applications of DAF pretreatment for membrane systems, especially low-pressure ones. DAF is also considered in the fields of water reuse and in treating spent filter backwash water. Case studies are presented throughout the chaptaer. The last chapter (Chap. 13) examines DAF as a seawater-pretreatment process in reverse osmosis desalination plants. The chapter starts with summarizing seawater chemistry, discussing contaminants of concern in pretreatment, and discussing and contrasting seawater coagulation to freshwater. The physical properties of seawater are examined and how they might affect DAF performance. We also consider the effects of seawater on dissolving air and available air in the saturator. Finally, we present examples of DAF in full-scale desalination plants.

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