Preface

Man's use of pollutants, in particular metals, began to affect the environment during the "*Industrial Revolution*". Although some metal ions are disseminated into the environment naturally by both geological and biological activity, human activity today produces a greater input. The toxicity of many of these metals is well known. Today, we are in the "*Pollutant Removal Age*" and, it is, therefore, not surprising that there has been considerable effort to develop technologies to reduce pollutant emissions. A significant proportion of these emissions are in the form of industrial wastewaters. Indeed, the industrial sector consumes significant volumes of water, and consequently generates considerable amounts of wastewater discharge. This sector is today considered to be one of the most polluting in spite of the considerable effort made to clean up the processes over the last 30 years. Wastewater treatment is becoming ever more critical due to diminishing water resources, increasing wastewater disposal costs, and stricter discharge regulations that have lowered permissible contaminant levels in waste streams. It is important to note that the diversity of water pollutants calls for a wide range of treatment methods that are not only effective, but also technologically and economically feasible. The most common methods for the removal of pollutants from industrial effluents include chemical precipitation, solvent extraction, evaporation, chemical oxidation, biodegradation (biological reactors, lagoons), electrochemical approaches (dialysis, electrodialysis, electrolytic extraction), cementation, membrane filtration (reverse osmosis), ion-exchange, and carbon adsorption. Over the last few decades adsorption/sorption has gained importance as a separation, purification and/or detoxification process on an industrial scale. Adsorption is used to purify, decolorize, detoxify, deodorize, separate, and concentrate to allow removal and to recover the harmful products from liquid solutions and gas mixtures. Consequently, adsorption is of interest to many economic sectors and concerns areas such as chemistry, food and pharmaceutical industries, and the treatment of drinking water and industrial wastewater. In general terms, activated carbon must be thought of as being a most effective sorbent and, as such, its performance in removing contaminants/pollutants such as drugs, metals, dyes, phenolic and aromatic derivatives has been examined widely. In addition, in the field of wastewater treatment, sorption onto carbon has proved efficient in removing colloidal substances and soluble organic substances that are non-biodegradable or chemically stable like recalcitrant synthetic molecules. Attention has also focused on ion exchange using organic polymeric resins as another non-consumptive method. However, despite the excellence of their performance, commercial activated carbon and organic resins are expensive to use and, as such, cannot be thought of as a truly viable option in many parts of the world. Because

of this, attention has turned to the sorptive properties of other non-conventional solid materials. Recently, sorption onto low-cost materials such as carbons produced from wastes or natural by-products, natural sorbents, and biological materials has been the focus of much attention. Since the range of solid materials proposed in the literature is extremely extensive, attempting to provide a comprehensive list of potential effective sorbents would be unrealistic. This book, however, shows a typical selection of the types of conventional and non-conventional materials studied and used in wastewater treatment, with emphasis on industrial effluents. The types of materials considered range from conventional sorbents such as activated carbons (Chapters 4 and 5) and silicas (Chapter 6), to non-conventional solids such as sawdust (Chapter 9), chitosan (Chapter 10), and fungal biomass (Chapter 14). Sorbents for specific applications are also discussed in detail: colour removal in Chapters 7 and 8, metal extraction in Chapters 11 and 12, and fluoride removal in Chapter 13. The past two decades have also shown an explosion in the development of new polymeric networks, nanocomposites and nanoporous materials. These include cyclodextrins (Chapter 15), calixarenes (Chapter 16), nanocomposites (Chapter 17), molecularly imprinted polymers (Chapter 18), and nanoparticles (Chapter 19). The sorption properties of materials remain largely unexplored. For people who are new to the field, two special overview chapters, dealing with the principles and properties of adsorption processes, are provided at the beginning of the book. A detailed review of sorption features is given in Chapter 2. Also, the book also provides a comprehensive source of knowledge on fixed-bed contacting systems (Chapter 3). The intended audience for this book includes students, environmentalists, engineers, water scientists, civil and industrial personnel who wish to specialize in adsorption technology. Academically, this book will be of use to students in chemical and environmental engineering who wish to learn about adsorption and its fundamentals. It has also been compiled for practicing engineers who wish to know about recent developments on sorbent materials in order to promote further research toward improving and developing newer sorbents and processes for the efficient removal of pollutants from industrial effluents. However, the book is not meant to be an extensive treatise on adsorption and sorbents. For example, particular aspects on modelling or biosorption are not considered because the reader can find abundant information on these topics in the literature. It is hoped that the book will serve two main functions: 1) a readable and useful presentation not only for undergraduate and postgraduate students but also for the water scientists and engineers; and 2) a convenient reference handbook in the form of numerous recent examples and appended information. The editors extend their thanks to all the authors who contributed to this book. Thanks are also due to our past and present students and associates, with whom we have had so much pleasure in learning. The creation of this book would not have been possible without the assistance of several friends deserving acknowledgment. They have helped by choosing contributors, reviewing chapters, and in many other ways. Finally, we would like to thank the staff at *Presses Universitaires de Franche-Comté* (Besançon, France) for their highly professional editing of the publication.

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