

Phosphorus in Environmental Technology

Principles and Applications

Edited by

Eugenia Valsami-Jones



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Preface

Phosphorus is both hero and villain in the history of Earth. It receives good publicity for being the backbone of the molecule of life, DNA, and bad for being a persistent pollutant that costs UK industry, for example, more than £150 million per year due to freshwater eutrophication^a. In addition, phosphorus is at the centre of the structure of the basic energy-providing biological entity, ATP, and is a key component of the scaffold of all vertebrates, bone. But it also forms some of the most toxic chemicals known, organophosphates, which have been used in applications as diverse as pesticides and nerve agents, and which have left a legacy of severe contamination. In between these extremes lie a whole host of other applications of phosphorus, from fertilisers and foodstuffs to detergents, catalysts, biomaterials, medicines, fire retardants, stabilisers, radioactive element hosts and more. Knowledge of the chemistry of phosphorus witnessed a vast expansion in the 20th century, rivalled only by carbon, with known phosphorus compounds now exceeding 100,000^b.

In this context, planning a book entitled “Phosphorus in Environmental Technology” means that the choices of topics to cover are endless. To give the book a focus, three main ideas were set at the core of planning. Firstly, that the book should be self-contained and therefore include aspects of the fundamental science of phosphorus. Secondly, that it would aim to describe technological applications with global industrial or economic implications, presented in dedicated chapters. Thirdly, that the book would emphasise and prioritise novel and topical technological themes. From the latter, two sections stand out: one dedicated to phosphorus recovery for reuse, a topical theme for many different indus-

^aPretty et al., 2003. *Env. Sci. & Technology*, vol. 37, pp. 201–208.

^bCorbridge, D.E.C., *Phosphorus 2000, Chemistry, Biochemistry and Technology*. Elsevier.

trial technologies that is especially relevant to phosphorus, and a second dedicated to novel biotechnologies, an area of active and diverse expansion.

The book is divided into five parts. Part I is concerned with the chemistry, geochemistry, mineralogy and biology of phosphorus. The diverse roles of phosphorus in nature mean that this range of fundamental sciences underpin knowledge of its use in environmental technologies, and will serve to support later chapters.

Part II looks into the distribution of phosphorus in the environment. Beginning with a review of the mechanisms of phosphorus release, this part goes on to consider the role of phosphorus in agriculture and its transfer to sensitive waters, and to investigate the environmental fate of a special group of organophosphorus compounds, the phosphonates, commonly used in industrial applications. This part of the book ends with a global review of phosphorus pollution.

Part III focuses on phosphorus removal technologies and starts with the fundamental principles of phosphate dissolution-precipitation, which control phosphorus removal in industrial applications. That chapter is succeeded by a chapter dedicated to waste water treatment principles, followed by others on chemical and biological phosphorus removal. Solid phase adsorbents of phosphorus are then discussed and a case study on phosphorus removal by recovered ochre presented.

Part IV addresses a theme which has only emerged in the past few years: phosphorus recovery. The development of recovery technologies makes sense not only in terms of good environmental practice, but also because global phosphorus reserves are finite. Given the importance of phosphorus to life on Earth, its conservation may ultimately be of great significance. Phosphorus recovery is first examined through the eyes of the industry in a dedicated chapter. If recovery is to be implemented, appropriate recovery reactor technologies need to be in place, and the fluid dynamic principles of such constructions need to be considered; one chapter reviews the fundamentals of such technology. This is then followed by case study chapters, after which this part closes by considering the regulation and economics of recovery. The message from this last chapter is that, at present, there is no financial incentive for phosphorus recycling. Such incentives may take long to materialise and environmental criteria should perhaps be the driver to encourage recycling technologies.

The final part of the book sees the presentation of four novel phosphorus biotechnologies; the first involves the use of bacteria to precipitate metal phosphates as a mechanism of immobilising/neutralising toxic/radioactive metals. The second covers biomaterial technologies for bone substitution, and the third is about technologically-based rationalisation of phosphorus use in agriculture. The fourth covers novel methods for biodegradation of organophosphate nerve agents.

The editor's thanks go to all the authors of the book for their enthusiasm and diligence. I have also a great many people to thank for advice, reviews, or other help. In alphabetical order they are: Wole Akinremi, Paolo Battistoni, Raffaella Boccadoro, Robin Cocks, D.E.C. Corbridge, Gordon Cressey, Aleksandra Drizo, Bill Dubbin, Karin Hing, Mark Hodson, Yasmin Jaffer, Johnny Johnston, Greg Jones, Sharron McEldowney, John McGrath, A. Mersmann, Simon Parsons, Gary

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