“十二五”普通高等教育本科规划教材

CHEMISTRY OF THE ENVIRONMENT

环境化学

（双语教学用）

弓爱君　刘杰民　王海鸥　编著

化学工业出版社

“十二五”普通高等教育本科规划教材

环境化学

Chemistry of the Environment

（双语教学用）

弓爱君　刘杰民　王海鸥　编著

化学工业出版社

·北京·

This book includes five chapters, including Introduction, Atmosphere Environmental Chemistry, Water Environmental Chemistry, Soil Environmental Chemistry and Disasters and Environmental Protection. This book focused on atmosphere, water and biosphere, systematically illustrates the behavior of pollutants, the techniques and theories of easing and removing them. The section of biosphere combines the atmosphere, water and soil, thus it is not an independent chapter. Disasters and environmental protection are specifically included in the chapter 5 for the sake of enhancing the environmental awareness of modern constructors.

In order to improving the teaching effect, there are key points in every chapter and questions to be considered at the end. Meanwhile, the teaching board has already published an exercise book *Environmental Learning and Practicing Collection* for bilingual teaching.

The book can be used as the bilingual teaching material of Environmental Chemistry courses for undergraduates in environment, chemistry and biology majors. It can also be used as a reference book for postgraduates in related majors and environmentalists.

本书共五章，包括绪论、大气环境化学、水环境化学、土壤环境化学、灾害与环境保护。本书以大气、水、土壤三大圈层为主线，系统阐述了污染物的行为特征、减缓或消除污染的方法和原理。生物圈层的内容融入大气、水和土壤圈层，没有单独立章。为了增强新世纪建设者的环境意识，特将灾害与环境保护纳入本书的第五章。

为了提高本书的教学效果，每章正文开始前编有“本章要点”，每章末尾配有思考题。同时，我们教学组已经出版了与本教材配套的《环境化学习题集》（双语教学用）。

本书可作为高等学校环境、化学、生物等专业本科生的《环境化学》（双语）课程教材，也可作为相关专业研究生及环境工作者的参考书。

图书在版编目（CIP）数据

环境化学（Chemistry of the Environment）/弓爱君，刘杰民，王海鸥编著．—北京：化学工业出版社，2015.10
ISBN 978-7-122-24899-2

Ⅰ.①环… Ⅱ.①弓… ②刘…③王… Ⅲ.①环境化学-高等学校-教材-英文 Ⅳ.①X13

中国版本图书馆 CIP 数据核字（2015）第 187869 号

责任编辑：杨 菁 王 婧　　文字编辑：李锦侠
责任校对：王 静　　装帧设计：关 飞

出版发行：化学工业出版社（北京市东城区青年湖南街 13 号 邮政编码 100011）
印　　装：三河市延风印装有限公司
787mm×1092mm 1/16 印张 15½ 字数 387 千字　　2016 年 1 月北京第 1 版第 1 次印刷

购书咨询：010-64518888（传真：010-64519686） 售后服务：010-64518899
网　　址：http://www.cip.com.cn
凡购买本书，如有缺损质量问题，本社销售中心负责调换。

定　价：46.00 元

Preface

The development of human society is becoming increasingly fast while various environmental problems appear noticeable than as past. Environment events are alarming people and stirring more attention from the public. Those events are promoting the flourishing development of environmental chemistry and make people clearly aware of the significance and necessity of sustainable development. Higher education is the principal base of fostering elites, spreading environmental knowledge and researching into the environmental issues. Thus, compelling this bilingual material for undergraduates has an indispensable.

Environmental Chemistry is one branch of science, which studies on the existence, characteristics, behavior, and impact as well as chemical principles and strategies to control pollutants. The book is divided into five chapters, which are Introduction, Atmosphere Environmental Chemistry, Water Environmental Chemistry, Soil Environmental Chemistry and Disasters and Environmental Protection. It systematically illustrates the definition, principle, method, problem and last development in bilingual way.

In writing the book, we have been aided greatly by bilingual teaching demonstration curriculum construction project and the textbook project of the "12 five-year plan" in USTB. We highly appreciate it.

Due to knowledge limitation, writing and English level, mistakes may occur in this book. We sincerely hope readers' feedback and correction.

Editor

Jul. 2015

前　言

人类社会的发展日新月异，各种环境问题随之突显。环境事件给人们敲响了警钟，引起了人们对环境问题的高度重视，推动了环境化学的飞速发展，迫使人们清醒地认识到走可持续发展之路势在必行。高等学校是培养人才、传播环境知识、研究环境问题的重要基地。因此，编写本科生使用的环境化学中英文教材具有重要的意义。

环境化学是一门研究有害化学物质在环境介质中的存在、化学特性、行为和效应及其控制的化学原理和方法的科学。全书分为五章，即绪论、大气环境化学、水环境化学、土壤环境化学和灾害与环境保护，以中英文双语的形式系统阐述了环境化学的概念、原理、方法、问题及最新进展。

本教材的编写得到了教育部双语教学示范课程建设项目及北京科技大学“十二五”规划教材项目的大力支持，在此表示感谢！

限于学识、文字和英语水平，书中疏漏及欠妥之处在所难免，恳请读者批评指正。

编著者

2015 年 7 月

Contents

目　录

Chapter 1
Introduction

Key Point: Definition of Environmental Chemistry; Classification of Environmental Chemistry; Research Content of Environmental Chemistry; Characteristics of Environmental Chemistry; Development of Environmental Chemistry; Environmental Pollution; Eight public nuisances in the world; Recent years' the world famous public nuisance; The main environmental problems; People's awareness of environmental problem; The solution to the key problems of the prevention and control of environmental pollution in China.

Section 1 What is Environmental Chemistry?

1. Definition of Environmental Chemistry

Environmental Chemistry is one branch of science, which studies on the existence, behavior, and impact of hidden harmful chemicals and finally reduces or eliminates them. Three purposes are laid on it. First, it is supposed to study the existence, chemical feature, behavior and impact of harmful chemicals in their specific ambient medium. Second, it researches into the chemical principle and method of controlling contaminant. Third, it enables scientists to find and solve environmental issues by applying basic theories and techniques. Environmental Chemistry is the core proportion of Environmental Science and also an instrumental branch of Chemistry the subject.

2. Classification of Environmental Chemistry

Environmental Chemistry basically includes Environmental Analytical Chemistry, Environmental Pollution Chemistry and Pollution Control Chemistry.

① Environmental Analytical Chemistry aims at studying how to apply modern scientific theories and advance experimental techniques to differentiate and measure the types, composition which includes state and structure, and content. On the account of the features of analyzing pollutants, like the various categories, the low density and severe interfere, scientists are usually required to introduce the measurement that possesses high flexibility, selectivity, accuracy and precision. The progressively integration of automatic constant monitor and satellite remote sensing technology into Environmental Analytical Chemistry enhances its ability to control pollutants in real time. Environmental Analytical Chemistry comprises organic analytical chemistry of environment and inorganic analytical chemistry of the environment.

② Environmental Pollution Chemistry mostly researches into the chemical behavior and changing law of pollutants in mediums during their movement, acceleration and transforma-

tion. This subject includes Atmosphere Environmental Chemistry, Water Environmental Chemistry, Soil Environmental Chemistry and Pollution Eco-Chemistry.

③ Pollution Control Chemistry is a science that exposes the separation and control of chemical pollutants. It focuses on studying pollution control and other chemical problems that may occur in the course of treatment. It also provides theories and methods for the treatment. Pollution Control Chemistry includes air pollution control chemistry, water pollution control chemistry and solid waste control chemistry.

3. Research Content of Environmental Chemistry

The research content of Environmental Chemistry includes five points. ①It examines the density level and state of harmful substance in the environment. ②It studies the origin, distribution, migration, transformation and fate as well as their various behaviors when dealing with different environmental mediums. ③It explores the mechanism and risk of the impact those harmful substances have on the environment, ecosystem and human body. ④It finds out the methods to ease and remove bad effects made by harmful substances. ⑤It seeks the solution to avoid the production of harm.

4. Characteristics of Environmental Chemistry

The characteristic of Environmental Chemistry is to study the mechanism and prevention methods for macro environmental phenomenon and change. The core is the research into chemical migration and reaction of pollutants in specific environment.

(1) The substances of research have a large quantity and their systems are complicated

The pollutants have various forms with large quantity and complex composition. Meanwhile, many kinds of pollutants may have chemical reactions and physical changes under different mechanisms in the environment, which makes the substances of Environmental Chemistry a big system with various configurations, changeable states and complex mechanisms.

(2) The density of pollutant is very low, usually with the order of μg/mL or μg/L

Pollutant has a very low density with the order of μg/mL or μg/L. However it is on the normal level when comparing with other compounds coexisting. For the precision of qualitative and quantitative analysis of these pollutants, modern analytical techniques are often required, for example, the Infrared Spectrum Technology, the NMR (nuclear magnetic resonance) technology, the GS-MS (Gas Chromatography and Mass Spectrometry) and the isotope tracer techniques.

(3) The study of Environmental Chemistry needs a wide span of time or space and high comprehensiveness

It is difficult to control chemical reactions in the environment. Thus, doing Environmental Chemistry study demands wide time and spatial span. It explores the distribution, migration, transformation and fate of pollutants in ecosystem, especially their acceleration, interaction, biological effect and so on.

5. Development of Environmental Chemistry

As the environmental problems being increasingly severe and the awareness of the public enhancing, new directions emerge from the research of Environmental Chemistry.

(1) Environmental Analytical Chemistry

The direction of Environmental Analytical Chemistry mainly focuses on the refinement and exploration of pretreatment techniques of environmental samples. The substances of analysis change from mostly inorganic compounds to organic compounds and organic metal compounds. The analyzing techniques of instruments are generally improved for developing the precision and reproducibility.

(2) Environmental Pollution Chemistry

Environmental Pollution Chemistry studies pollutants' chemical behavior and ecological effect when they taking shape, migrating, transferring and ending in the environments of atmosphere, water and soil. The subjects of Atmosphere Environmental Chemistry include atmosphere particles, acid deposition, atmospheric organic compounds, trace gases, ozone depletion and global warming, etc. Its spatial scale goes from inner air, city, and regional environment even to the whole world.

Atmosphere Environmental Chemistry firstly studies river, lake and reservoir. Estuary, bay, offshore area and groundwater pollution are all of the second concerns. It mainly explores the process, for instance, water interface chemical process, metal morphology transformation dynamics process, organic compounds chemical degradation process, metal and metalloid methylation process, etc.

Soil Environmental Chemistry mainly studies agrochemicals' migration, transformation and fate and its effects on soil and human body in the environment of soil. It includes degradation of organic pollutants in the soil, the release of greenhouse gases, pollutants' chemical reactions process between solid and liquid interface and chemical and biological remediation, etc.

Ecology Environmental Chemistry generally researches into the process of agrochemicals taking effects in the ecosystem, such as the environmental chemical behavior and ecological security of rare earth application.

(3) Pollution Control Chemistry

Currently, pollution control has two models, which are the traditional terminal control and pollution prevention and clean production. Terminal control has positive effects on the development of pollution control techniques and pollution treatment in each country, but it can only reduce or control pollutants emission, not prevent the production of them. Terminal control research includes the contents, which are atmosphere pollution control, water pollution control, solid waste control and resource analysis. The study in pollution control material and technology includes flocculants, ion exchanger, membrane material, catalyst and separation technology, etc.

On account of the limitation of terminal treatment, in the mid of 1980s, European countries proposed the transformation of control model from End-of-pipe Control to whole

process control and also put forward several strategy views, including Pollution-Prevention, Cleaner-Production, Green Chemistry and Industrial Ecology. It aims at no harmful intermediate and sub product and builds inner circulation of waste and emission in order to achieve waste minimization, resource and energy maximization. It was one of the instrumental breakthroughs of environmental management strategy.

Section 2 Environmental Pollution Events

Environmental issue refers to various environmental recession and harmful effect on biosphere, mainly including acid rain, global warming, ozone hole, freshwater and other resources deficiency, and ecological degradation.

1. Environmental Pollution

Human factors destroyed ecosystem, led to the decrease of the quality of the environment, has affected people's normal life.

Pollution of the environment reflects in the following four aspects. First one is harmful substances pollution of the atmosphere, water, soil and animals and plants, and reaches the extent of the damage. Second one is improper interference and destruction of ecological system. Third one is that non-renewable resources are abused by excessive mining. Fourth one is that solid waste, noise, vibration, stench, radiation caused the damage to the environment. Factors that cause environmental pollution have three aspects of physical, chemical and biological, which caused by chemicals accounted for about 80% to 90%.

2. Eight public nuisances in the world

(1) Belgium Meuse Valley Smog Event

From December 1 to 5, 1930, excessive amounts of smog were discharged and could not spread from thirteen factories in Belgium Meuse Valley industrial district, which caused thousands of people there had chest hurting, coughing, tearing, sore throat and dyspnea. More than 60 people died within one week and then their relatives. It was the first record of atmosphere pollution in 20th century.

(2) America Los Angeles Chemical Smog Event

From 1940s, yellow smog started to emerge in the sky of Los Angeles in USA, which, at that moment, owned large amounts of vehicles. It was caused by photochemical smog and it harmed people's eyes, throat and lung and also brought symptoms like chest distress. A big scale of plants was affected, for example, the pine threes died and orange output dropped. In 1955, the number of victims reached 400 and it was the earliest atmosphere pollution due to automobile exhaust.

(3) Nora Smog Event

During October 26 to 31, 1948, it was smog constantly in Nora town, Pennsylvania, USA. It was just the plan where lay in major sulphuric acid plant, steel plant and zinc smel-