普通高等教育“十一五”国家级规划教材

21世纪环境科学

21ShiJiHuanJing KeXue

环境科学与工程专业英语

（第二版）

HuanJing KEXUE YU GONGCHENG ZHUANYE YINGYU

张　晖　张道斌　周丹娜　编著

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前　　言

《环境科学与工程专业英语》（第一版）自2004年5月出版以来，承蒙众多高校师生的厚爱，反映较为良好。尽管如此，本书选用的原版教材、专著和其他文献资料近年来已经再版或更新。并且，通过这几年的教学实践，我们日益感到有修订再版的必要。在科学出版社和武汉大学资源与环境科学学院的关心和支持下，本书入选普通高等教育"十一五"国家级教材规划，这使得修订工作得以付诸实施。

在保持原教材结构、内容和特点的基础上，我们进行了以下修订：①增加"Unit 18 Noise Control"和"Unit 20 How to Write A Scientific Paper"两个单元；②更换部分单元的内容（Unit 1 Reading Material B，Unit 2 Reading Material A、Reading Material B，Unit 3 Reading Material A、Reading Material B, Unit 4 Reading Material A、Reading Material B, Unit 5 Reading Material A、Reading Material B, Unit 6 Reading Material B, Unit 9 Reading Material A、Reading Material B, Unit 17, Unit 19（含 Reading Material A）；③更新部分单元的内容(Unit 1、Unit 3、Unit 4、Unit 6 Reading Material A、Unit 7 Reading Material A、 Unit 8 Reading Material A、Unit 10（含 Reading Material A)、Unit 11 Reading Material A、Unit 14、Unit 15、Unit 16 (含 Reading Material A)。

本书由张晖、张道斌和周丹娜编写修订。其中，张晖负责第1、2、6、10～17、19、20单元和附录A～附录D的修订，张道斌负责第18单元的修订和第1、10、14、16～20单元的校对，周丹娜负责第3～5、7～9单元的修订。武汉大学资源与环境科学学院2009级博士研究生吴捷和黄闻宇全程参与本书修订，2009级硕士研究生黄倩倩参与最后的整理工作。

感谢武汉大学资源与环境科学学院副院长钱沙华教授和科学出版社一直以来对本书给予的关注。感谢武汉大学环境工程专业2001级、2004～2006级本科生对本书的反馈意见。

尽管本书第二版对原有内容进行修订更换，并增加新的内容，但囿于编者知识背景与见识，本书难免有疏漏与不妥之处，恳请广大读者不吝赐教。

张　晖　张道斌　周丹娜

2009年4月于武昌珞珈山

Contents

Unit 1

Introduction of Environmental Engineering and Science

A variety of metrics suggest that the scope and importance of environmental engineering and science continue to grow. *As developing nations industrialize, pollutant concentrations and the numbers of exposed individuals increase; as new chemicals are added to our environment we discover more complex and troubling impacts; as we more carefully monitor ecosystems, we become more alarmed at the threats our activities have on the very fabric of life on Earth.*[1] Emissions of greenhouse gases are changing our climate and acidifying our oceans, endocrine disrupting compounds are appearing in waters throughout the world, high levels of mercury, PCBs, and other toxics are threatening marine mammals, fish, and other organisms.

Progress has been made on many environmental fronts, including continued improvement in the quality of much of the surface water in the United States, more sophisticated techniques and instrumentation for monitoring the state of our environment, and mandated implementation of preventative technologies such as liners in municipal landfills, double-walled underground storage tanks for liquid fuels, and improved exhaust emission controls on automobiles. There is evidence that the protective ozone in the stratosphere is starting to recover and the concentration of chlorine in the stratosphere is dropping. Lead and chlorofluorocarbon emission have been drastically reduced and, in a 2007 Supreme Court decision, carbon dioxide was finally recognized as a pollutant that can be regulated under the *Clean Air Act*[2], which will have enormous implications on controlling greenhouse gas emissions. It can also be reasonably argued that we have gotten better at allocating our environmental-improvement dollars. Monitored natural attenuation of subsurface contamination can potentially save millions of dollars in clean-up costs with little likelihood of increase human or ecological risk. Redevelopment and use of modestly contaminated industrial and commercial sites under *brownfields* [3] initiatives have helped slow urban sprawl and encouraged revitalization of abandoned land. Increasingly stringent energy-efficiency standards for appliances and buildings are helping to reduce emissions from power plants at far lower cost than efforts to control stack emissions.

The breadth and complexity of the environmental problems we face and the scientific, economic and social impediments to their solution emphasize how important it is that environmental scientists and engineers gain an appreciation for the processes and functioning of all environmental compartments — air, soil, water, and energy — and intentionally account for the long-term consequences and sustainability of the actions they propose, whether they be preventative or remedial [4]. One such example is the arsenic crisis in many developing countries. Millions of wells were dug in India, Bangladesh, Southeast Asia, Chile, and Argentina in an attempt to reduce exposure to pathogens found in surface water sources of drinking water. However, because the subsurface geochemistry of these regions was not adequately evaluated beforehand, an epidemic of arsenic poisoning now affects millions of people who are drinking water from wells that are contaminated by naturally occurring arsenic. The story of *MTBE* [5] provides another example of unintended consequences. MTBE was first added to gasoline in the early 1980s to replace the octane enhancer tetraethyllead and to help clean the air by reducing exhaust emissions. Inadvertent leakage from cars and storage tanks, however, has led to MTBE contamination of groundwater, including drinking water sources, in many parts of the United States. Such examples reinforce the need for environmental engineers, scientists, and an informed public, to broaden their range of expertise to include the full range of environmental threats that our industrialized society creates.

(Adapted from: Masters GM. Introduction to Environmental Engineering and Science, 3rd ed. Upper Saddle River, NJ：Prentice Hall Inc, 2008)

New Words and Expressions

metric ['metrɪk]	*n.*	统计数据，度量
monitor ['mɔnitə]	*v.*	监控
acidify [ə'sidifai]	*v.*	使酸化，使成酸
endocrine disrupting	*n.*	内分泌干扰物
sophisticated [sə'fistikeitid]	*adj.*	复杂的，尖端的，精密的，高级的
tank [tæŋk]	*n.*	(盛液体，气体的大容器)罐、槽
fluorocarbon [ˌflu(ː)ərə'kɑːbən]	*n.*	碳氟化合物
attenuation [əˌtenju'eiʃən]	*n.*	衰减，减弱，衰耗
sprawl [sprɔːl]	*v.*	扩展，扩张，延伸
impediment [im'pedimənt]	*n.*	妨碍，阻碍，障碍物，障碍物

sustainability	*n.*	可持续发展，可持续性
remedial [ri'mi:djəl]	*adj.*	挽回的，纠正的，补救的，治疗的
arsenic ['ɑ:sənik]	*n.*	砷，砒霜
geochemistry [ˌdʒi(:)əu'kemistri]	*n.*	地球化学
epidemic [ˌepi'demik]	*n.*	时疫，疫疾流行，流行病
octane ['ɔktein]	*n.*	辛烷
inadvertent [ˌinəd'və:tənt]	*adj.*	不注意的，疏忽的，无意中做的
contaminate [kən'tæmineit]	*v.*	污染
enormous [i'nɔ:məs]	*adj.*	巨大的
scope [skəup]	*n.*	(活动)范围，机会，余地
pathogens ['pæθədʒəns]	*n.*	病原体(物)
landfill [ˋlændfil]	*n.*	垃圾掩埋法，垃圾
leakage ['li:kidʒ]	*n.*	漏，泄漏，渗漏
liner ['lainə]	*n.*	班机，画线者，衬垫

Notes

[1] As developing nations industrialize, pollutant concentrations and the numbers of exposed individuals increase; as new chemicals are added to our environment we discover more complex and troubling impacts; as we more carefully monitor ecosystems, we become more alarmed at the threats our activities have on the very fabric of life on Earth.

当发展中国家正在工业化时，污染物聚集(程度)以及暴露在这些化学品影响之下的人数都在逐渐增加；当新的化学物质被应用到我们日常环境中时，我们发现了越来越多的复杂和麻烦的影响；当我们越来越细心仔细地监视着生态系统时，我们也变得对由我们自己日常活动给地球上基本生活结构带来的威胁越来越警觉。

[2] Clean Air Act

空气洁净法

[3] brownfields

“棕地”，即工业废弃地。“棕地”一词于 20 世纪 90 年代初期开始出现在美国联邦政府的官方用语中，用来指那些存在一定程度污染、已经废弃或因污染而没有得到充分利用的土地及地上建筑物。美国国家环保局(EPA)对棕地有一个比较明确的定义：棕地是指废弃的、闲置的或没有得到充分利用的工业或商业用地及设施，在这类土地的再开发和利用过程中往往因存在着客观上的或意想中的环境污染而比其他开发过程更为复杂。

[4] The breadth and complexity of the environmental problems we face and the scientific, economic and social impediments to their solution emphasize how important it is that environmental scientists and engineers gain an appreciation for the processes and functioning of all environmental compartments — air, soil, water, and energy — and intentionally account for the long-term consequences and sustainability of the actions they propose, whether they be preventative or remedial.

我们所面临的环境问题的广度和复杂程度以及对解决这个问题的科学的、经济的、社会的阻碍，都集中到了这样一个重要性：环境科学家与工程师们获得一个对所有环境因素诸如空气、石油、水、能量的流程和功能的判断，有意阐明所提议的行为的长期结果和可持续发展性，是否它们(环境问题)可以预防和补救。

[5] MTBE

methyl-*tert*-butyl ether: 甲基叔丁基醚(用做汽油添加剂)。

Questions and Discussions

1. What is the scope of environmental science and engineering?
2. Which progress has been made in the field of environmental science and engineering? And how do we benefit from the progress?
3. How do we change the way we think about and deal with our environmental challenges?
4. Which is the biggest problem of drinking water in the place you live?
5. As an environmental science/engineering undergraduate student, what is your opinion on your major?

Reading Material A

What is Environmental Research?

Environmental research is a complex blend of pursuits that have several objectives. To some, the highest form of environmental research is that which seeks only to extend knowledge and is driven by a combination of curiosity and disciplinary traditions. It seeks to describe the structure and function of the natural world, as well as the relationship between this world and humans or human civilization. This is the body of research that provides much of our understanding of biology and earth systems science.

Thoughtful research with similar motivations also informs us of how humans relate to nature and how our beliefs, attitudes, and values affect that relationship. Between these two extremes, there is a beautiful continuum of research in the sciences, social sciences, and humanities that relates to the "environment", broadly defined.

Another form of environmental research focuses on the changes that are taking place in the natural and human environments as a result of human activity, either to understand these changes or to seek solutions. For the past 30 years or so, this type of research has come to dominate the agenda of government agencies that support environmental research. Encouraged by funds appropriated by governments that are motivated by public interest, researchers have turned their research to evaluate damage or potential damage to the "environment" — to humans, other species, or systems that need to be protected. The presumption is that we can measure this damage, which we have come to call impact, and determine its cause. Sometimes this is so, and the cause-and-effect relationship is clear. Increasingly, however, it is becoming extremely difficult to make this judgment accurately because the system is so complex, and we do not have a full understanding of the "system" before the impact.

If the impact is serious enough, that is, the risk is high by some standard, then we make an attempt to mitigate the impact. We have actually become pretty good at this in some cases, but in other cases, our hands are tied because the systems we are forced to deal with are so complicated. As a result, we are often forced to use models of the systems that we are studying. Mice instead of real humans, single fish in a laboratory rather than fish in the wild, smog chamber rather than an urban airshed, or a microcosm rather than a real ecosystem. Seldom do we really have supreme confidence in these models. Verifying them is just too expensive, so we often resort to uncertainty or bounding analysis. This means that the information that we give to the general public does not appear to be clear, cut, especially to those who are not scientists. The current debate over global warming is a good example, but there are many others. Often, this uncertainty throws the decision-making process into the political arena or the courts, and in this environment, the role of science is compromised. Scientists get pulled into the political debate over the interpretation of the data, raising issues of bias and conflict of interest. It is often said that science cannot provide the answers, only inform. Unfortunately, to some, that means, "we don't really believe that science has the answers at all."

Occasionally, we pass a rule to eliminate the cause of the impact, such as taking DDT or tetraethyllead off the market, but more often, we strike some sort of compromise. We just regulate the level of the agent or minimize the action that is causing the problem. The prevailing paradigm has become, how can we minimize risk? Implicit in this is our resignation to the fact that the problem will probably not go away, so we will have to accept and deal with it. In other words, we agree to work within the constraints of our society as it has evolved over the past few centuries, especially since the industrial revolution — a society that was not designed with environmental protection in mind. We do our best.

There is a growing belief that this problem — this poorly designed society — will be replaced by one that is designed with new principles in mind. William McDonnough, Amory Lovins, and others have described these new design principles and are attempting to lead us in applying them. The idea is pretty simple. Rebuild every sector of human society using energy and materials resources that will have as little impact as possible. Don't use toxic or earth system-disrupting substances that will seep into the environment; don't discharge such substances into our waters, air, or soil. Don't disturb the habitat of keystone species. Design all products so that they will be recycled. Don't rely on energy sources or materials that are not using the energy of the sun in real time. Don't just tweak our current system by making it less polluting, redesign it.

If this is the new paradigm of environmental protection, as many claim, what is the role of research in this process? More to come.

(Adapted from: Glaze WH. Environmental Science & Technology, 2001, 35(11): 225A)

New Words and Expressions

blend [blend]	*vt.*	混合
	n.	混合，混合物，合金
pursuit [pə'sjuːt]	*n.*	追赶，追随，从事
disciplinary ['disiplinəri]	*adj.*	学术的，学科的
extreme [iks'triːm]	*n.*	极端，极端的事物
continuum [kən'tinjuəm]	*n.*	连续统一体，连续介质
dominate ['dɔmineit]	*v.*	支配，占优势
agenda [ə'dʒendə]	*n.*	议事日程，记事本，备忘录
evaluate [i'væljueit]	*vt.*	估计，评价，计算
impact ['impækt]	*n.*	影响，效果
mitigate ['mitigeit]	*v.*	减轻，缓和
tie [tai]	*vt.*	约束，束缚
smog [smɔg]	*n.*	烟雾

airshed [εə ʃed]	*n.*	机库，风干棚
microcosm ['maikrəkɔz(ə)m]	*n.*	小宇宙，微观世界
ecosystem [iːkə'sistəm]	*n.*	生态系统
supreme [sjuː'priːm]	*adj.*	最高的，极大的
bound [baund]	*n.*	范围，限度
	v.	跳跃，限制
arena [ə'riːnə]	*n.*	竞技场，舞台
sue [sjuː, suː]	*v.*	控告，提出请求
eliminate [i'limineit]	*vt.*	排除，消除
DDT	*n.*	二氯二苯三氯乙烷，滴滴涕
tetraethyllead [ˌtetrə'eθəlliːd]	*n.*	四基乙铅
agent ['eidʒənt]	*n.*	代理人，试剂，作用力
prevailing [pri'veiliŋ]	*adj.*	占优势的，主要的，流行的
implicit [im'plisit]	*n.*	暗示的，隐含的
resignation [rezig'neiʃən]	*n.*	放弃，屈从
constraint [kən'streint]	*n.*	抑制，约束 [条件]
disrupt [dis'rʌpt]	*vt.*	干扰，毁坏，使…混乱
seep [siːp]	*v.*	渗出，渗漏
tweak [twiːk]	*v.*	拧
paradigm ['pærədaim]	*n.*	范例
habitat ['hæbitæt]	*n.*	(动植物的)产地、栖息地，居留地

Reading Material B

Environmental Engineering: Training for the Next Round

It seems to me that environmental engineering as a discipline has reached something equivalent to its mid-20s. It is past those awkward but somewhat euphoric and booming teenage years. It is past the age of majority and prepatterned education. It has had a few harsh doses of reality that have taken some of the gloss off its "everything is possible" early outlook—something akin to a few rejection letters from the first job or grad school applications, and the realization that some of the people to whom you are pitching your great ideas have already been "there and done that." Essentially it is at a point where it must take charge of (and responsibility for) its subsequent livelihood, having grown out from underneath the assured protection and patronage of its parent, Civil Engineering. On a more personal level, the leaders who changed the discipline from sanitary engineering to environmental engineering are retiring from the forefront and the next generation is taking over. In short, Environmental Engineering is at an age where it can reflect on its upbringing and critically evaluate the path it will need to take to meet its future obligations and challenges.

The transition from Sanitary Engineering to Environmental Engineering was largely a transition from specialization in the design of water and wastewater treatment to specialization in the cleanup and control of environmental insults. This is not to say that many environmental engineers do not still work predominantly on water/wastewater processes, but that an equal or greater number work on environmental cleanup or control of environmental discharges. Further, the present-day water/wastewater engineers are often preoccupied with removal of aqueous contaminants that are the result of historical or continuing poor chemical management practices, rather than the conventional contaminants of sanitary engineering concern, such as BOD, turbidity, and pathogens. Perhaps this transition is most clearly seen in the variety of pollutants and problems with which an environmental engineer now must be knowledgeable. Beyond the problem of removing the conventional, aqueous pollutants, the graduating environmental engineer will deal with a broad range of issues, including toxic air pollutants, greenhouse gases, pharmaceutically active compounds in water, noise pollution, energy conservation, solid and liquid radioactive wastes, toxic compounds in porous media, recalcitrant synthetics, and complex mixtures of landfill leachates — just to name a few of the current areas of concern. This leads to my first suggestion that the training that well prepared the sanitary engineer may not be the training that will well prepare the environmental engineer. At a minimum the environmental engineer must have a working knowledge of a diversity of media, chemistry, and toxicology far beyond that of the sanitary engineer.

From another viewpoint, the next generation of environmental engineer may align themselves more with the traditional sanitary engineer's perspective than with that of the environmental engineers of the last 20 years. Traditional sanitary engineers were as proactive as they were reactive. An excellent example is the forward thinking (aka preventative engineering) taken by Abel Wohlman in the 1920s and 30s when he masterminded a system of protected water supply reservoirs and conduits that still provide the City of Baltimore with a reliable and safe source of drinking water. However, with the advent of the environmental movement of the late 1960s and 70s (and the consequent birth of what I am calling environmental engineering), the perspective became predominantly reactive. It was the charge of the environmental engineer of that time to remediate the residues and consequences of toxic and environmentally destructive discharges — both past and present. For instance, consider the large number of environmental engineers graduated in the last 20 years whose careers have revolved around either the cleanup of contaminated subsurface sites or of combustion gases. It seems to me that the successes from this preoccupation with remediation combined with a realization of its limitations has brought environmental engineering to the point where it must once again balance reactive efforts with an equal dose of proactive efforts. If successful, these proactive efforts will even further decrease the need for reactive responses. This shift is seen in the call for "green engineering." It implies a broadening of thinking to produce an essentially life-cycle assessment of pollutants analogous to what we attempt with natural resources. Therefore, my second suggestion is that the training of the next generation of environmental engineers must focus equally on the tools to prevent as well as clean up pollution. They must understand the workings of the processes (industrial, municipal, and domestic) that produce the pollutants and their precursors as much as those that control remediation of the pollutants once released.

What then should the training of new environmental engineers include? Nearly all undergraduate engineering programs, regardless of discipline, are initiated with a block of courses including mathematics through (at least) ordinary differential equations, one year each of general chemistry and physics, and courses in a computer programming language, statics, dynamics, and some form of continuum (deformable-body) mechanics. The coursework of the various engineering disciplines diverges off of this common base. Traditionally, the environmental engineering undergraduate has followed the civil engineering path. However, in recent years two alternative routes have emerged. One is a dedicated undergraduate track in which the student graduates with a degree in environmental engineering (rather than, say, a civil engineering degree with an environmental emphasis). Another variation is inclusion of environmental engineering within a chemical engineering department. This path yields a chemical engineering undergraduate degree with an environmental emphasis. The civil engineering and chemical engineering routes support the concept that the entry-level degree for Environmental Engineering is the Masters degree, whereas the Environmental Engineering BSc degree breaks that traditional model. Discussion as to whether or not environmental engineering should be its own undergraduate discipline is beyond the scope of my present thesis. To me that question is more a matter of academic economics than the presence or lack of inherent capabilities within the civil or chemical engineering disciplines. That is to say, is the manpower demand from the environmental engineering market sufficient to warrant dedicating educational resources to another, separate degree program? However, I do want to consider what training best prepares an environmental engineer in the two areas I have suggested above as now being integral to our field: a working knowledge of a broad diversity of media and chemistry and a balanced capability between proactive and reactive responses.

Chemistry training beyond the freshman, introductory level is critical to the environmental engineer. It is not only necessary to understand the nature and behavior of the pollutants with which we deal, but equally to grasp the kinetics and limiting conditions of chemical transformations in the environment. It is as important to understand the chemical dynamics of the environmental system as those of the pollutant discharged into it. Likewise, it is as important to understand the limitations and options of the industrial process as those of the pollutant that is generated by it. I would suggest, at a minimum, exposure to courses in basic organic chemistry, chemical kinetics, and chemical thermodynamics as prerequisites to an environmental engineering degree. I would add to this a need for basic courses in mass transport, reactor engineering, and perhaps (looking ahead) biochemistry. In addition, preventative environmental engineering implies an understanding of the processes by which a pollutant is produced and how those processes may be economically modified or replaced to curtail the target's production. Typically the fundamentals of this latter understanding are taught in chemical process design and economics courses. Add these requirements to the curriculum common to all engineering and the necessary training looks much like the course requirements for a chemical engineering undergraduate major. However, that is not the whole picture; an environmental engineer must also have a firm foundation in the physical processes that dictate the nature of the interwoven systems that constitute the natural and man-made environment. For instance, an understanding of physical geology, hydrology, fluid mechanics, the properties of materials, and perhaps meteorology are needed. These subjects look very much like the basic stuff found in a civil engineer's core curriculum. Finally, practicing engineers will spend much of their time in verbal and written communication, so training in public speaking and technical writing is a necessity.

Altogether, I would argue that neither chemical nor civil engineering undergraduate curriculums provide all of the foundation courses needed by environmental engineers. A civil engineering undergraduate will find him or herself