Introduction

Although humans or the human society have always reacted early and in a very sensitive manner towards environmental pollution, counteractions by industrial enterprises or by governmental policy were slow and time-consuming and seemed to be influenced by economic considerations of the respective company or the policy of the country. Except for single production accidents with a spatially restricted and exceptionally high level of pollution, permanent environmental pollution was usually caused by gaseous, liquid, or solid production residues of many industries which had to be treated by so-called end-of-pipe technologies. Treatment of these wastes primarily was costly and reduced the profit. As a consequence of the strict (legal) requirements to reduce or even totally avoid certain wastes in developed countries and because of cheap labor elsewhere, many companies moved production into less developed countries with less stringent environmental regulations. Alternatively, they had to develop new, environmentally sound production processes. Nevertheless, in industrialized countries a high standard for the treatment of liquid and solid domestic and industrial wastes and of accidental spillage soil has been achieved within the last centuries. In contrast, in most developing countries the range of environmental protection activities reached from no treatment of residues at all over low-tech partial treatment to truly high-tech waste or wastewater treatment processes.

This was the situation when planning Volumes 11 a–c of the Second Edition of *Biotechnology*. The Editors had to cope with a wealth of highly advanced knowledge and a much broader field of environmental biotechnology compared to the First Edition. Numerous new processes or procedures, sometimes leading to unexpected drawbacks of the original expectations, are meanwhile widely encountered. The three volumes on environmental biotechnology cover the present technological status and the microbiological basis of industrial and domestic wastewater treatment (Volume 11a), of soil (bio-)remediation processes (Volume 11b), and of solid waste handling, off-gas purification techniques, and drinking water preparation (Volume 11c).

Wastewater led to visible damage of lakes, rivers, and the sea and for this reason, the development of treatment systems already began early in the 19th century. The comparably small amounts of mainly bioorganic solid wastes were used together with cattle dung as a fertilizer in agricultural areas or they were
dumped within restricted landfill sites at the borders of big cities. Hence, they were almost “invisible” for most of the population harming only the direct neighbors of dump sites. Air pollution by sanitary landfill gas or groundwater contamination by leachates was either not known, not expected, or not thought to be really relevant at that time. Later, air pollution from the fast development of industrial production processes was well recognized, but for a long time was thought to be not really relevant because of the immense dilution capacity of the atmosphere. Similarly, the drinking water supply from unpolluted mountain regions or from high-quality groundwater seemed to be unlimited.

At the time of prosperous industrial development and increased consumption after World War II in Europe the per capita amount of solid waste increased drastically to more than 250 kg per year. This was in particular due to the increase of package wastes. Sanitary landfills grew to huge mountains, causing atmospheric and groundwater pollution and, as a consequence, they endangered the groundwater reservoir in general and especially in the vicinity of settlement areas. Therefore, solid waste treatment – apart from just deposition in one way or another – was obligated required, either by incineration or mechanical/biological treatment to “inertize” the material. However, both treatment modes are relatively young technologies and due to the inhomogeneities of the material the treatment steps must be arranged in a rather sophisticated manner in order to maintain the daily throughput. Many different ways of solid waste handling are meanwhile practised by city authorities or industry.

This book gives a general overview over the presently applied solid waste treatment procedures, off-gas purification processes, and techniques of drinking water preparation. Except for the development of solid waste inertization procedures, soil remediation arose as a new problem of not just local significance during the last 30 years, due to the infiltration of harmful pollutants into soil and groundwater and the dilution and distribution of pollutants with the groundwater. For centuries, non-clean industrial production processes made whole industries intolerable or even abundant. Industrial sites highly contaminated with oil, chemicals, or inorganic material had to be decontaminated for the use of other industries or settlement areas or to prevent long-term groundwater contamination. The methods suitable to cope with contaminated soil or groundwater are summarized in Volume 11b.

Since experience with environmental protection or remediation techniques in the field meanwhile are numerous, an adequate overview covering all important facts or at least the general tendencies required a division into related fields. Volume 11c is one of three volumes on environmental biotechnology and should, therefore, mainly cover biotechnological processes of solid waste, off-gas, and drinking water treatment, but most practically applied procedures are combinations of biological and/or chemical and physical reactions embedded in a technologically engineered process. The treatment procedures for, e.g., solid waste inertization or off-gas purification sometimes are chemical or physico-chemical processes without a biological component. For this reason, we felt that we at least should mention, e.g., the principles of classical waste or sludge incineration and of newly developed systems, since these are the processes by which most of the total solid waste mass is presently conditioned or inertized before final disposal of the slags. Some of these processes might become the methods of choice in the near future. Whether one or the other process is favored is more or less an individual decision of the responsible authority and must be discussed in connection with the available infrastructure, including waste collection and waste separation. There may be situations when even the biowaste fraction is better incinerated than composted and other situations, where the non-recyclable waste fraction should be treated mechanically and biologically before disposal instead of incineration.

In rich European countries waste inertization by incineration may be the most intriguing process, since it leads to the highest reduction of volume and mass. Deposition of the slags is supposed to cause less aftercare than deposition of otherwise stabilized wastes. To be competitive on the world market, however, especially in developing countries it is necessary not only to provide solutions of the most
sophisticated technological standard, but also to provide or supply less costly solutions with a high, but maybe not the highest standard of environmental protection. It would, e.g., not be realistic to expect a slaughterhouse in a megacity of a developing country to operate a waste and wastewater treatment system which requires more investment and operating costs than the slaughterhouse itself. Thus, it is important for developed countries to improve the techniques for application in their own country, but also to supply experience with less advanced technologies. Taking out 80% of the pollutants from wastewater or wastes countrywide is a better option for the environment in developing countries than taking out 100% in a few places at the same total costs. The decision must, however, be made for each individual case.

The editors of this volume hope to provide the reader with an overview of the present state of solid waste treatment, off-gas purification techniques, and the principles of drinking water preparation. For more detailed insight into single processes the reader is referred to special references given in the respective chapters. Together with Volume 11a on wastewater purification systems and Volume 11b on soil remediation this volume rounds out the actual status of environmental biotechnology in different fields and presents the state of the art and of future trends.

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