

Waste Gas Treatment for Resource Recovery

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Waste Gas Treatment for Resource Recovery

Edited by **Piet N.L. Lens, Christian Kennes,
Pierre Le Cloirec and Marc A. Deshusses**



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Top, right: Bioreactor treating CS₂ containing waste gas of a cellulose casing production plant (courtesy of Bart Kraakman, Bioway, The Netherlands).

Top, left: CH₄ gas molecule entrapped in the cavity formed by water molecules in a hydrate structure (courtesy of Prof. Kuhs, University of Göttingen, Germany).

Bottom: Fungal biofilm (*Ophiostoma* sp.) treating α -pinene polluted air in a packed bed bioreactor (courtesy of Christian Kennes, University of La Coruña, Spain).

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Preface

Environmental contamination of air, water and soil by (eco)toxic pollutants is a serious threat to the quality of our primary resources for life. Of particular concern is the pollution of air with organic and inorganic volatile pollutants or particulate matter. This is a major contribution to climate change, acid rain, smog formation in industrialized cities, and the appearance of new diseases, among others. There is now overwhelming evidence that human health directly depends on the quality of the air we breath and the general state of our environment. Consequently, a better balance is needed between disease-centred (therapy) and environment-centred (prevention) measures. We can never approach sustainable development, a goal constantly reiterated by almost all governments, if we do not find efficient ways and means of either preventing pollutants entering the environment or eliminating them from contaminated ecosystems.

In recent years, energy and feedstock materials for the chemical industry are in increasing demand. With constraints related to availability and use of oil, the energy and chemical industry is undergoing considerable changes. The need for the use of cheaper and widely available feedstocks, and the development of sustainable and environmentally friendly chemical processes is rapidly growing under both economical and public pressure. Therefore, waste gas treatment has gradually been integrated into process design. Instead of discharging their waste gases into the atmosphere, industries increasingly attempt to become self-sufficient and recover compounds from their own wastestreams or use (upgraded) wastestreams of neighbouring industries as raw material. Sustainable gas treatment concepts are under development, and can lead to the recovery of useful by-products like energy in the form of biogas, hydrogen or electricity, and chemicals in the form of fertilizers (ammonia, phosphates) or raw materials (elemental sulfur, sulfuric acid, etc.), for example. Obviously, adding value to waste gas by upgrading the recovered compounds will only be a reality if it is demonstrated that there is a fundamental basis and a tangible advantage in using these recovered compounds rather than buying raw materials and feedstock.

To understand the treatment alternatives available to control and solve air pollution problems, and to decide on the abatement strategy to be adopted, several aspects need to be considered. This book volume covers these aspects, including socio-economic considerations, legal incentives in European and other recent directives concerning air

pollution, characterization of waste gases, as well as technical solutions available to treat contaminated air and to recover valuable compounds from these polluted waste gases.

Promising new uses of different physical, chemical and biological technologies, or a combination of them, are suitable for resource recovery from waste gases. In many cases, it was shown that bioprocesses are able to permanently eliminate pollutants inexpensively as well as to convert them into a recoverable form. Intriguing properties of bacteria, fungi and protozoa have been described, which enable expansion of biofilters and bioscrubbers into sectors still rather unfamiliar with environmental biotechnology, as the chemical industry. Probably the best example for this is the striking commercial success of air and off-gas treatment in bioreactors, a field in which many companies have established as the technology has proven to be cheap and reliable. Significant developments have recently also been made in non-biological processes based, among others, on catalytic activities and mass transfer processes. All these advances in the development of new sustainable routes for product recovery from gases will be strongly promoted by increasing integration of efforts and expertise. This book covers many of these different aspects and includes case studies that demonstrate the technical and economic feasibility.

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