14 Odor Removal in Industrial Facilities

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14.1 Introduction

Air pollution, once the concern of only large urban settlements, is rapidly spreading worldwide and becoming one of the major challenges of modern civilization. Greenhouse gases, harmful and hazardous inorganic and volatile organic compounds (VOCs), nauseous odors – these are just some of the problems to be solved to ensure a healthy and comfortable environment for future generations. The principal sources of modern air pollution are vehicles, industrial sites, and municipal facilities dealing with water treatment, collection and disposal of waste, etc. (Table 14.1). There are several approaches to the problem. The preferred solution is, of course, the development of new “green” technologies that impose less burden on the environment, and the use of new, cleaner energy sources, including non-conventional ones. Nevertheless, efficient abatement technologies, i.e., end-of-pipe solutions, will in the near future remain an essential tool for reducing air pollution.

Whatever future advances we make in industrial production, one element of modern civilization will continue to aggravate air pollution. Mankind generates more and more waste, and its collection, disposal and recycling is a substantial factor in the sustainable development of our economies. All these activities generate various odors and smells that are detrimental to the environment and quality of life. These problems will persist indefinitely, and the only foreseeable remedy is the development of efficient and economical ways to treat these sources of air pollution.

Biological methods of air purification are indispensable when large and diluted volumes of VOCs and/or odor-laden air are to be treated (Cox and Deshusses 1998; Devinny et al. 1999; Cox and Deshusses 2000; Shareefdeen et al. 2003). Their main advantages over traditional methods (incineration, activated carbon adsorption, etc.) are well known and mainly reside in low operational costs. Moreover, they do not generate secondary waste streams and/or pollutants, and are readily accepted by regulating authorities and the general public. Biofiltration has been successfully used to neutralize odors of different origin (agricultural, municipal, industrial) containing sulfur and nitrogen compounds, and to remove an impressive number of various volatile
Table 14.1. Main sources of urban air pollution (major sources of pollutants are marked in italics)

<table>
<thead>
<tr>
<th>Source</th>
<th>Pollutants</th>
<th>Remedies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicles and public transport</td>
<td>CO, NOx, SOx, benz(a)pyrene, etc.</td>
<td>Alternative energy sources, “clean fuel”, environmentally friendly engines, catalytic neutralizers</td>
</tr>
<tr>
<td>Industrial facilities</td>
<td>NOx, SOx, VOCs, odors</td>
<td>New technologies, re-profiling, closing or moving to a new location, end-of-pipe solutions</td>
</tr>
<tr>
<td>Municipal facilities (collection and disposal of waste, water treatment, etc.)</td>
<td>VOCs, odors solutions</td>
<td>New technologies, end-of-pipe solutions</td>
</tr>
</tbody>
</table>

chemicals. These include solvents and diluents (BTEX, aliphatic hydrocarbons, esters, alcohols, chlorinated compounds, etc.), and components used in the industrial production of polymers, plastics and dyes (styrene, vinyl chloride, epichlorohydrine, formaldehyde, phthalates, cyclohexanone, etc.), including recalcitrant and poorly biodegradable ones (Devinny et al. 1999).

The difference between VOC and odor abatement is tenuous. It depends on individual circumstances and national legislation, and can be considered purely semantic. However, it is worth outlining some of the differences between the two principal biofiltration applications (Table 14.2).

### 14.2 Substrate Composition and Concentration

Standard VOC abatement application is usually confined to the removal from an airstream of a limited number of pollutants, often of close chemical structure and physicochemical properties. A common example is BTEX, aromatic poorly soluble compounds, while combinations of water-soluble alcohols and/or carbonyl compounds, usually not more than three to five substances altogether, are characteristic of flexographic printing applications (Popov et al. 2004). It is not uncommon that only one VOC has to be removed to comply with existing regulations. Thus, the use of specific monocultures adapted to the highly efficient destruction of a limited number of substrates is justified for VOC treatment, and may lead to advantageous results (Popov et al. 2000).

At the other extreme, even conventional malodorous airstreams may contain dozens of compounds that are highly diverse in structure and properties, which have a bearing on their elimination by microorganisms. As an example, Table 14.3 presents a composition of an air vent from a pet-food producing factory. More than 20 different chemicals were detected by