Odour Pollution of Air

Causes and Control

W. SUMMER

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Preface

In all industrialized countries, the problems of the polluted environment have become acute. Legislation now provides, in most of them, a legal basis for complaints and the rectification of nuisances, for compensation for losses and for offence caused. With a new awareness, the citizen has begun to react against soot and smoke and noise and smell, all things that have been until quite recently accepted as a more or less inevitable background of town life. The subject has become a major concern of governments, administrators, chemists, engineers and town planners. It concerns all the construction industries; it has for generations been a matter for lawyers; and in Europe certain states have even been guilty of poisoning each others' air and water.

Pollution by smell, the subject of this book, is admittedly the least directly harmful to health of all the environmental nuisances. But it can seriously affect mental attitudes and destroy the peaceful enjoyment of our homes and neighbourhoods, while it is often the sign of a wasteful process. At all events, a process of the kind society will no longer tolerate.

An intriguing aspect of this study is its partly subjective character. For while we have instruments that will measure with accuracy the density of smoke, the size of grit particles, the intensity of noise or the composition of engine exhausts, only the human nose can 'measure', or even say what we mean by, smell. There is no instrument available to make man-related measurements of odour, no possibility of expressing the quality of an aroma in such terms that everybody would recognise it forthwith. Its quantity may be approximately described in terms of chemical concentration, but even this must not be regarded as having any bearing on its perception.

The amelioration of the present conditions is an urgent necessity. Signs are not wanting that improvements in production, and of concept, are arriving.

This book aims at supplying both theoretical and practical background for coping with all the main problems of smell, its production, sensation, and abatement.

It is not possible without intolerable repetition to discuss in a book of this kind technical details of every process or branch of industry which is producing, or plagued by, offensive odours. It has been found expedient first to discuss general principles, then, in the practical sections of the book, some typical applications of each principle. The engineer will be able to select the correct method, or technique, in accordance with the characteristics of each case.

W. SUMMER
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Conversion factors

To convert	*into*	*multiply by*
British thermal unit	gram-calorie	251·996
Centimetre	inch	0·393
	foot	0·033
cm/sec	ft/sec	0·033
cmHg	inch H_2O	5·352
	lb/sq. inch	0·193
	kg/m^2	135·951
Cubic cm	cubic inch	0·061
	litre	0·001
Cubic ft	m^3	0·028
	litre	28·316
Cubic inch	cm^3	16·387
	litre	0·016
Cubic metre	cubic inch	61 023·375
	cubic foot	35·314
Ft/min	m/sec	0·005
	km/h	0·018
Ft^3/min	m^3/h	1·701
Inch Hg	atm	0·033
	kg/m^2	345·316
Inch H_2O	cmHg	0·187
	kg/m^2	25·400
Miles/hour	m/sec	0·447
kcal	kJ	4·184

Introduction

Air pollution is not a feature of the industrial age, although it is often linked with the beginning of the 'industrial revolution', i.e. the second half of the 18th century. The emission of soot and smoke from domestic chimneys was a nuisance to Londoners even in medieval times. Richard III (1377–99) taxed heavily the use of coal, and Henry V (1413–22) instituted a stringent control over its movement into London. Two centuries later, in 1661, John Evelyn addressed a dissertation called *Fumifugium: Or the Inconvenience of the Aer and Smoake of London* to Charles II. In this pamphlet, Evelyn suggested some remedies, which however did not reduce the nuisance (1). A person called Justel presented before the Philosophical Society 'An Account of an Engine that Consumes Smoke', 1686, but his invention was quite unsuccessful.

The buoyancy of particulate matter, whether solid or liquid, floating in air, is affected by many factors, not the least important of which is wind. The smallest particles may remain suspended in the atmosphere for very long periods of time and thus increase the density of pollution more in the higher strata of the atmosphere than in the lower. This may, in time, have serious climatic consequences, because the particles reflect some of the incident solar energy. Again, thermal equilibrium on our planet is maintained by the atmospheric carbon dioxide which is opaque to a certain range of wavelengths in the infra-red, but transmits luminous solar radiation. As its amount is slowly increasing, it would be a justifiable conclusion that the temperature of the lower atmospheric strata is in consequence slowly going up.

Yet recent temperature measurements indicate the contrary: world-wide cooling, not heating, is taking place. From investigations by workers at the National Centre for Air Pollution Control, Cincinnati (2), a very sorry picture develops; since the turn of this century the air over a populated place like Washington has been 'enriched' by about 28×10^6

aerosol particles per cm^2 of ground, assessed for the height of the atmosphere. Even in Davos, the Mecca for sufferers from pulmonary tuberculosis, the annual growth rate of aerosols is more than 10^7 per annum per cm^2. It is this 'dusty' atmosphere which causes the net cooling down of our environment.

Human activities produce, and release into the air, combustion products which largely increase the numbers of artificial condensation or 'Aitken' nuclei. These are generated naturally by the action of suitable radiation, e.g. light, on volatile matter released by vegetation. They are macromolecules which disappear again by agglomeration and precipitation; and the volatile matter consists, in the main, of terpenes (3).

We are not here concerned with the nuisance of air 'pollution' by noise. Ignoring such extremes as supersonic bangs from aircraft, noises of ordinary human occupation have greatly multiplied over the last fifty years.

The third great atmospheric offender is smell. In most cases it is a question of an obnoxious smell, one which causes discomfort and distress, but sometimes it is an odour which, under different conditions, might be considered pleasing.

Of these three scourges of civilization, solid and liquid particulate air pollution (aerosols and mists), and the pollution of air by noise, have been given legal formulations in Britain (*Clean Air Act*, in force since 5th July, 1958; and *Noise Abatement Act*, in force since 27th November, 1960) (4, 5). These are based on technically defined standards of pollution by smoke (Ringelmann Chart) (6) and by noise (sound level meter) (7). The definitions have been accepted by Parliament and have been included in the respective legislation.

There are no units or systems by which to express the pollution of air with osmogenic matter: the experts have failed to suggest, so far, an acceptable unit and method of measurement, or to construct an instrument for objectively measuring smells. Chemical trace-detection methods, such as chromatographic analysis, cannot replace organoleptic tests. The latter, however, are by no means objective, repeatable or reliable: they depend on numerous imponderabilia of human behaviour. The only time the law can interfere in the highly complex matter of human chemical production *v.* human comfort is by invoking the old definition of 'nuisance', and leaving it to the judge to decide whether or not such has been committed.

There are many other aspects of osmogenic air pollution which are, or will be, of importance to the individual and to society. As the population increases, the need for synthetic products will grow, at least in the same proportion, but probably faster. The national income per head is on the

increase, and so is the variety of individual demand, which industry is eager to satisfy.

Much contemporary town planning shows vision and understanding. Regions for light, mixed and heavy industry are set apart, and the work-people are housed close to their places of work. Yet the attempt to please everybody, the economist and the builder, the nature conservationist and the architect, does not always result in satisfaction in relation to the problems we are considering.

Industry—under the guidance of well-defined laws and at great expense—keeps the air free from smoke and soot, controls vibration and noise, and treats its harmful effluents. In the United States of America this will cost some $275 000 000 000 between now and the year 2000. Of this enormous sum, two-fifths will be used in an attempt to halt, and reverse, water pollution; a similar amount will go in attempts to stop, and limit, air pollution; and the last fifth will serve the disposal of solid waste (8).

Yet, no provisions are made by manufacturers, or required by law, to *prevent* smells either from occurring or, if inevitable, from spreading to other areas. Local Authorities, having the power to penalize others, are yet often the worst offenders themselves with their sewage treatment works. Neither planners nor Authorities take into consideration the simple truth that 'wind knoweth no boundaries'. If and when a sufferer is successful in his claim for a reduction of his rates, £5 is the usual maximum concession. In each case the Local Authority agrees—without ever saying so—that the complainant has proved his case, that there is an offensive smell, that it is where it should not be, and that the Local Authority cannot, or will not, do anything about it.

It is not only the sewage works which give offence. Waste processors, garages burning old rubber tyres, chicken breeders trying to get rid of the bird manure either by burning it, or drying it in a kiln, sausage skin manufacturers, and the chemical and biochemical industry, all are potential, and very often actual, producers of obnoxious smells.

Against such pollution, at best, the condition will be written into an agreement or permit or licence that the trade must be carried on in a place so many miles away from town, and that it must not give offence to residents. Such a clause is inserted only in cases of officially confirmed and recognized offensive trades as specified in *Statutory Instrument* 1950, No. 1131 (9). Classes (iv) and (viii) are of special interest, the former comprising such trades as bone boilers, breeders of maggots from putrescible animal matter, chitterling boilers, fat melters, fellmongers, fish oil manufacturers, glue makers, and many more. Class (viii) is named in this *Statutory Instrument* the Special Industrial Group D

amongst which are listed the petrochemical industry, the plastics, paint, and lacquer industry, the reclamation of rubber, and others. Group D is a summary of those industries which emit obnoxious smells and must be housed on estates well removed from residential, or even light industrial, areas. How, and how far removed, is left to the discretion and wisdom of the planners. The *Statutory Instrument* 1950, No. 1131 presents merely a classification of industrial occupations from the point of planning for human comfort, but offers neither advice nor refers to a Code of Practice as a guide to the abolition of smell nuisance caused, or likely to be caused, by these industries.

Administration requires only Classification. Town planners and engineers, however, want to know more about smells before they can offer designs of factories and industrial estates which, theoretically in Group D, no longer emit offensive odours.

To the ventilating engineer whose task it is to deal with a given odour problem, aesthetic aspects and differences of opinion carry no weight. To him, the problem usually resolves into two steps: first, to decide upon the method of odour control most appropriate to the case in point and, second, to overcome the financial argument that capital spent on "waste" is wasted. There are two fundamental approaches to odour control: (i) to avoid the production of smell, which may be possible, or partly possible, by altering that stage of the manufacturing process which causes the smell; and, should that not be feasible, (ii) to reduce the chances of the general air becoming polluted with air from the production areas, and to treat the latter by appropriate means before discharging it to open atmosphere.

It is regrettable practice to call in the ventilating engineer after the plans of a new factory have been completed. Considerable savings can be achieved if ventilation is introduced at the stage where the manufacturing processes are decided, flow sheets constructed, and machinery is sited. Production sections can be so laid out that the separation of foul from unpolluted air is achieved with a minimum of effort and cost; that processing plant giving off obnoxious odours is completely enclosed and connected to the ducted system carrying the foul air; and that odour control points are arranged in accordance with the requirements of the method used.

To expect to eliminate smells purely by redesigning manufacturing processes is a fruitless idea for reasons of economics except where, as in one or two cases, the odoriferous by-product is of reasonable commercial value. A sounder approach is to plan a new town, or new industrial estate, on the principle of the odourless factory, i.e. a factory in which

generation, distribution and destruction of smells are as exactly controlled as are the manufacturing processes. Town and Country Planning will only be really successful when air pollution can be effectively controlled. Control means, in the case of particulate matter, prevention; in the case of noise, insulation; and in the case of smell, destruction. Feasibility has been demonstrated in all three groups. If planned from the beginning as an essential item of design, freedom from air pollution, especially by smells, is not an uneconomic factor, not a burden on production, nor a waste of capital.

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