

#2404

# RESEARCH REPORT

## INDOOR AIR POLLUTION

*P R Warren* investigates indoor air quality and the various pollutants commonly found in buildings

One of the objectives of the building services engineer, dealt with in some depth in *Parts A1* and *B2* of the *CIBSE Guide*, is to ensure a safe, healthy and comfortable environment for the occupants of buildings. A major factor in achieving this is the control of indoor air pollution.

Indoor airborne pollutants may arise from a number of sources including building materials, furnishings, activities within the buildings and the occupants themselves, as well as being present in outside air used for ventilation. They may be in the form of gases, vapour or particulates; the table illustrates the range.

Part of the current research programme is to carry out a comprehensive review of possible pollutants and to identify appropriate methods of control. This involves:

- Identifying the pollutants of importance and their sources;
- Specifying limiting concentrations (based upon effects on occupants or building fabric);
- Identifying typical concentrations found in practice and the factors such as source characteristics which influence these;
- Reviewing means of control.

This work is being assisted by participation in an International Energy Agency Working Group dealing with ventilation requirements which allows information to be pooled internationally.

Means of control may be divided between air control and source control. In the latter the emission of a pollutant is controlled either by removal of the source altogether (eg asbestos), sealing or quality control during design or production (eg carbon monoxide emission from heating and cooking appliances).

Once the pollutant is in the air it may be removed close to the source (eg local extract ventilation; flues) or by dilution with uncontaminated air drawn from outside or filtered by a conditioning system. Recent and current BRE research is concerned with both approaches.

Formaldehyde vapour is a common pollutant of the indoor air, deriving from many sources, including the combustion of natural gas, tobacco smoking, and materials such as chipboard which contain urea-formaldehyde as an adhesive. In the latter case British Standard *BS 5669:1970* sets limits to the total extractable formaldehyde present after manufacture and

hence provides a degree of source control. Usually concentrations are well below those which are likely to give rise to discomfort or health effects, but occasionally higher levels have occurred, in particular, shortly after the installation of urea-formaldehyde foamed insulation either in situations not recommended in the appropriate British Standard (*BS 5618:1978*), or where the inner leaf failed to provide an adequate barrier to the movement of formaldehyde vapour. BRE has developed appropriate techniques for measuring low concentrations of formaldehyde and has led a continuing programme of field measurements from which advice in dealing with affected buildings has been derived<sup>1</sup>. Techniques are currently being developed which will enable low concentrations of other organic pollutants in the indoor air to be

determined.

Radon is a colourless, odourless gas which occurs naturally as a radioactive decay product of radium. Exposure to the decay products of radon increases the risk of lung cancer, although this increase is only significant at unusually high doses. It has become clear that levels which could give rise to concern can occasionally be found in buildings, particularly dwellings<sup>2</sup>, and BRE has worked closely with the National Radiological Protection Board for a number of years, initially to identify levels in UK dwellings and to measure emission rates for typical building materials<sup>3</sup>. More recently it has examined remedial measures, such as sub-floor ventilation and enhanced sealing of the floor slab, for use in the relatively few dwellings where high levels are found. A *BRE Information Paper* on

radon in buildings is currently being prepared.

As criteria for setting ventilation requirements, radon and formaldehyde are not suitable because they affect relatively few buildings. Such criteria are best based upon pollutants which are found more widely and for which no other form of control is appropriate, such as body odour, tobacco smoke, water vapour or combustion products. *BRE Digest 206*<sup>4</sup> sets out an approach to this and our current work will allow this to be updated and will provide a basis for revisions of codes and standards. In housing the ventilation required to control water vapour, and hence condensation and mould growth will, generally, control other pollutants.

One aspect of indoor air quality which is of increasing concern is the dissatisfaction expressed by the occupants of recently built office or institutional buildings, often airconditioned. The symptoms complained of by the occupants have come to be referred to as the "sick building syndrome". Although in a few cases specific causes or pollutants have been identified, in most cases there is no single obvious cause. The nature of the problem requires a multi-disciplinary approach and this was illustrated by the recent investigation at the Public Record Office, Kew, in which, under the direction of the consultant, BRE worked with experts from the fields of medicine, occupational psychology and chemical analysis. The work at the PRO included studies of ventilation efficiency which is important where ventilation is the means of pollution control. It is usual to specify the required flow rate on the assumption that the diluting air and the pollutant will be well mixed within the space. If this is not the case, then higher than expected pollutant concentrations may occur in some parts of the space.

#### References

1. Cockram A H and Arnold P J. Urea-formaldehyde foam cavity wall insulation: reducing formaldehyde vapour in dwellings. *BRE Information Paper IP 7/84*.
2. O'Riordan M C, James A C, Rae S and Wrixon A D. Human exposure to radon decay products inside dwellings in the United Kingdom. National Radiological Protection Board Report NRPB-R152, February 1983.
3. Cliff K D, Miles J H C and Brown K. The incidence and origin of radon and its decay products in buildings. National Radiological Protection Board Report NRPB-R159, February 1984.
4. Building Research Establishment Digest 206 - Ventilation Requirements.

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BRE apparatus for measuring formaldehyde levels in houses.

#### Examples of indoor air pollutants

Gases and vapours  
Water vapour  
Carbon dioxide  
Carbon monoxide  
Nitrogen oxides  
Formaldehyde  
Radon  
Organic vapours

Particulates  
Fibres  
Dusts  
Aerosols  
Spores  
Bacteria  
Viruses  
Dust mite faeces