MINIMUM VENTILATION RATES AS A BASIC REQUIREMENT FOR ENERGY CONSERVATION - RESULTS FROM AN INTERNATIONAL CO-OPERATION

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Abstract

To propose guidelines for minimum ventilation rates which are sufficiently large to meet the demand for fresh air without unnecessarily wasting energy in Annex IX "Minimum Ventilation Rates" within the IEA Program "Energy Conservation in Buildings and Community Systems" nine countries are co-operating. The participants have in a first step summarized existing knowledge, national standards and current and required research. The work that was required covers a wide range of disciplines, from hygiene and medicine on one hand to engineering and building science on the other. The Annex IX provides a highly suitable mechanism for coordinating the research in these diverse fields and for encouraging the necessary contributions from participating countries. The indoor pollutants being of most importance have been identified.

The Problem: Energy Conservation by Minimizing Air Infiltration and Ventilation

Air infiltration and ventilation contribute 20 to 50 percent to the energy consumed for heating or cooling purposes in public and residential buildings. An increase in the standards and regulations for the improvement of the buildings' thermal insulation will tend to raise this percentage since heat losses by transmission will be lowered. Besides improving the quality of insulation, conservation of energy must also be focussed at omptimizing infiltration and ventilation phenomena.

From a viewpoint of energy conservation air infiltration and ventilation have to be minimized. A certain amount of fresh outside air, however, has to be supplied to a building in order to maintain healthy and comfortable conditions for the inhabitants and to avoid structural damages. The optimization of these adverse requirements will result in guidelines for minimum ventilation rates which are just large enough to meet the indispensable fresh air demand but small enough to avoid useless waste of energy.

The International Energy Agency (IEA): An Effective International Co-operation in the Field of Energy Conservation

In order to strengthen cooperation in the vital area of energy policy (including energy conservation), an agreement on an International Energy Program was formulated among a number of industrialized countries in November 1974.

The International Energy Agency (IEA) was established as an autonomous body within the Organization for Economic Cooperation and Development (OECD) to administer that agreement. Twentyone countries are currently members of the IEA, with the Commission of the European Communities participating under a special arrangement.

As one element of the International Energy Program, the participants undertake cooperative activities in energy research, development, and demonstration. A number of new and improved energy technologies which have the potential of making significant contributions to our energy needs were identified for collaborative efforts. The IEA Committee on Energy Research and Development (CRD), coordinates the energy research, development, and demonstration program.

The International Energy Agency sponsors research and development in a number of areas related to energy. In one of these areas, energy conservation in buildings, the IEA is sponsoring various exercises to understand much better and to predict more accurately the energy balance in buildings and the influences on this balance. Of the influencing factors convenction and, in particular, infiltration, is least understood and most affected by the individual behaviour of the inhabitants.

Thus within the IEA in the year 1980 the work under Annex IX "Minimum Ventilation Rates" had been started with the obejectives:

- To quantify more closely the factors which determine the concentrations of indoor air pollutants and to determine the inter relationships between these factors;
- To establish minimum ventilation rates and all other suitable methods for ensuring that these pollutants are kept to acceptable levels;
- To summarize the information that is available about various techniques and their merits for controlling air quality and conserving energy;
- To catalogue and assess measurement and sampling techniques that may be useful in solving the problems connected with maintaining acceptable air quality in buildings.

Present within the Annex IX nine countries are co-operating: Canada, Denmark, Germany, Italy, The Netherlands, Sweden, Switzerland, UK and USA. The international co-operation will possibly be extended because further countries, e.g. Norway and the EC, have shown interest to participate in the joint program.

First Conclusions drawn from the Program

To meet these above mentioned objectives the co-ordinated effort of the participating countries involved the following activities:

- To review relevant literature and existing and proposed standards, to summarize relevant ongoing research on national scale
- To review some special topics in detail, to identify and to outline research fields necessary to resolve open questions.

A summary of the Annex IX work had been given in the Air Infiltration Review (1). A detailed report will be published in spring 1984 (2).

A summary of the first results shows, that if the generation rate of CARBON DIOXIDE is known, the quantity of outdoor air required to maintain carbon dioxide concentration below an acceptable level can be calculated. In some standards a minimum supply of outdoor air is specified based on a maximum acceptable concentration of carbon dioxide for physiological requirements. Other standards specify higher minimum outdoor air requirements to control odour and other air contaminants.

The annoyance caused by TOBACCO SMOKE corresponding to carbon monoxide concentrations of 1 to 2 ppm is an acceptable level for healthy persons. Air ventilation rates should be adjusted accordingly so that this level is not exceeded in smoking rooms.

FORMALDEHYDE is a chemical substance widely used as a component of materials in buildings and households. It has become necessary to agree upon regulations concerning safe levels for formaldehyde concentrations in homes. Some European countries have suggested the maximum tolerable level to be 0,1 ppm as an indoor standard. In this connection it is indispensable to formulate regulations regarding the tolerable amount and/or emission rate of formaldehyde containing products.

In order to put the problem of BIOCIDES in perspective the future trend of biocide application in households had to be known. Due to the lack of statistics no extrapolations are available. It could be presumed that the Chemical Industry even in the future will continue to expand with new products and up to now there are few - if any - administrative regulations for these markets. In a pessimistical version an increasing trend of indoor biocide application can be assumed and this will certainly limit the further reduction of ventilation rates.

During recent years there have been discussions within different international bodies on how to deal with the part of natural RADIATION, especially RADON, that is increased by technical activities. This radation has been referred to as Technologically Enhanced Natural Radiation (TENR). These discussions, however, have not yet resulted in adoption of any international guidelines.

Sweden is the only country for the moment where the authorities have adopted nation wide guidelines for both existing buildings and future constructions.

The most common sources of microbial contamination of indoor air by MICROORGANISMS are the aerosol generators, air humidifiers, air ventilation units, wet surfaces and the human being. In most cases such contamination does not have any health consequences. But certain bacteria, fungi and their dissociation products could cause allergies or infections in respiratory organs. A higher risk does exist in the operating theaters and intensive care units of hospitals and in the sterile production of drugs.

By taking appropriate preventive measures the microbial contamination of indoor air can practically be avoided.

The outgasing from building materials, furnishing, household and consumer products results in an air contamination by ORGANIC SUBSTANCES as e.g.

HYDROCARBONS, METHANOL, ETHANOL, ACETONE and HIGHER ALDEHYDES and FATTY ACIDS. Further and more detailed investigations have to show how these components and their effects will influence the need for air exchange and ventilation rates.

Concerning COMBUSTION PRODUCTS inadequate air supply to open-flued appliances, which may include gas and oil-fired central heating and hot water boilers (furnaces), solid fuel fired boilers and open fires, may result both in incomplete combustion and the "spillage" of the flue gases. They then become partially flueless appliances, albeit with a higher total emission rate of combustion products since they generally have a much higher rating.

Prevention of mal-operation of open-flued appliances has been the subject of a number of studies and requirements for air supply are contained within Building Regulations, Codes of Practice and professional Guides in many countries.

The HUMIDITY of ambient air varies considerably with time and location, being determined by geographical and climatic factors. A review of the possible effects of humidity on occupants and the fabric of buildings shows that the air exchange rates should not remain under certain values which have to be defined more closely in the further working program.

BODY ODOUR is the main reason for ventilation of many densily occupied spaces. It is therefore surprising that so little research has taken place in this area. The principal findings of two major studies on body odour and ventilation requirements do not provide completely satisfying data for fixing a required ventilation rate. Field validation of the observation would be essential.

In the field of PARTICULATES AND FIBRES inventigations on the effect of indoor particulate and fibres pollution on ventilation rates are needed.

The dilution of indoor air contaminants with outdoor air requires a considerable amount of energy to condition that air. The amount of outdoor air, and consequently the energy for its conditioning, can be reduced through the use of air cleaning devices for TREATMENT OF recirculated ROOM AIR. The concept of using air cleaning devices to permit reduction of outdoor air supply rate is relatively new. Hence, data are required on the performance of ventilation systems using such devices to control air contaminants.

The RELATIONSHIP BETWEEN OUTDOOR AND INDOOR AIR POLLUTION and the implications of observed differences, depends substantially upon whether the major sources of the pollutant of concern are indoors or outdoors. Typically, radon and formaldehyde have lower concentrations outdoors than indoors, and the indoor pollutant cencentrations are not significantly affected by outdoor concentrations.

This is also true for some combustion pollutants if there is an indoor combustion source (e.g., unvented gas-fired space heater) and outdoor concentrations are relatively low. Outdoor air pollutant levels affect indoor pollutant concentrations the greatest when there is no indoor source of the pollutant of concern. Such a situation occurs often with combustion pollutants and almost never with radon and formaldehyde.

Some of the substances which had been under investigation in the present Annex IX work can be used as an indicator for acceptable air quality with respect to determine recommendable ventilation rates. These are for example:

carbon monoxide, as an indicator for tobacco smoke

carbon dioxide , if arising from occupants, can be an indicator for body odour

radon , to a lesser extent, as an indicator for ionizing radiation.

The determination of concentration limits for minimum ventilation rates is to a great extent correlated with risk analysis and risk strategies, and should be discussed in more detail in the following working phase.

The author wishes to acknowledge all experts who are co-operating in Annex IX and refers to the detailed report (2). The German contribution is part of the r&d program "Air Infiltration and Ventilation in Buildings" sponsered by the Federal Ministry for Research and Technology and the Federal Ministry for Regional Planning, Building and Urban Development.

References

(1) Trepte, L. Report on minimum ventilation rates - Annex IX

Air Infiltration Review, Vol. 4, No. 4, Aug. 1983, pp. 7 - 8

(2) Trepte, L. and A. Le Marié (Eds.)

Annex IX Minimum Ventilation Rates, Final Report, will be published in spring 1984