GUIDELINES FOR MINIMUM VENTILATION RATES: THE IEA ANNEX IX

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Introduction

The optimization of the conflicting requirements "healthy and comfortable conditions for the occupants", "avoiding demage to the building fabric" and "energy conservation" will result in guidelines for minimum ventilation rates which are sufficiently large to meet the demand for fresh air without unnecessarily wasting energy. In consequent continuation of their research work the participating countries of IEA Annex IX "Minimum Ventilation Rates" study

- emission rates and time dependence for materials being of most interest and their dependence on varions factors including human behaviour
- indoor transfer and interactions
- control and air treatment
- modelling indoor pollution including economic and social factors
- strategies for indoor air pollution control under the restraints of energy conservation.

The results of this international programme will be pooled to produce recommendations for guidelines.

The paper will give a general view of the state of the art, intermediate results and an outlook on the participating countries' contribution to the joint target.

Ventilation and Energy Conservation

From the viewpoint of energy conservation air infiltration and ventilation have to be minimized. A certain amount of outdoor air, however, has to be supplied to dwellings and buildings in order to maintain healthy, safe and comfortable conditions for the occupants and to avoid damage to the building fabric. Within IEA Annex IX "Minimum Ventilation Rates" twelfe countries are co-operating and trying to optimize these conflicting requirements in guidelines for minimum ventilation rates that are suffiently large to meet the demand for outdoor air without unnecessarily wasting energy.

In 1980 the Annex IX within the International Energy Agency's programme "Energy Conservation in Buildings and Community Systems" has been established. Participating countries in the running phase II are Canada, Denmark, European Community (Ispra Establishment) Fed. Republic of Germany, Finland, Italy, Netherlands, Norway (observer status), Sweden, Switzerland, United Kingdom and U.S.A.

Objectives of IEA on Annex IX "Minimum Ventilation Rates"

In phase I the work was dominated by air quality problems involving a review of existing knowledge, national standards and current and required research (1).

In the running phase II principal consideration will be given to the energy issue, especially to strategies for indoor air control under the restraints of energy conservation.

The objectives of this international effort are:

- to quantify more closely the factors which determine the concentrations of the pollutants identified in the first phase of the work of Annex IX 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.

The participants are aiming at March 86 as ending the investigations with the following breakdown of the overall scope:

- emission rates and time dependence for different polluting materials and sources and their dependence on
  - . composition and processing
  - . installation and handling
  - . human behaviour
  - . indoor climate
- indoor transfer and interactions
  - . ad-, ab- and desorption
  - . dilution
  - . chemical reactions and other interactions
- control and air treatment
  - . pollution measurement, sampling and identification
  - . ventilation
  - . air cleaning and dehunidification
  - . separation and recovery
  - . reduction of emission rates
  - . indoor - outdoor relationship
- modelling indoor pollution including economic and social factors
- strategies for indoor air pollution control under the restraints of energy conservation.

The results will be pooled to produce a document identifying more closely the factors which determine the concentrations of the pollutants and the relationship between them, describing minimum ventilation rates and all other suitable methods for accaptable air quality levels as well as technical measurements for controlling air quality and conserving energy.

Approaches to Minimum Ventilation Rates

To reduce energy consumption on one hand and to maintain an acceptable level of indoor air quality on the other in many countries standards have been introduced detailing airtightness of buildings and ventilation rates (2,3). A problem is the definition of the term "acceptable level". In some of the standards e.g. the carbon dioxide level was a basis for determing ventilation rates, thus adjustment in carbon dioxide levels had a profound influence on standards. Some countries have set the maximum carbon dioxid level at 2500 ppm. others at 1000 ppm.

The German ventilation standard DIN 1946 Teil 2 "Raumlufttechnik" (4) e.g. in principle refers to a carbon dioxide level of 1500 ppm and consequently establishes minimum ventilation rates which are dependend on the number of persons and on the kind of room. An average value of outdoor air rate is 30 m^3/h per person, in case of annoyance by tobacco smoke the rate has to be raised by 20 m^3/h per person.

The German ventilation standard, as standards in other countries too, will be revised for several reasons. More emphasis has to be laid on aspects of energy conservation, criteria for indoor air quality should include the most common pollutants and not only base on carbon dioxide levels, outdoor air rates or air changes are not necessarily criteria for indoor air quality because different ventilation strategies may result in different ventilation efficiencies.

IEA Annex IX "Minimum Ventilation Rates" Activities

The pollutants under consideration in IEA Annex IX include formaldehyde, tobacco smoke products, radon, moisture, microorganisms, body odour, carbon dioxide, organic substances and biocides, combustion products, particulates. In phase I (1,5) these pollutants have been identified as being of most importance and for which research is likely to yield results within a reasonable time scale. It can be assumed that the Annex IX results will influence the efforts of various countries to revise or to establish national ventilation standards.

In Table 1 the coordination of the work, the involved countries and their main activities is shown. Each country contributes depending on the national program to a more or lesser extent to each working point. Responsible for reports on the various pollutants are the countries set out in column 2. Phase I was dominated by investigations and research work in the fields of "emission rates" and to some extent "control and air treatment" (1).

Results including discussions concerning acceptable levels and minimum ventilation rates are summarized in an unrestricted IEA report (1).

Table 1: Annex IX activities, involved countries and their co-operation (may be modified slightly in running phase II)

- Symbols: CAN Canada, DK Denmark, EC European Community, D Germany, SF Finland, I Italy, NL Netherlands, S Sweden, CH Switzerland, UK United Kingdom, USA United States of America

		WORKING POINTS																		
MAIN TOPICS	RESPONSIBLE COUNTRY	1 EMISSION RATES				2 INDOOR TRANSP			3 CONTROL and AIR TREATMENT						4 MODELLING HEALTH ASPECTS	5 STRATEGIES
		1.1 Composition and processing	1.2 Installation and handling	1.3 Human activities	1.4 Indoor climate	2.1 Adsorption-desorption	2.2 Dilution	2.3 Chemical reactions	3.1 Measurements	3.2 Ventilation	3.3 Air cleaning	3.4 Separation	3.5 Reduction emission rates			
1 FORMALDEHYDE	D	UK SF D	SF D	SF D	SF D	D	D	SF D	EC CH	EC CH D		D	D		D	D, SF
2 TOBACCO SMOKE PRODUCTS	CH	DK CH	DK CH	DK CH	DK CH	CH	CH	CH	CH	CH	CH	CH	CH		CH	CH
3 RADON	S	S UK	S UK	UK	S	I S	S	S	SF I CH S	SF I UK	UK S I	UK S	UK S		S	S, SF
4 MOISTURE MICROORG etc	UK	UK	UK	UK	UK	UK	UK	UK	UK	DK NL	CH NL	CH NL	CH NL		UK	UK
5 BODY ODOUR and CO_2	DK	DK	DK	DK	DK	DK	DK	DK	CH NL	CAN NL	CH	CAN DK	CAN DK			DK, CAN
6 ORGANIC SUBST. BIOCIDES	D	D	D	D	D	D	D	D		D		D	D			
7 COMBUSTION PRODUCTS	NL	CAN USA	CAN USA	CAN USA	CAN		NL	NL	NL	NL	NL			NL	NL	NL, CAN, USA
8 PARTICULATES	USA					USA	USA	USA	SF		SF					

In some standards a minimum supply of outdoor air is specified on the maximum acceptable concentration of carbon dioxide for physiological requirements (6). ANSI/ASHRAE Standard 62-1981 specifies a limit of 2500 ppm to provide a safety factor to allow for individual activity, diet, and health variations. The proposed limits for European countries range from 1000 to 1500 ppm based on the relationship between odour and carbon dioxide concentration. Calculations for the outdoor air rate necessary to maintain 1000 ppm resp. 1500 ppm levels result in about 25 m^3/h p. person resp. 15 m^3/h p. person.

The annoyance caused by tobacco smoke corresponding to carbon monoxide concentrations of 1 to 2 ppm is recommended as an acceptable level for healthy persons (7). Ventilation rates should be adjusted so that this level is not exceeded in smoking rooms. Calculations show that at a constant smoking rate of 1 cigarette p. hour an ventilation rate of 33 m^3/h is necessary to keep the carbon monoxide concentration below the proposed maximum allowable level of 2 ppm.

Although measures to limit formaldehyd levels should apply reduction of emission e.g. by coating or avoiding meterials containing formaldehyde there can be a need to control levels by ventilation, e.g. in problem buildings. In some countries a limit of 0.1 ppm is recommended, others 0.02 ppm, the range covers 0.003 to 1 ppm. In exceptional cases also supply air rates above 50 m^3/h could not decrease formaldehyde below 0.1 ppm (8).

Problems with pollutants as moisture, e.g. damages to the building fabric, and formaldehyde suggest to distinguish between a basic ventilation rate and an additional ventilation rate dependent on number of persons or special emission situations. In IEA Annex IX phase II the participating countries will analyze different ventilation strategies and a result formulate guidelines for minimum ventilation rates.

Conclusion

First steps have been done for a definition of indoor air quality. There are two different but important aspects of indoor air quality requiring each individual and careful consideration: protection from risk and personal acceptance. Above all for hygienic reasons minimum ventilation rates should be defined, and this not only on the basis of a carbon dioxide level. No 100 % acceptance level of air quality can be expected, the best attainable is a minimum number of rejections. New ventilation strategies are coming up, requiring a lower exchange rate for the some amount of air pollution removal.

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SUMMARY

L. Trepte: Minimum Ventilation Rates, IEA Annex IX

The optimization of the conflicting requirements "healthy and comfortable conditions for the occupants", "avoiding demage to the building fabric" and "energy conservation" will result in guidelines for minimum ventilation rates which are sufficiently large to meet the demand for fresh air without unnecessarily wasting energy. In consequent continuation of their research work the participating countries of IEA Annex IX "Minimum Ventilation Rates" study emission rates and time dependence for materials being of most interest and their dependence on various factors including human behaviour; indoor transfer and interactions; control and air treatment; modelling indoor polution including economic and social factors; strategies for indoor air pollution control under the restraints of energy conservation. The results of this international programme will be pooled to produce recommendations for guidelines. The paper will give a general view of the state of the art, intermediate results and an outlook on the participating countries' contribution to the joint target.

SOMMAIRE

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Les mesures entreprises pour optimiser les exigences quelquefois contradictoires d'hygiéne et de confort dans les habitations, pour éviter des dégâts physiques dans la construction et pour économiser l'energie ont donné lieu à des directives par rapport à un taux minimum du renouvellement de l'air. Ces directives tentent à assurer une alimentation satisfaisante en air externe sans cependant mener à une utilisation non-économique de l'énergie de chauffage. Les pays membres de l'accord IEA, annexe IX, ont décidé de poursuivre leur projet en se basant sur le programme suivant: Etude des taux d'émission de produits nocifs, de leur comportement dans le temps et d'autres facteurs d'influence, tels que le comportement des utilisateurs, par exemple; interactions et repartition de l'émission dans les habitations; possibilités de contrôle; etude de modéles en tenant compte des facteurs économiques et sociaux; développement de stratégies de ventilation permettant d'économiser l'énergie et assurant une quelité satisfaisante de l'air à l'intérieur des habitations. Les résultats de présent programm international vont être résumés sous forme de recommendations. Le présent discours s'entend comme informations sur l'état des travaux, les résultats intermédiaires et la participation des différents pays membres.

KURZFASSUNG

L. Trepte: Minimum Ventilation Rates, IEA Annex IX

Die Optimierung der sich teilweise widersprechenden Anforderungen an Hygiene und Komfort in Wohnungen, die Vermeidung bauphysikalischer Schäden und die Forderung zur Energieeinsparung führt zu Richtlinien für Mindestluftwechselraten. Sie sollen eine ausreichende Außenluftrate gewährleisten, ohne daß Heizenergie unrationell eingesetzt wird. Die Teilnehmerländer am IEA-Annex IX "Mindestluftwechselraten" haben die Fortsetzung ihrer Arbeit vereinbart und sich dazu folgendes Programm vorgenommen: Untersuchung der Emissionsraten von Schadstoffen, des zeitlichen Verhaltens und des Einflusses anderer Faktoren, wie z.B. des Benutzerverhaltens; Wechselwirkung und Verteilung in Wohnräumen; Kontrollmöglichkeiten; Modellbetrachtungen, die wirtschaftliche und soziale Faktoren mitberücksichtigen; Entwicklung von energiesparenden Lüftungsstrategien zur Gewährleistung einer ausreichenden Innenraum-Luftqualität. Die Ergebnisse dieses internationalen Programms werden in Empfehlungen zusammengefaßt. Der Vortrag soll einen Überblick über den Stand der Arbeiten, über Zwischenergebnisse und den Beitrag der einzelnen Länder geben.