ISO TC 205: AN ATTEMPT OF INTERNATIONAL STANDARDISATION ON INDOOR AIR QUALITY CRITERIA

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ABSTRACT

The working group WG4 of ISO TC 205 aims to define Indoor Air Quality criteria. The draft standard contains several methods for determining ventilation rates, based on these criteria. The ventilation rates obtained with some of these methods are compared for several premises: ASHRAE 62-1999, the method of perceived IAQ of CR 1752, and the prescriptive method of AS 1668.2. To improve the comparison, ventilation rates are also calculated with the prEN 13779 method.
The studied buildings contains offices, classrooms and a play area. Ventilation rates obtained with real occupancy and default occupancy given in the draft are also compared. Then, the way to take into account smokers by the different methods has also been considered.
There are large discrepancies in the results: the CR 1752 category A always gives the highest ventilation rates, while the ASHRAE version in the ISO TC 205 and AS 1668 often give lowest results. Use of default occupancy increases the differences.

KEYWORDS

Indoor Air Quality, ventilation rates, ventilation

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ISO TC 205

ISO TC 205 deals with building indoor environment design. Several subgroups specify methods for expressing acceptable design criteria for thermal, acoustic, visual environment and Indoor Air quality (IAQ). The working group WG4 of ISO TC 205 aims:

- to specify methods to express the quality of indoor air for human occupancy
- to express several levels of acceptable quality
- to express air quality based on its effect on human health and comfort

The project standard currently describes the design methodology: to take into account the project specifications, pollution sources (indoors, outdoors, and in the system), the eventual use of source or local control (filtration, local exhaust…) in order to choose a method to determine the ventilation rates. These following ventilation design methods are presented in the ISO TC 205 project:

- tabulated ventilation rates

- mass balance equations to achieve a target level of pollutant concentration
- ASHRAE 62-1999 : ventilation rate for acceptable IAQ. This method is under continuous maintenance, regularly modified by addenda.
- CEN CR 1752 based on Perceived Indoor Air Quality
- AS 1668.2 (Australian standard): Amenity or Dilution Index

Standards and presented methods above have different criteria and can take into account or not various parameters such as mono or multiple zone, recycling , filtration or ventilation efficiency…

THE CALCULATION METHODS USED

Several ventilation design methods were compared on rooms of an office building and a school. They are:

- Ventilation for acceptable indoor air quality, from the ASHRAE 62-1999. We used the method of the current edited standard (ventilation rates are function of the occupancy), as well as the project version which is in the ISO TC 205 document, and which is a revised version (ventilation rates are also function of the room surface area, to take into account the pollution by indoor building materials)
- The perceived IAQ method, from the CR 1752. The outdoor air ventilation rate is calculated from the desired indoor air quality (A, B or C) and from the sensory pollution load, which is function of the occupation, the occupants' activity and the room surface area. The CR 1752 considers the occupants as "unadapted" (i.e sensitive to the odours in the room in which they have just entered)
- The prescriptive method of AS 1668.2, whose principle is to calculate the ventilation rate linked to the occupancy and the ventilation rate linked to material emissions, and to keep the highest rate
- To improve the comparison, ventilation rates were also determined with the prEN 13779: this European draft standard, from CEN TC 156 WG7, describes the essential requirements for ventilation system to provide a comfortable and healthy indoor environment. It defines a classification for indoor air quality, from IDA1 to IDA3, and requires fresh air ventilation rate according to the desired category.

We present here some examples of the calculations done for an office, a classroom and a play area. Occupancy is known for each of them. Figures provide also the CO_2 concentration levels induced by the ventilation rate of every method, calculated in steady state for 350 ppm in outdoor air and a generation rate of 18,6 l/h of CO_2 per person. Occupancy influence is then studied by comparing the results obtained with real occupancy and default occupancy given by each method. The last part deals with the expressions given by the ASHRAE 62-1999, CR 1752 and AS 1668.2 to calculate the additional ventilation rates in smoking room according to the proportion of smokers.

Table 1 in Annex 1 gathers the ventilation rates per person and the air changes per hour for each of the studied cases.

RESULTS FOR THE OFFICE

Figure 1 gives the results of the different methods for an office of 24 m^2, whose occupancy is 8 people per 100 m^2.

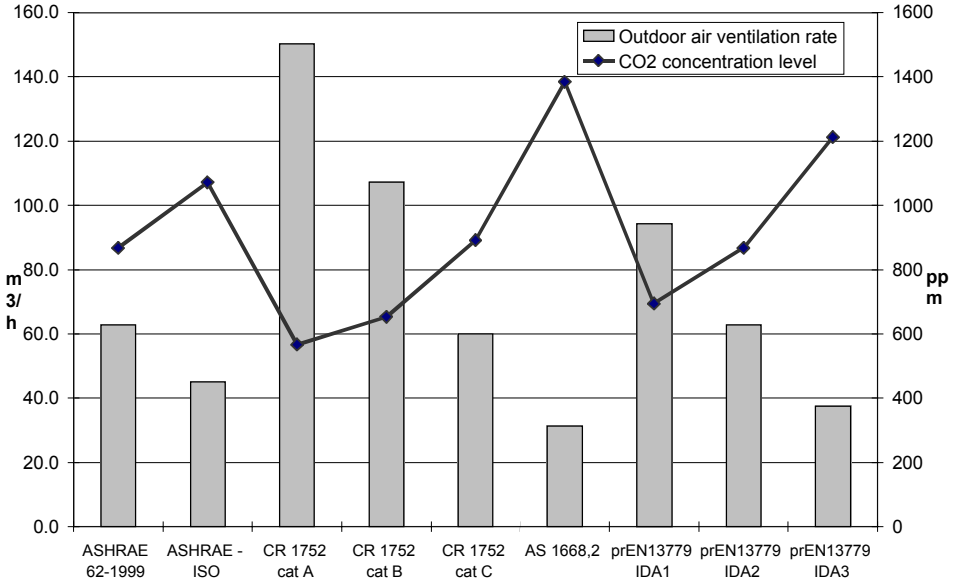

Figure 1: Outdoor air ventilation rate in an office

CR 1752 category A requires the highest ventilation rate with 140 m^3/h, inducing a CO_2 concentration level lower than 600 ppm. Ventilation rate required by AS 1668.2 is the lowest with about 30 m^3/h (CO_2: 1400 ppm). It must be noticed that the ASHRAE revision project in the ISO TC 205 reduces the ventilation rates by 27% compared to the ASHRAE 62-1999 for this case.
There is a ratio of 4,5 between the ventilation rates required by the AS 1668.2 and the category A of the CR 1752.

RESULTS FOR A SCHOOL

Classroom

The studied classroom has an area of 60 m^2 and can contain 28 pupils. Results are shown on figure 2.

The revised version of ASHRAE gives the lowest ventilation rate: 400 m^3/h inducing a CO_2 concentration level of 1500 ppm. The reduction of the ventilation rates between the ASHRAE 62-1999 and the ASHRAE version in the ISO TC 205 is very clear (44% of reduction). CR 1752 category A always requires the highest ventilation rate, around 1900 m^3/h.

There is a ratio of 4 between the ventilation rates required by the revised ASHRAE and the category A of the CR 1752.

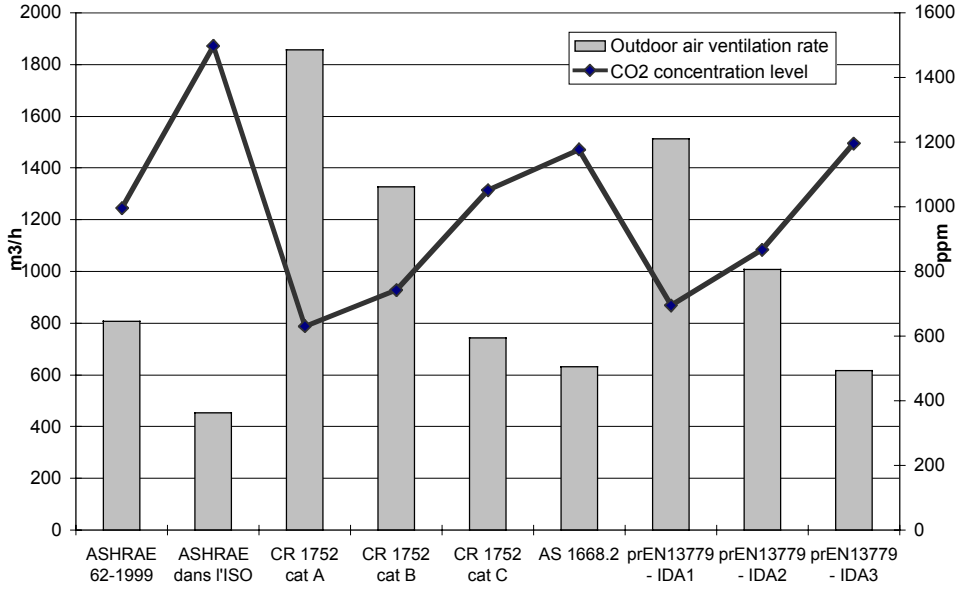

Figure 2: Outdoor air ventilation rate for the classroom

Play area

Figure 3 gives the ventilation rates for the play area, where the pupils practice sport and play in when there is bad weather outside. 140 children may be active on a 180 m_ surface area which is a high density of occupation in these periods.

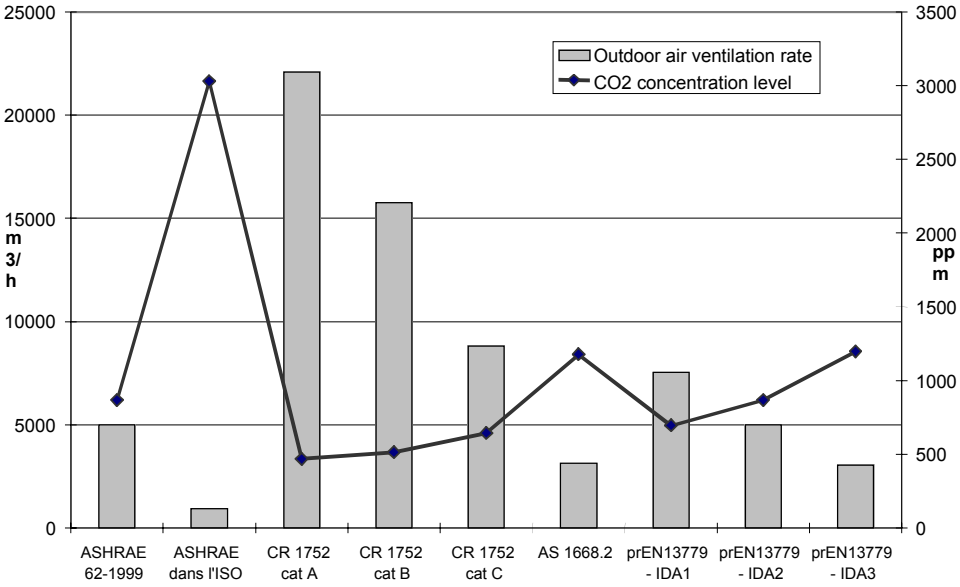

Figure 3: Outdoor air ventilation rate for the play area

The ventilation rate required by the ASHRAE version in ISO is very low, and induces 7 m^3/h per person. This low value can be explained by the fact that this standard gives only a ventilation rate by surface area (5,4 $m^3/h/m^2$), and can not then take into account the high children density. The induced CO_2 concentration level is then high: 3000 ppm.

Ventilation rates obtained in that case are very different: they vary between 7 m^3/h/person (ASHRAE in ISO) and 158 m^3/h/person (CR 1752), it means a ratio of 22 between these two methods. It is equivalent to 20,5 air change par hour for the CR 1752 and 0,9 for ASHRAE in ISO.

OCCUPATION INFLUENCE

Default values given in the texts, particularly for the occupancy, increase the differences between the standards when they are used. Figure 4 shows a comparison of the ventilation rates with the real and default occupancy for the meeting room, and show off the high variations. For this example, the real occupancy is 29 persons on 100 m^2, using default values (from 33 to 50 persons on 100 m^2) changes a lot the resulting ventilation rates.

Some of the methods (ASHRAE 62-1999, AS 1668.2) have a difference of more than 70 % between the ventilation rates calculated with real and default occupancy.

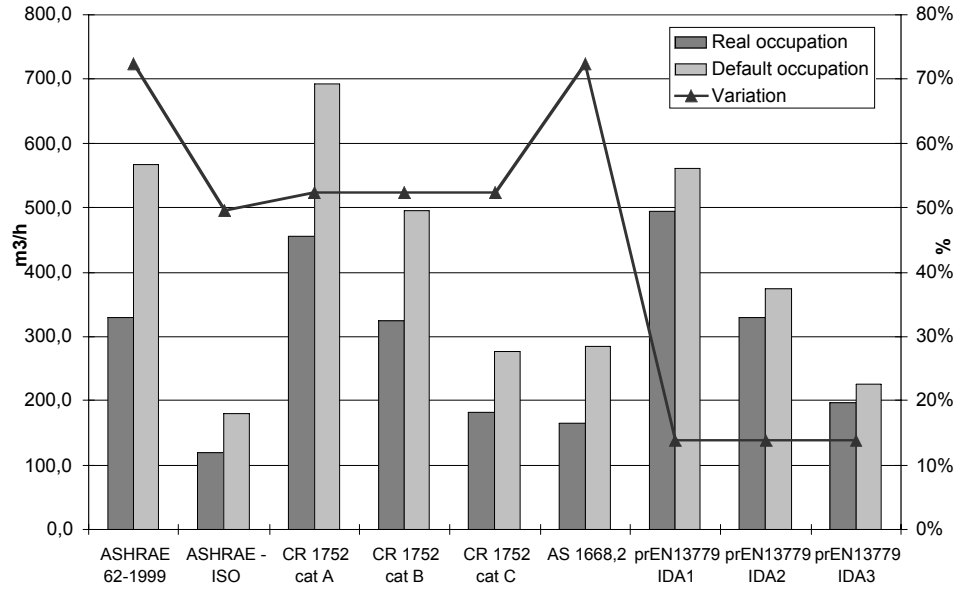

Figure 4: Comparison of the outdoor air ventilation rates for the meeting room – real and default occupation

The draft standard lacks clearness, it is indeed difficult to know if the occupancy values are mandatory or advisory.

CONSIDERATION OF THE SMOKERS

The methods explain also the ventilation rate determination methods for the smoking rooms. Beyond the default values which are given for 20% of smokers in the local (ASHRAE in ISO and CR 1752), and for one cigarette smoked per occupant and per hour (AS 1668.2), these standards give also the mathematical expressions to obtain the additional ventilation rate per person for other smokers proportions.

Figure 5 gives then the additional ventilation rate per person according to the smokers' proportion among the occupants, for ASHRAE in ISO and CR 1752. These both standards consider that smokers are more tolerant to the cigarette smoke than the non-smokers, and ASHRAE in ISO goes further than the CR 1752: the additional ventilation rate decreases beyond 60% of smokers. AS 1668.2 has a different principle because it gives an additional ventilation rate directly proportional to the quantity of cigarettes smoked per person and per hour.

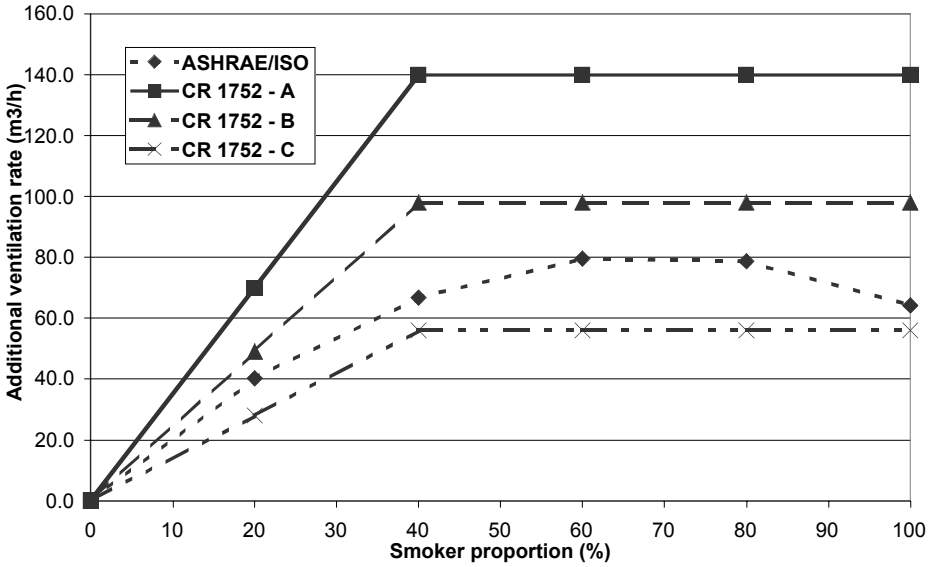

Figure 5: Additional ventilation rate per person according to the smokers proportion among the occupants

CONCLUSION

The diversity of the ISO TC 205/WG4 methods, which is still a project, shows the difficulty to express the IAQ criteria. Assumptions of these methods, considered parameters and the results are very different:

- Several methods lead in some cases to CO_2 concentration levels very high (more than 1000 ppm), particularly ASHRAE in ISO and AS 1668.2.
- Depending on the method chosen by the designer, the ventilation rate can vary in a ratio from 1 up to 22 (in the case of the play area), often around 5.
- These differences may increase with the use of various default occupation

Engineers need to know the real impact of their choices (methods, parameters taken into account, occupation values…) when dimensioning a system. The ISO TC 205 draft standard will be sent in parallel CEN vote. If it is accepted and becomes a European standard, generally of volunteered application but mandatory in some buildings of some countries of the European Union, the diversity of the results following the choice of the method may be a real brake. Yet, work is still in process in ISO TC 205 WG4 and the project is still evolving.

ANNEX 1

Table 1
Outdoor air ventilation rate per person in m^3/h (air change per hour in vol/h)

	Office	School	
	Bureau	Classroom	Play area
ASHRAE 62-1999	36 (1,0)	29 (3,8)	36 (4,7)
ASHRAE / ISO	26 (0,8)	16 (2,2)	7 (0,9)
CR 1752 category A	86 (2,5)	66 (8,8)	158 (20,5)
CR 1752 category B	61 (1,8)	47 (6,3)	113 (14,6)
CR 1752 category C	34 (1,0)	27 (3,5)	63 (8,2)
AS 1668.2	18 (0,5)	23 (3,0)	23 (2,9)
PrEN 13379 – IDA1	54 (1,6)	54 (7,2)	54 (7,0)
PrEN 13379 – IDA2	36 (1,0)	36 (4,8)	36 (4,7)
PrEN 13379 – IDA3	22 (0,6)	22 (2,9)	22 (2,9)