# SIGNING OF INDOOR LEGISLATION AND NEW ELEMENTS IN LAWFULNESS FOR VENTILATING OF ROOMS

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## INTRODUCTION

he purpose of indoor ventilation is to secure the comfort and low health hazard for the ›itants. By effective ventilation which is coupled with concentration of pollutants in ıst in rooms and concentration of pollutants in air in breathing zone the energy ımption for heating/cooling is increased. The effective ventilation assures the comfort orresponding indoor air quality.

he energy crisis in 70's sparked idea of energy saving which caused the reduced sity of indoor ventilation and increased air tightness of buildings. These measures led :rease of health problems of inhabitants due to impaired indoor air quality.

lovenia adopted the Resolution on Strategy of Energy Use and Supply having for main to achieve a long term reliable and sufficient energy supply and increase of efficiency ergy use coupled with increased environment concern and decreased health hazard for uilding users.

'he purpose of indoor ventilation is to achieve such an effectiveness which assures the ›r comfort, low health hazard and low energy consumption.

## ELEMENTS OF INDOOR ENVIRONMENT DESIGNING

ı the process of designing of indoor environment the following terms were introduced:

- thermal environment,
- air quality,
- acoustic environment,
- illumination.

ı spite the designing if indoor environment must be considered as whole each of its ıents must be also handled separately. This article deals with thermal environment and or air quality.

### THERMAL ENVIRONMENT

'he human response to thermal environment is defined by PMV value (Predicted Mean ·) and PPD value (Predicted Percentage of Dissatisfied) which show the percent of ›le, exposed to given warm or cold thermal environment and is considered as whole an body.

\t human the local thermal discomfort can occur due to warming up or cooling down ›ody. This is caused by air movement (draft), too large temperature differences between ·r parts and lower parts of body, too warm or too cold surroundings floor or too large

temperature asymmetry. Local discomfort is sensed at most in case of light activities in sitting position.

PPD value is one of measurements of thermal environment quality. It tells the average human response. PMV value tells average value of thermal environment of group of the people and it has 7 degrees (see Table 1). The mutual connection among those two values is expressed by equation 1. PMV value is determined by hand of 6 parameters which are: human physical activity (metabolism), thermal resistance of clothing, indoor air temperature, mean radiation temperature of surrounding walls, indoor air velocity, indoor air humidity.

In the process of designing the desired PMV value is/can be pre-set.

Table 1

| PMV | +3 | +2 | +1 | 0 | -1 | -2 | -3 |
|---|---|---|---|---|---|---|---|
| | hot | warm | slightly warm | neutral | slightly cool | cool | cold |
| PPD | | 75% | 26% | 5% | 26% | 75% | |

$$PPD=100-95 \exp(-0.03353\ PMV^4 - 0.2179\ PMV^2) \quad (1)$$

The new legislation draft proposes the possibility of choosing between three levels of thermal environment (see table 2). The narrow tolerance in case of PMV value gives options of choosing among pleasantly warm and pleasantly chill level which means there are 15% of dissatisfied in room allowed.

Table 2

| level | PPD | PMV |
|---|---|---|
| A | <6 | -0.2 < PMV <+0.2 |
| B | <10 | -0.5 < PMV <+0.5 |
| C | <15 | -0.7 < PMV <+0.7 |

- Operative temperature

The limit values of indoor air temperature are expressed in terms of human activity and clothing. There was a new term introduced - so called operative temperature. In working/dwelling zone there is also necessary to take into account the total influence of air temperature and mean (asymmetric) radiation temperature of surrounding walls. The operative temperature shall nowhere inside working/dwelling zone exceed the pre-set allowable limits.

- Air movement - turbulence

As draft is expressed an undesired local cooling of the human body caused by air movement and change of its temperature. The turbulence is of importance because its cause the air to move. It was found out that air turbulence , even at very low speed, is a source of discomfort and health problems. The degree of turbulence is defined as ratio between standard deviation of measured momentary values of air speed and mean air speed. The allowable air speed therefore depends on local air temperature and air turbulence limit

Average air speed depends on local air temperature and turbulence intensity which
e value in normally ventilated rooms is 30-60%.

Radiant asymmetry

radiant asymmetry can also cause discomfort. The people are most sensitive to it
t's caused by radiating heating (warm ceilings and walls). Radiant asymmetry is
it problem in case of ventilated and air-conditioned rooms, except in case of highly
ated rooms and large glass surfaces. Direct sun radiation shall be avoided in
g/dwelling zone by appropriate architecture and shade-casting devices.

**NDOOR AIR QUALITY**

dealing with problem of inappropriate indoor air quality in closed rooms the
sion "sick building" is known. The World Health Organization prescribes that air
is inappropriate when 20% of inhabitants experience health hazardous symptoms
are medically pretty difficult to diagnose. Those symptoms which are coupled with
llness signs and overall bad mood and feeling of people, are different. Such signs are
body responses to momentary discomfort and pass relatively quickly after leaving
mises. But intense and long term being in rooms with poor ventilation and without
ent fresh air can lead to acute and professional illnesses.

ere are two basic demands to air quality set:

health hazard due to inhalation of air has to be negligible,

air must be more fresh and pleasant and must not be irritating and stuffy.

e indoor air quality shall be controlled by combination of check at entrance and
tion. Ventilation requires check on danger for specific air pollutants which must be
l regardless the purpose of the room.

ceived air quality can be expressed in terms of percent of dissatisfied people who
er air as unacceptable immediately after entering the rooms. The pollution of air
is caused by one standard person (sitting clerk) is called one olf. The intensity of
ollution sources in room can be expressed as human equivalent which is the number
dard persons (olf) who equals pollute the indoor air as actual pollutant. Perceived air
y is expressed in decipols (dp). This means that in case of unpolluted air supply of 10
lp equals an indoor air quality having intensity of pollution source of 1 olf (1 dp = 0.1
)).

nsed degree of air pollution cause those pollution sources which influence the
tion of air quality. The air pollutants are classified according to room purpose.
n dioxide is quantitative the most important biological human factor of influence on
ality (bioeffluent). But is serves also as good indicator of other human bioeffluents
are also marked as unpleasant. Therefore the $CO_2$ is used as indicator of indoor air
y especially in business rooms. The other pollutants are evaluated in special cases.

## 3. VENTILATION EFFECTIVENESS

The concentration of pollutants in room can be reduced only by sufficient forced (artificial) ventilation. The sufficiency of ventilation is determined by two ways:

- Method of appropriate air quantity sets necessary quantity of air in l/s ($m^3/s$) per person and/or $m^2$ of surface. That method takes into account the degree of room load under assumption that prescribed air quantity of induced air will dilute the concentration of pollutants in indoor air to such degree that the indoor air will not cause dissatisfaction and heath hazard.
- Method of appropriate air quality is in use for rooms with unusual pollutant sources. That method determines air quality set by surveillance on all known pollutants and induction of air quantity which prevents that pollutant reach the critical level. Therefore the main pollutants, their intensity and allowable level of pollution must be known.

Quality of air in ventilated room can be different. The air quality in working/dwelling zone in area of breathing is of importance. This is expressed by ventilation effectiveness:

$$\varepsilon = \frac{Ce - Cvz}{Ci - Cvz} \qquad (1)$$

where

| | |
|---|---|
| e | ventilation effectiveness |
| Ce | concentration of pollutants in outside air |
| Cvz | concentration of pollutants in fresh (induced) air |
| Ci | concentration of pollutants in air in breathing zone |

The ventilation effectiveness depends on air distribution in room, location of pollution sources in room, temperature of induced fresh air in room and quantity of fresh air. It may, therefore, have different values for different pollutants:

- if there is complete mixing of air and pollutants the ventilation effectiveness is 1
- if the air quality in the breathing zone is better than in the exhaust, the ventilation effectiveness is higher than one, the desired air quality in breathing zone can be achieved with a lower ventilation rate.
- if the air quality in the breathing zone is poorer than in exhaust air, the ventilation effectiveness is lower than one and more ventilation is required.

From the point of view of estimation of ventilation effectiveness the spot of air supply/drain to/from the room is of importance. The most frequent applied system is mixing of air layers which separate the room in two zones - the first zone is zone of air induction and the second is working/dwelling zone. This is true especially in case of horizontal air induction under ceiling. The most ventilation effective is achieved in case of horizontal air induction at floor level and air draining from the ceiling level and at negative temperature difference between induced air and indoor air. In such case the room is so called "washed away" - the indoor air is under-pushed and the minimum mixing of fresh air and indoor air is achieved. By calculation of ventilation effectiveness the impact of fresh air distribution in

is taken in account but location of pollution sources in room is not (only their unequal bution is taken in account).

## NECESSARY AIR QUANTITY

here are two components which must be separately taken into account at ventilation valuation of air quantity:

- dilution of pollutants caused by human and its activity
- dilution of pollutants causes by building itself.

ıe fresh air has an significant impact on indoor air quality because indoor air is up to nes more polluted. The necessary amount of fresh air is defined by equation:

$$= V_L \cdot L \cdot R + Vo \cdot Ao \qquad (2)$$

:

| | | |
|---|---|---|
| planned (necessary) air quantity | R | factor of difference |
| minimum air quantity per person | Vo | minimum air quantity per $m^2$ |
| number of persons | Ao | room area ($m^2$) |

## DEMANDS ON VENTILATION OF ROOM - LEGISLATION

y building of new buildings with higher tightness the appropriate (controlled) ation and simultaneously taking into account the energy cost and following criteria be secured:

- security,
- health,
- comfort.

ıfortunately there is a fact that in past 20 years there has not been enough effort on :ting the building users in terms of indoor environment quality. There are still the ete standards in use (some of them from 1967) which are not in mutual correlation and ven mutual exclusive; they are not in concordance with contemporary European ards and progress of the science.

ıe members of Building physics committee (TC 156) filed a proposal to state Bureau tandardization and metrology for acceptance of European pre-standard bill for ating of buildings with criteria for designing of indoor environment. Currently it is worked on the technical regulation for criteria for designing the indoor environment ı will prescribe the mandatory use of specific standards and other regulations from the ɔf designing the indoor environment.

## THE SLOVENE PRE-STANDARD BILL FOR VENTILATION OF ROOMS AND CRITERIA FOR DESIGNING OF INDOOR ENVIRONMENT

ıe bill for pre-standard stems from series of standards prescribing natural and artificial ation of buildings. It sets the criteria of indoor environment as comfort (thermal ɔnment), air quality and acoustic environment for all buildings except residential ones. ite that the criteria of indoor environment are considered separately the indoor

environment must be considered as whole. If this is not so the different demands can lead to discrepancy which causes the problems to designer who might not be possible to achieve optimum parameters for reaching the comfort in building. The pre-standard prescribes three levels of indoor environment and sets assumptions and criteria for its designing.

## 7. CONCLUSION

By known heating, cooling, ventilating and air-conditioning devices serving the purpose of securing the human health and comfort there is additionally necessary to met set and desired criteria in buildings in order to achieve optimal working and dwelling conditions. The time will show whether the change in understanding the thermal environment will have any consequences on swapping the warm water heating by warm air heating systems. This process is expected to be mostly influenced also by economy of such systems in terms of energy cost.

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