DWELLING-HOUSES OPERATIVE ENERGETICAL CLAIMS MINIMALIZATION BY USING CONTROLLED VENTILATION SYSTEMS

J. Kalaš, Z. Vranayová
Faculty of Civil Engineering, Technical University of Košice
Vysokoškolská 4, 040 01 Košice, Slovakia

ABSTRACT

A renovation of a dwelling stock in Slovak republic primary mission is a dwelling environment quality increase and dwelling houses essential operative energetical claims decrease. Considerable means of an operative energetical claims decrease of these buildings is their airiness reduction, that leads to an infiltration air change under level of sanitariness needful. A heat consumption for ventilation optimalisation beside a collateral dwelling environment quality increase is possible to reach through a controlled ventilation systems applications.

1. INTRODUCTION

A ventilation scope is in a close space provision required air quality, i.e. oxygen ratio required provision in interier air and nascent maligances concentration decrease on the value, that does not users space ventilation health abuse.

Maligances in dwelling-houses are man-making, their activity, eventually they are loosen from construction materials and from internal building equipments. The most frequent maligances in dwelling-houses interiers are vapour, carbon dioxyde (CO_2), formaldehyde or radon.

In the frame of dwelling stock renovation in Slovakia (SR), the main stress is lays to a space dwelling sanitariness increase and dwelling-houses operative energetical claims decrease next-to a static limitations solution. Dwelling-houses operative energetical claims decrase is reached by building coat thermal resistance increase and building constructions airiness decrease, windows and doors especially. A building constructions airiness decrement is contributed in to operative energetical claims decrase meaningly on the one side, on the second side it can violates flats using sanitariness assumptions very seriously. From arguments listed above a dwellings ventilation problematic is standing in foreground of a technical public interest.

2. DEMANDS ON DWELLING-HOUSES ROOM VENTILATION

In SR demands on dwelling-houses ventilation are not legislative adequate adapted. The Slovak Standard 74 7110 [1] actual from 1988 is not accounts to contemporary ventilation conditions and demands, whereas it is determines only intensity ventilation demands in individual flats kitchins and toilet facilities (Table 1) and with dwelling rooms ventilation it is not deals. Into a novelisation this standard is possible to consider solving ventilation minimal ventilation intensities at individual dwelling rooms according to german standard DIN 1946 [2], eventually according to gallice edict [3].

TABLE 1: Air change desired intensities accordig to Standard 73 3110 [1]

VENTILATED SPACE	AIR FLOW $[m^3.h^{-1*}]$	$[m^3.h^{-1**}]$
Sitting and sleeping rooms	-	-
Kitchins	100	80 - 100
Bath-rooms	75	60 - 80
Water closets	25	20 - 30

* - calculating flow in $m^3.h^{-1}$

** - permissible flows range in $m^3.h^{-1}$

TABLE 2: Recommended air flows for dwellings and houses individual groups [2]

GROUP		I	II	III	IV	D[1)]
Dwelling area	m^2	72	95	104	116	82
Number of inhabitants	P	2	3	4	6	2 till 3
Basic ventilation	$m^3.h^{-1*}$	50	70	90	100	70
Additional ventilation	$m^3.h^{-1*}$	10	20	30	80	20
Global bulk flow[2)]	$m^3.h^{-1*}$	60	90	120	180	90

[1)] average values

[2)] strange cases of loading (for example moisture higher development, fume, greater number of persons a s. o.) has to be adjusted with relative additionals

TABLE 3: Needful air flows across individual flats rooms accordance to dwelling rooms numbers [3]

DWELLING ROOMS NUMBERS	NEEDFUL AIR FLOW ACROSS ROOM $[m^3.h^{-1}]$			
	Kitchen	Bath-room	Lavatory	WC
1	75	15	15	15
2	90	15	15	15
3	105	30	15	15
4	120	30	15	30
5 and more	135	30	15	30

3. CONTEMPORARY STATUS OF DWELLING-HOUSES VENTILATION

In individual dwelling rooms in dwelling houses realized in SR after 1948 year are applicated following ventilation systems:

a) Innate ventilation

   a.1. Air inlet and outlet by infiltration, eventually open windows ventilation

   a.2. Air inlet by infiltration, air outlet by downcasts

   a.3. Air inlet and outlet by downcasts

b) Compound ventilation

b.1. Air inlet by infiltration, air outlet with aid central fan placed on the roof

b.2. Air inlet by infiltration, air outlet by autonomous fans placed in toilets facilities (bath-room, WC) and in a kitchen.

Contemporary used ventilation systems are not abble to ensure indoor comfort needful quality during all year, it can be state on the base of experimental measurements realized. Concerning that, at an innate ventilation intensity of ventilation is an outdoor climate conditions function (outdoor air temperature and wind rate and direction speed), a ventilation intensity fluctuation is lawful. Maximal intensities are reached in the minimal outdoor temperature time, what cause heat losses by ventilation excessive increase.

4. USABLE VENTILATION SYSTEMS AT A RENOVATION DWELLING STOCK AND IN NEW CONSTRUCTION

Indoor comfort parametres optimalization in individual dwelling rooms can be secured by using following controlled ventilation systems:

a) Vacuum ventilation centralized system

In these systems air inlet is solved across self-controlled supply elements placed in an outside stall, eventually in window frames; air outlet with an aid of central ventilation unit placed on the roof. These systems can operate:

a.1. with a ventilation air constant flow, with possibility flow increase in the time of an intensive malignances flow into interier

a.2. with a ventilation air changeable flow, that air flow is a vapour flow into ventilated rooms function, together with this minimal flow is secured also in the time without vapour formation

An advantage of these systems are low capital and operating expenses; disadvantages that they do not enable a complex air adjustment inclusive cooling.

b) Vacuum ventilation decentralized system

In these systems air inlet is solved across self-controlled supply elements placed in an outside stall, eventually in window frames; air outlet with aid autonomous fans placed in kitchens, bath-rooms and WC, with debased air discharging by two vertical ducts. These systems can operate with a central ventilation unit placed on the roof. These systems can operate with a constant or changeable air flow (like a.1. and a.2.).

c) Constant-pressure ventilation centralized systems

These systems have a central air inlet and outlet with a ventilation unit placed on the roof. It is possible to integrate recuperative and regenerative exchangers for making use of heat from discharged air, eventually air cooling.

An advantage of these systems is possibility of complex air adjustment inclusive recuperation and cooling. Operating expenses are low, capital expenses are high.

d) Constant-pressure ventilation decentralized systems

An individual rooms ventilation is secured with aid autonomous ventilation units for air inlet and outlet, with this these units can be furnished recuperative heat exchanger.

An advantage of these systems is their low operating expenses and possibility of a heat recuperation, a disadvantage is high capital expenses. They can be favourable used at individual flats renovation, whereas there is not used a common duct for dwelling one over second.

5. DWELLING VENTILATION INDIVIDUAL SYSTEMS ENERGETICAL CLAIMS COMPARISON - CONCLUSION

A heat energy consumption for a ventilate air heating within a year we can calculate from the following ratio:

$$Q_r \quad \sum_{1}^{n} \sum_{\tau 1}^{\tau 24} V.\varsigma.c.\left(t_i - t_{e(\tau)}\right) \qquad [\text{kWhr.year}^{-1}] \qquad (1)$$

Where:	V	- bulk air flow accross the room	$[m^3.sec^{-1}]$
	c	- specific heat capacity	$[kJ.kg^{-1}.K^{-1}]$
	ρ	- air density	$[kg.m^{-3}]$
	$t_{e(\tau)}$	- outdoor air temperature	[°C]
	t_i	- indoor air temperature	[°C]
	n	- heating days number	[-]

An heat energy yearly consumption for heating ventilate air analysis was realized at using different ventilation systems and following boundary conditions:

- Dwelling group largeness according to [2]: III
- Desired flow according to [2]:
  - basic : 90
  - overall : 120
- Number of persons : 4
- Airiness windows factor : $i = 1{,}2.10^{-4}\ m^3.s^{-1}/m.Pa^{-0{,}67}$
- Loop-hole lenght : 34 m
- Air temperature in the room : 21 °C
- Air humidity in the room : $10\ g.kg^{-1}$
- Outdoor air calculated temperature in winter : -15 °C
- Average outdoor air temperature : 3,0 °C
- Heating days numbers : 218

Analysis results - listed in Table 4 - manifest, that from the energetical claims point of view are the most suitable systems with changeable air flow, controlled in relativity from a room relative humidity. Not controlled innative ventilation systems do not satisfy needful ventilation intensity in generality part of year, save that their energetical claims is very high.

TABLE 4: Dwelling ventilation different systems comparison

VENTILATION SYSTEM	**Heat demand for air heatig [kW]**			**Yearly heat consumption for ventilation**
	t_e [°C]	**V [$m^3.hr^{-1}$]**	**Q_v [kW]**	**Q_R [kWhr. $year^{-1}$]**
Innative - - not controlled	- 15 - 5 + 5 + 12	183 147 117 81,4	2,21 1,29 0,63 0,24	4 485
With changeable air flow	- 15 - 5 + 5 + 12	22,8 26,25 36,0 99,9	0,27 0,23 0,193 0,26	1 367
With constant air flow V = 120 $m^3.hr^{-1}$	- 15 - 5 + 5 + 12	120 120 120 120	1,45 1,05 0,65 0,363	3 804
With constant air flow V = 90 $m^3.hr^{-1}$	- 15 - 5 + 5 + 12	90 90 90 90	1,089 0,78 0,484 0,27	2 850

REFERENCES

[1] Slovak technical standard STN 74 7110: Housing cores

[2] German standard DIN 1946, Part 6 - Luftung von Wohnungen - Anforderungen, Ausfurung, Prufung, 1994

[3] Arette du 24 mars 1982 modifie relatif aux dispositions relatives a l'aeration des logements

[4] J. Kalaš and col.: Dwelling ventilation alternative systems for reconstruction dwelling houses and flats, VTP6-400/97 Košice, 1997