Effect of Quality and Maintenance of the Ventilation to the Indoor Air Quality

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Introduction

The aim of this study was to find out the indoor air quality in the real estates of the state and what was the effect of ventilation to the indoor air quality in these buildings.

Methods

Ten different buildings were studied. Five of them were old buildings and five new or primary repairs were done during the last two years. Indoor air quality and ventilation were measured in each building and the MM-40 questionnaire(1) was performed among workers in each building. Temperatures in four different areas, temperature gradient were measured according to the international (2) and Finish standards and air speed were determined in the areas, where draught was expected. The indoor air chemicals, dust, formaldehyde, ammonium, TVOC, ozone, carbon monoxide and carbon dioxide were measured selecting the measuring place using the worst case method/3/. Temperature and chemical measurements were classified: how many of the results were worse than the indoor air quality class 2. The rate of ventilation volume was measured and results were compared to the Finnish recommendations. Quality of ventilation maintenance and faults in ventilation equipments were studied and the objects were classified to the groups. The ventilation rate was also classified in the groups: class1 over 80 %, and class3 less than 50 % of recommendation values. The classified ventilation rate, maintenance status and defaults were calculated into the one quantity, the total status of ventilation.

Results

Table 1. The classified results of indoor air temperatures, indoor air chemicals, ventilation rate according to the Finnish recommendations, classified level of ventilation maintenance, classified rate of the observed defects and total classified status of ventilation.

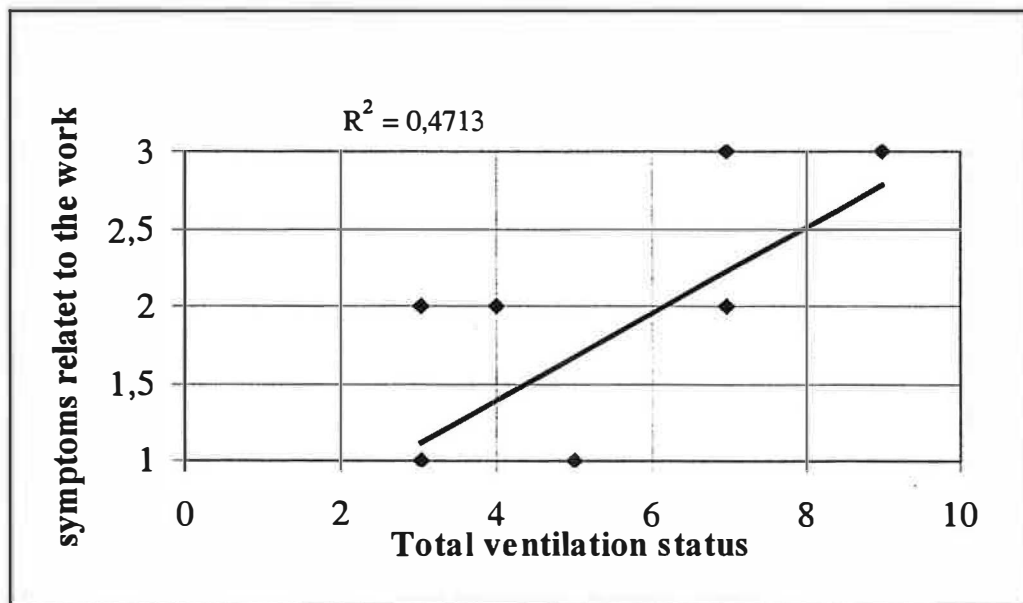| subject	temperature	chemicals	ventilation rate %	maintenance of ventilation	ventilation defects	status of ventilation
1	2	1	86	1	1	3
2	4	1	115	1	1	3
3	1	2	33	1	2	6
4	3	2	59	1	2	5
5	4	1	139	11	2	4
6	1	2	102	1	2	4
7	2	1	153	1	1	3
8	1	1	67	3	2	7
9	1	3	30	2	2	7
10	1	2	30	3	3	9

Figure 1. The total classified status of the ventilation as function of the classified rate of workers symptoms.
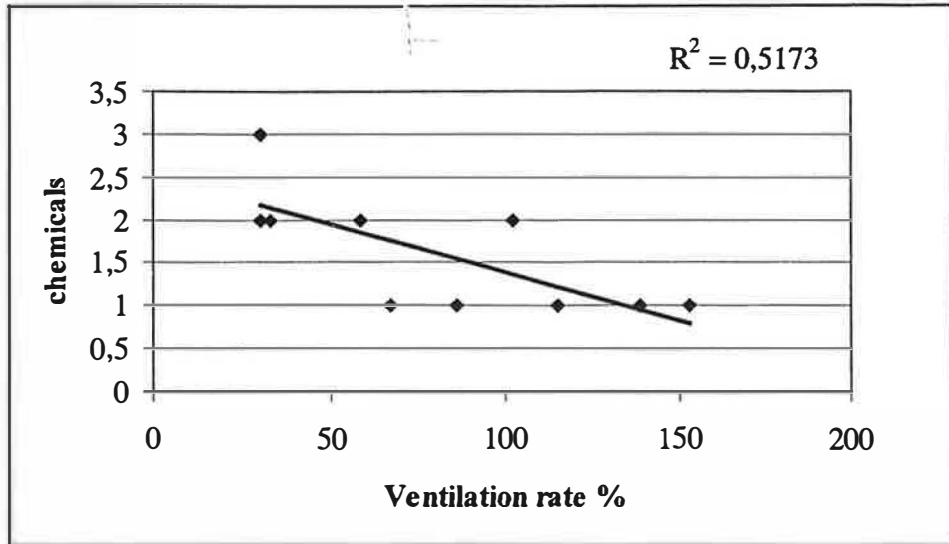
$$R^2 = 0,5173$$

Figure 2. The ventilation rate of the buildings against to the classified measured
percentage of chemicals. The class of chemicals depends on amount of
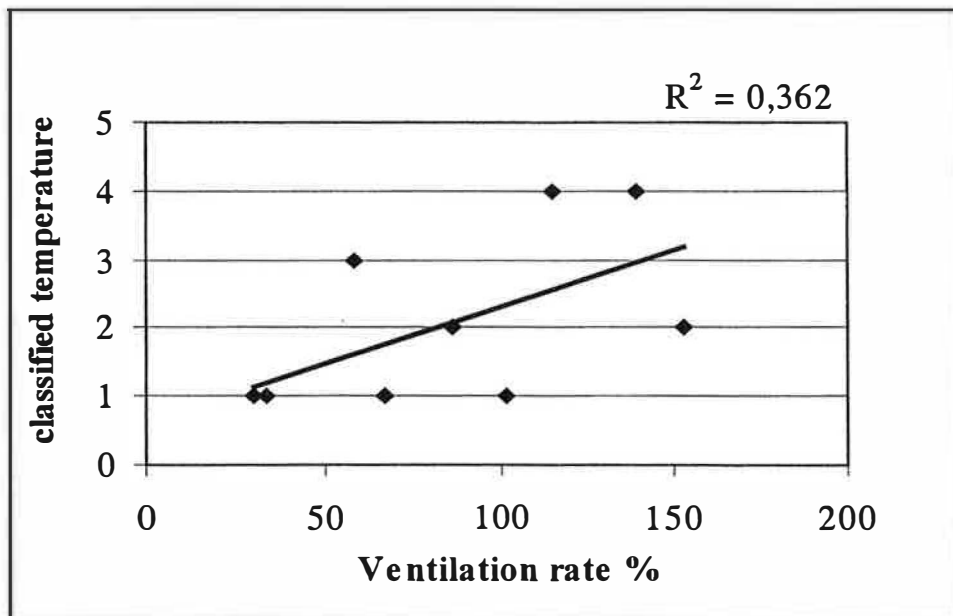components were outside the indoor air quality class 2.

$$R^2 = 0,362$$

Figure 3. The ventilation rate against the classified temperatures in the dwellings. The
Classified rate of temperature is depending how many of temperatures were
outside the indoor air quality class 2.

Discussion

The ventilation rate varied from 30 % to 150 % of recommendation rates. There was none documented maintenance program for ventilation. Still the maintenance was mainly in good conditions, but the timetables and procedure were in the mind of experienced service mans. The documented maintenance system started to build up during the study in this organisation. The registered faults of ventilation were single and these defects can be seeing in some indoor air parameters, but not in statistic.

The indoor air quality in the studied buildings was mainly in the class 2. Tendency of exceptions in temperatures was always below to the lower limit of recommendation, 21-23 °C. Figure (1.) show, that when the ventilation volume was high, then the classified temperature was poor. So the temperature of the supply air of the ventilation system was too low generally.

The percentage of chemical agents was in indoor air mainly in the quality class 2. Single exceptions were found, but the content was only a little bit over the limit of class 2. When the ventilation rate was low, exceeding of limits were more numerous (figure 2). The recommended ventilation rate, 100%, seemed to be a very good recommendation and exceeding of the classification limits of chemical agents at this rate of ventilation didn't occur.

Status of the ventilation system was found out also in the questionnaire. Symptoms related to work rised when the total status of ventilation was poor. The most mentioned symptoms were irritation of nose and the biggest complements concerned about unpleasant odour and stuffy air.

The class-2 of indoor air quality is attainable in this kind of buildings by ventilation. Primary we need that the rate of ventilation is according to the recommendations and the supply air temperature is correct. Secondly we need to develop and support the maintenance system for ventilation. Then also the workers symptoms and complaints are few.

References

1. MM-40-FIN: Questionnaire of Indoor Air: Institute of Occupational Health, Helsinki. 1995
2. ISO 7726: Thermal environments and methods for measuring physical quantities. International Organisation of Standardisation: Geneva 1985. 35p.
3. EN 482/1994: Workplace atmosphere- general requirements for the performance of procedures for the measurements of chemical agents. European committee for Standardisation: Brussels 1994.