VENTILATION IN DUTCH HOUSES –

A STUDY IN A REPRESENTATIVE SAMPLE OF THE DUTCH HOUSING STOCK

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1. Introduction

The goal of this study was the determination of the existing situation in houses with regard to air quality and energy used for ventilation in relation to the health of inhabitants. For the energy policy the Government is considering increased energy requirements for dwellings. They are permanently opposed in doing so by people who are concerned about negative health effect due to increased requirements on for instance air tightness of buildings. To have at least a reference point, they are interested in the existing situation. The objective was to get information for houses on:

- existing air quality
- the relation between IAQ and the way inhabitants use their houses, including the use of the ventilation provisions
- the air tightness of the houses
- the real temperatures
- other parameters determining the energy performance

The set up of this project was:

- an enquiry in 1000 houses which should be as representative as possible for the Dutch housing stock concerning the ventilation, comfort and some health related aspects
- measurements in about 100 houses on ventilation and temperatures during a whole heating season and the air tightness
- detailed measurement in 10 houses on IAQ, ventilation, temperatures and energy related parameters, to get information on the distribution over time

In this publication there is no results of the details measurements are given. The reason for this is that not all analysis have yet been done.

2. Sample of the Dutch housing stock

The Dutch housing stock consist of 6 million houses. A separate study was made by some specialist to find the housing estates that were representative for the Netherlands particularly in relation with ventilation aspects.

Representative for instance in terms of:

- Location
- Exposure
- Population density
- Dwelling type
- Year of construction
- Family type
- Ventilation system
- Heating system

Finally about 30 housing estates or sites were chosen. Some existing studies for which comparable measurement and enquiry data was available were added to make the the sample as representative as possible.

3. Enquiry

One of the studies which was added to this investigation was the so called GGD study. This study carried out by a group of municipality health organizations concern the possible differences in ventilation and health related aspects between houses with balanced ventilation and heat recovery and houses with other ventilation systems. In about 450 newly built houses with high energy performance (balanced ventilation and heat recovery) and about 450 houses in a reference group (natural ventilation systems and systems with mechanical extraction) an enquiry was held under the inhabitants. The enquiry used in both studies were almost identical and carried out by the same consultant.
For this study about 3000 families were approached with a questionnaire consisting of about 73 questions concerning:

- the dwelling itself
- the way the family use their dwelling
- cooking
- ventilation system
- the use of all ventilation provisions
- the satisfaction on their house
- the satisfaction on the ventilation system
- maintenance of the ventilation system
- the heating system
- health related aspects such as respiratory diseases
- family information

The most relevant and important results are summarized below. In the data is where possible also included data from the GGD study.

Some results are given in figures 1 to 4.

Ventilation

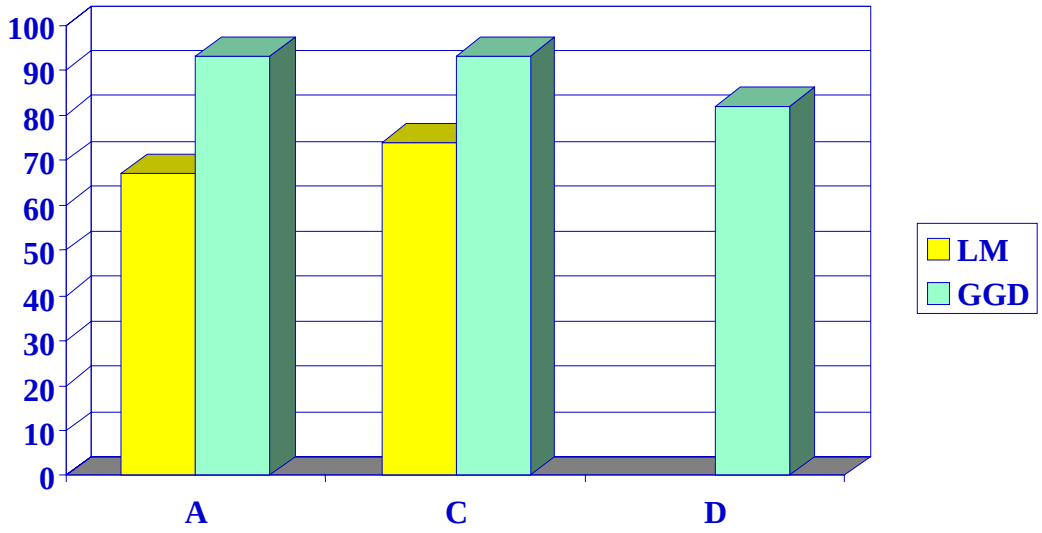

Figure 1 Satisfaction with the supply of ventilation in %

Ventilation system A is natural supply through grills or vents to rooms and natural exhaust from at least toilet, bathroom and kitchen, C is natural supply and mechanical exhaust and D is balanced ventilation with heat recovery.

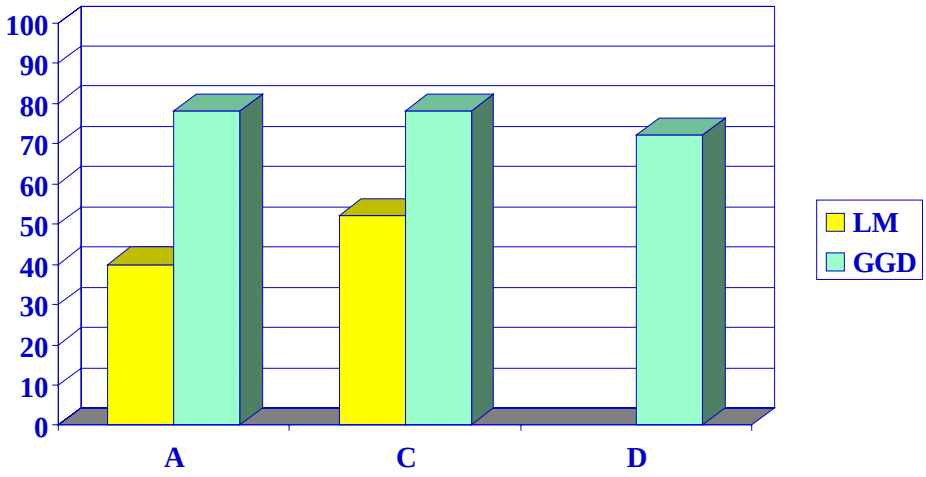

Figure 2 Satisfaction with the exhaust of ventilation in %

About 75 % of the families ventilate some times at lower levels than they themselves desire. The important reasons for this are:

- burglary
- to low temperatures
- draught
- noise
- energy
- nasty smells

Heating

Some data of the heating system:

- 10 % of the houses have no central heating system
- 73 % of the houses have central warm water heating with a room thermostat.

Answers to questions to inhabitants about the thermostat settings deliver averaged over all houses the following:
–19.4°C during daytime
–15.2°C during nighttime

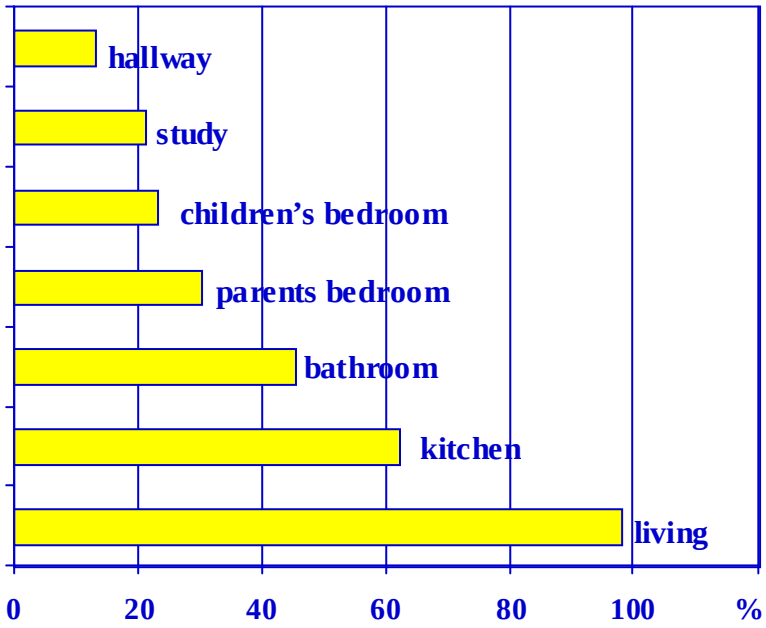

Figure 3 The use of warm water radiators in the different rooms

Health

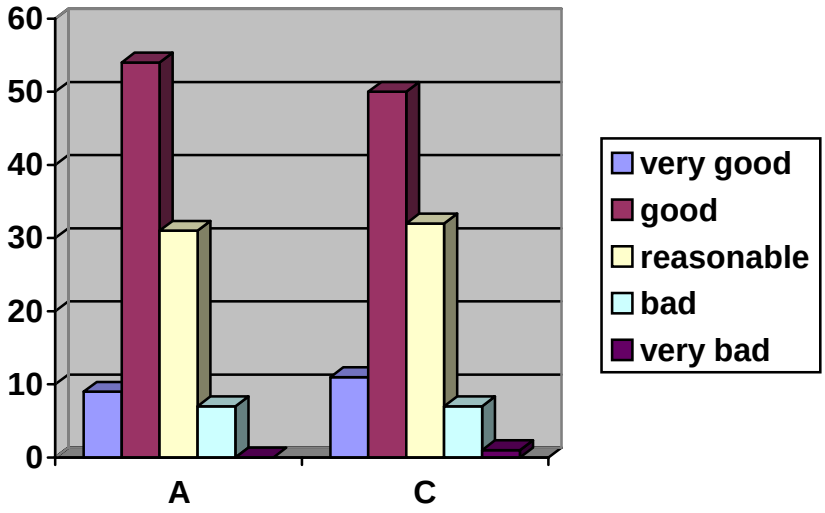

Figure 4 Answers on general occupants judgment about their health for ventilation system with natural supply and exhaust (A) an system C natural supply and mechanical exhaust (C)

More than 60 % of the families say to be in good or very good health condition. One third is reasonable and 7% is in bad health conditions.
In 12 % of families investigated people answered to have health problems of which they are thinking to be related to their dwelling.
In 22% of the families is someone where a medical doctor has determined a respiratory decease.

4. Measurements

Eventually in only 88 houses measurements were carried out:

- Passive tracer gas measurements (PFT) in living, kitchen, two bedrooms and bathroom during the heating season
- Heating season average of temperatures in living and bedroom
- Measurement of mechanically extracted airflow where applicable
- Measurements of the air tightness of the house

The most important results are summarized in the figures 5 to 8 .

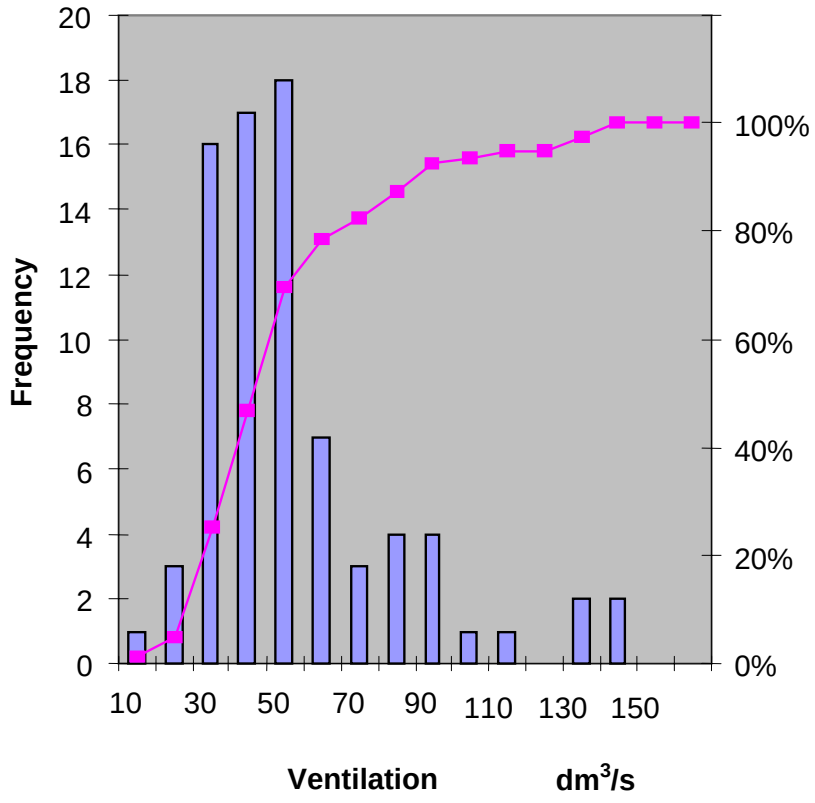

Figure 5 Results of PFT measurements averaged over the dwelling

The average over all dwellings during the heating season was about 58 dm^3/s.

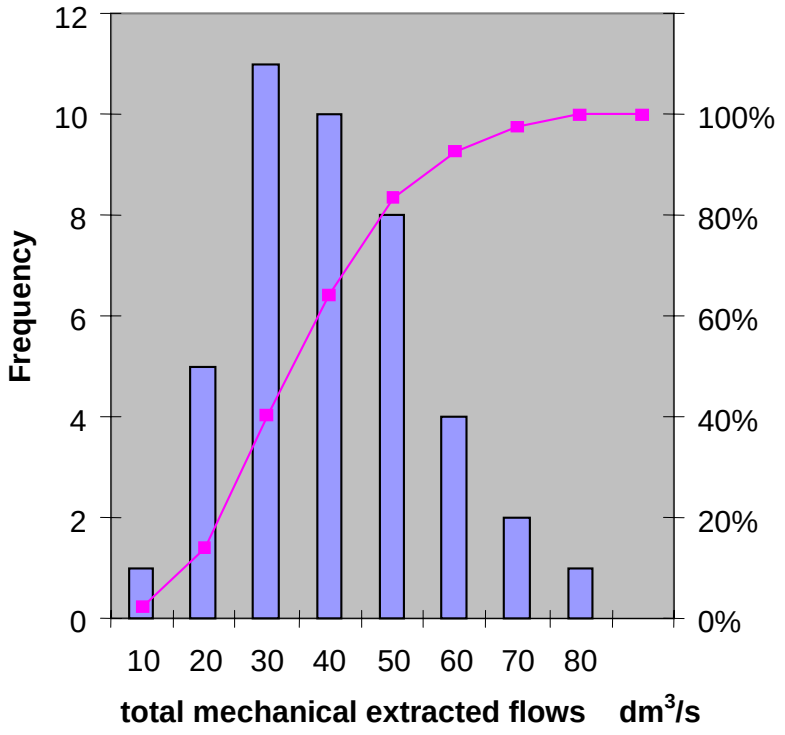

Figure 6 Distribution of total mechanical extracted flow rate at maximum fan position.

The average over all dwelling was 37.4 dm^3/s.

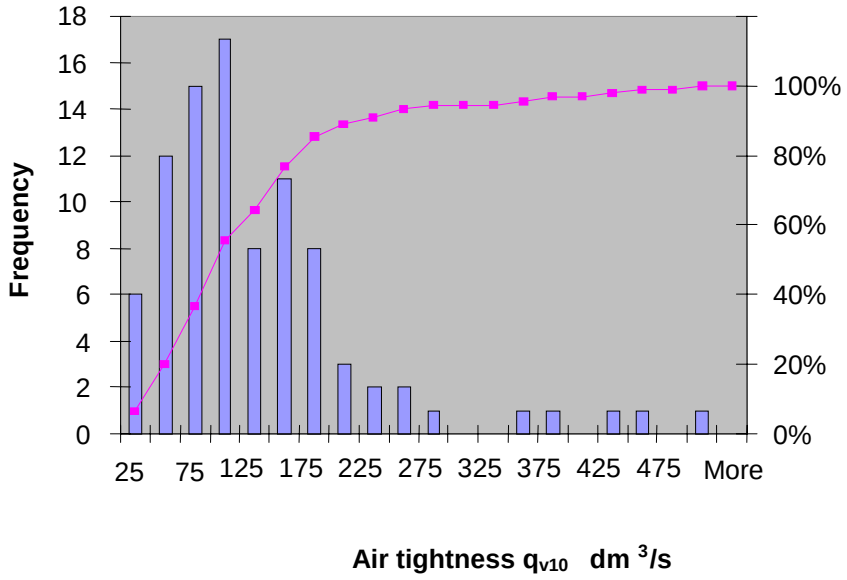

Figure 7 Distribution of air tightness of the dwelling

The air tightness of buildings in the Dutch building regulations is expressed as a flow rate at 10 Pa pressure difference. For comparison the relation between q_{v10} and N_{50} is depending on the flow coefficient (n) a division by about 25 – 30. The average air tightness (q_{v10}) is about 113 dm^3/s which equals an N_{50} of about 3.5 to 4.5.

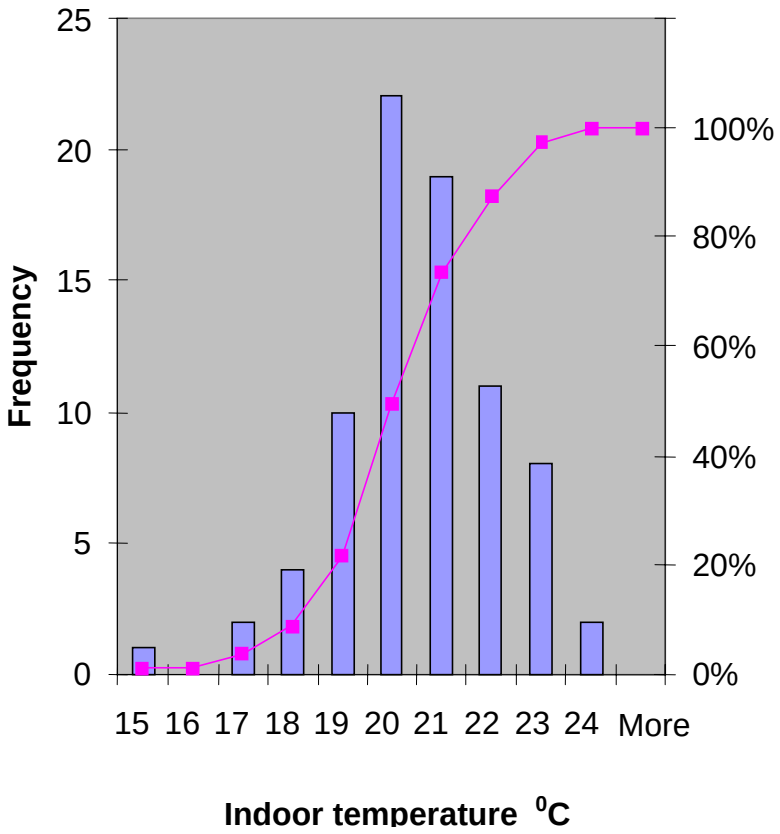

Figure 8 Distribution of the average indoor temperature in the dwelling

The average measured indoor temperature in the heating season was 19.9 ^{0}C.

5. Analysis

Enquiry: *Health*

There are according to the answers of the occupants almost no differences in their feelings about health between families living in houses with and without mechanical extraction. (see also figure 4)
The most important complaints about health are:

- Running nose
- Headache
- Dry nose or lips
- Dryness, irritation of the skin
- Eye irritation
- Fatigue
- Tightness of chest
- Sore throat

By families who are dissatisfied with their dwelling and or their ventilation system the frequency of respiratory decease is higher. These needs further investigation.

Enquiry: ***Satisfaction about ventilation system***

About 80 % of the families are satisfied about their ventilation in general.
People are more satisfied about the supply then about the exhaust of air.
The most important complaints are:

- draught
- dust
- condensation on windows

In more recently built dwellings there are more complaints on:

- discoloring due to the ventikation system
- noise from the ventilation system
- draught caused by the mechanical supply

In more recently built dwellings there are less complaints on:

- draught from natural vents
- dust
- condensation on windows
- nasty smells

Measurements: ***Mechanical extracted flowrates***

The maximum of mechanically extracted flows are in about 50% of the cases not according to the Dutch Building Decree. The requirement for kitchen, bathroom and toilet together is 42 dm^3/s.
In 10 % of the dwellings the extracted flowrate is even lower than 20 dm^3/s. This indicates shortcoming of the installations themselves, but it can also be explained by bad maintenance. In about 10% however the extracted flowrate is higher than 60 dm^3/s. This may lead to unnecessary energy use.

Measurements: passive tracergas

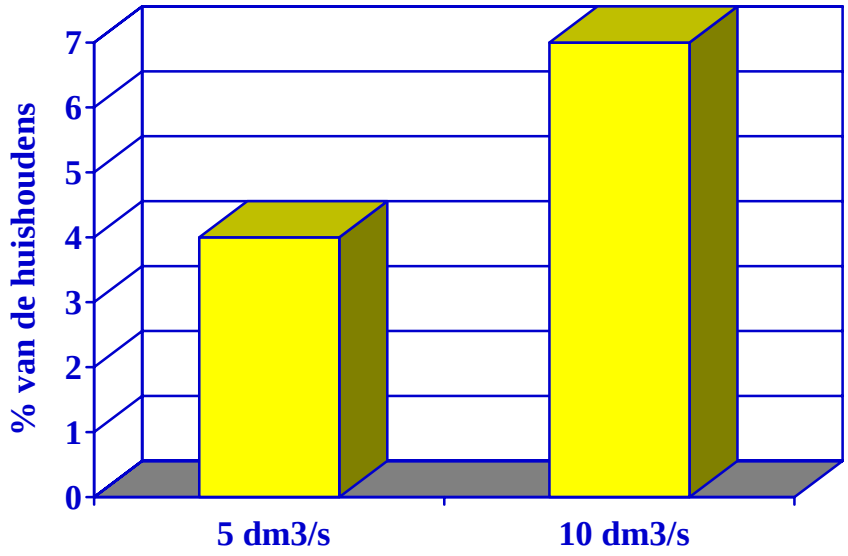

Figure 9 The average flow rate per person for the lower tail of the distribution of figure 5.

The average over the heating season of 58.3 dm3/s seems to be rather high. This does not mean that every person at any time has the right minimum flowrate.
But as a total it is above the level required in the standard where 42 dm3/s is the minimum for a normal dwelling
From the IAQ point of view it is interesting to analyze the lower tail (< 30 dm^3/s) of the distribution of figure 5 with the number of persons in the family. Results are given in figure 9.
There is no person in these dwellings with an lower average ventilation during the heating season than 5 dm3/s. Only 4% of the families falls in that category.
In 7% of the lower tail distribution the average flowrate person is no less than 10 dm^3/s. The analysis of the upper tail of the distribution which is important in terms of energy use delivers also remarkable data. See figure 10.

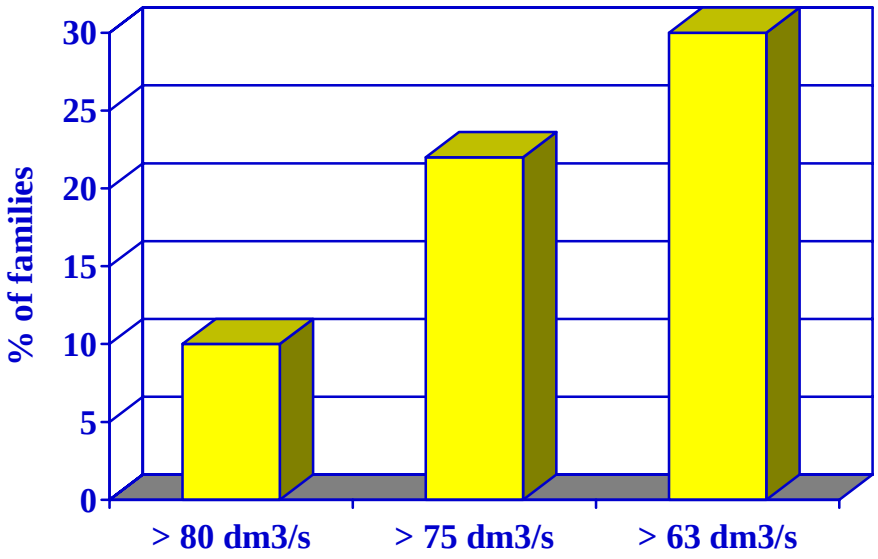

Figure 10 Total flowrate per dwelling over the heating season for families with 1 or 2 persons.

From figure 10 one can easily draw that over ventilation in winter also take place. About 30% of the families have a higher total flowrate averaged over the heating season than 63 dm^3/s.

The average measured ventilation over the heating season is about 58 dm3/s for the total dwelling which is about the value (60 dm3/s) taken into account in the Dutch energy performance standard.

Demand controlled ventilation may overcome the problems for as well to low as to high ventilation.

Measurements: relations between ventilation related measurements

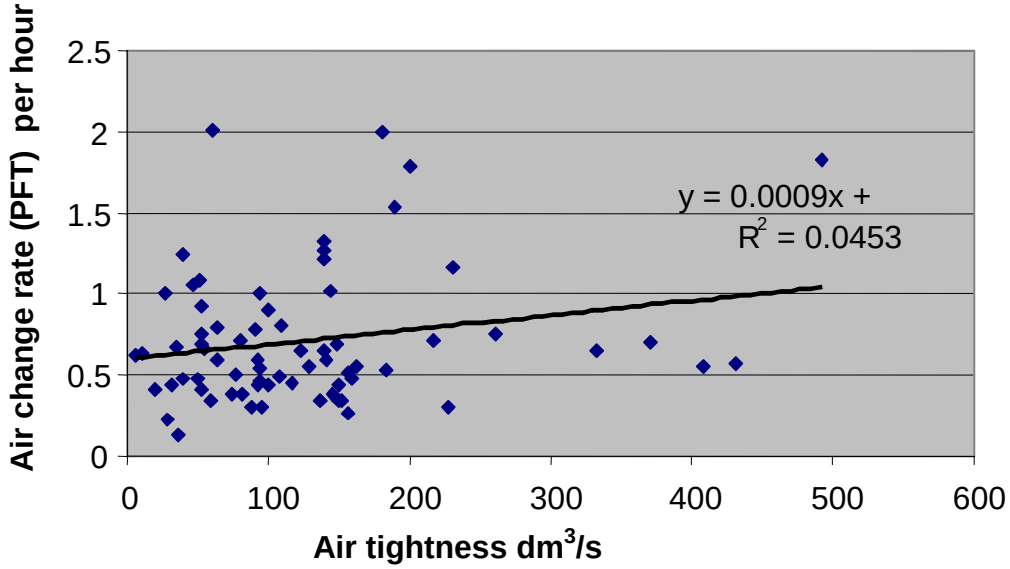

Figure 11 The relation between air tightness of the dwelling and the average measured air change rate

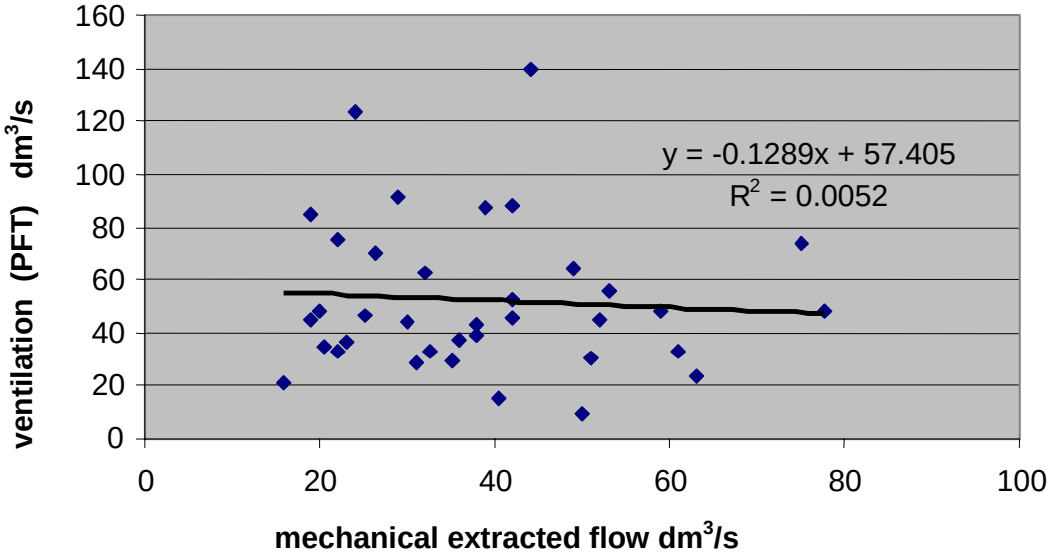

Figure 12 The relation between mechanical extracted flow and the average measured total flow per dwelling

From figure 11 and 12 no significant relation can be shown between the measured total ventilation (PFT) during the heating season and air tightness of the dwelling nor with the mechanical extracted flowrate.
This suggest that other factor determine the ventilation. The only explanation which can be given is the use of the ventilation provisions such as windows by the occupants.

6. Conclusions

- The ventilation of Dutch dwellings in general is not very bad .
- In only 4 % of the cases the average flow rate per person is about 5 dm^3/s.
- The average flowrate over the heating season is in 30 % of the dwelling higher than 63 dm^3/s.
- The general fear under people that air tight dwellings lead to bad IAQ cannot be confirmed by the results of this study.
- Higher requirements on ventilation in the Dutch Building Regulation cannot be justified on the basis of this study.
- The ventilation of dwellings seems to be more depending on the use of the ventilation system than on the air tightness of the dwelling or the type of ventilation system
- Improving ventilation in practice requires better information to occupants
- Demand controlled ventilation can improve IAQ as well as minimise the energy use needed for ventilation
- Further investigation in the reasons for the high prevalence of respiratory deceases is needed.

7. References

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Onderzoek naar de bestaande situatie met betrekking tot de optredende luchtkwaliteit en het daarmee gepaard gaande energie gebruik in relatie tot gezondheidsaspecten voor een representatieve steekproef van het Nederlandse woningbestand.
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