QUALITY OF DOMESTIC VENTILATION SYSTEMS IN SWEDEN

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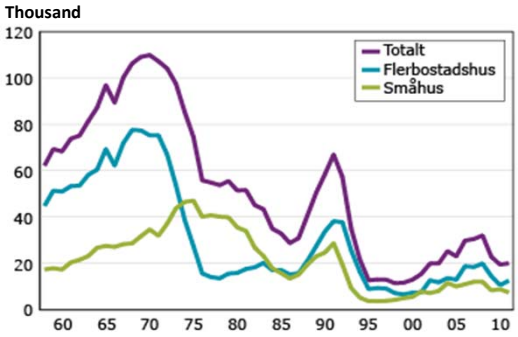
Swedish Dwellings

- 4.4 million dwellings in Sweden are divided in rather equal parts between multi-family buildings (2.4 million) and single-family houses (2 million).
- 40% of the dwellings in multi-family buildings are privately owned (as all the single-family houses) while the rest (60 % of the dwellings) are rented.
- The age of the buildings, which of course influences the installed type of ventilation system, varies:
  65 % was built before 1970,
  14 % during 1971-1980,
  8 % 1981-1990,
  7 % 1991-2000, and
  6 % after 2000.

Number finished dwellings in Sweden (**totally**, **multi-family houses** and **small houses**)



Distribution of ventilation system types in the residential building stock in Sweden

Type of system	Swedish System Designation	Distribution %
no ventilation system	-	-
natural supply and exhaust	S-system	40
natural supply and mechanical exhaust	F-system	40
natural supply and mechanical exhaust with heat pump	FVP-system	8
mechanical supply and natural exhaust	(T-system)	0
mechanical supply and exhaust without heat recovery	FT-system	4
mechanical supply and exhaust with heat recovery	FTX-system	8

Problem 1: Oil Prices and Sick Buildings (SBS) Ventilation System Changes

- The first oil crisis 1972 often lead to a change of systems from natural ventilation to mechanical extract.
- Increasing energy prices and a trend toward sustainability have further lead to balanced ventilation systems with heat recovery or mechanical extract systems with heat pump.
- Many Swedish and Nordic studies showed that defective and badly maintained ventilation systems and insufficient airflows was a main reason for sick buildings. One large study showed e.g. that this resulted in health problems for children at home, in schools and day nurseries.

Problem 2: High indoor radon levels in Swedish dwellings

- Another problem with ventilation of dwellings has also been identified – **the impact of radon exposure on humans**.
  There are two facts making this a major problem – up until 1975 it was very common in Sweden to use radon emitting **(blue) light concrete** ("Alum Shale Concrete") as a construction material.
  This coincided with a period with extensive building activities – between 1965 and 1975 **one million dwellings** were built in Sweden.
- The other factor regarding the radon problem is that about ten percent of all multi-family and single-family houses are built on **high radon ground**.
  The **cure:** tighten the slab and/or creating under pressure under the slab.
- Estimation shows that out of the ca. 3,000 people that die from lung cancer every year in Sweden ca. 500 die as a result of excess levels of radon in homes. Almost **half a million homes in Sweden are so badly affected by radon that they need to be sanitized**.

Problem: High Radon Levels!
One solution: Better ventilation but lack of interest!

- The Swedish Radiation Protection Agency SSI estimates that about 150,000 homes have a radiation level higher than 400 Bq/m^3 compared to the threshold value of 200 Bq/m^3. A similar amount of homes probably have a radon level between 200 and 400 Bq/m^3 which also is far too high.
- In 2003 the national program for radon decontamination of single homes set aside a fund to help home owners to finance improved ventilation (15,000 SEK per home) but the interest from the home owners to apply for this subsidy has been very low!

A new building law requiring ventilation control

During the 1980-ies several studies reported health problems from emissions in badly ventilated dwellings.

This resulted in in a new Swedish law requiring compulsory inspection of ventilation systems – the OVK commissioning system – mandatory control of ventilation systems with aim to control and improve the function of ventilation installations.

The ordinance (1991:1273) requires that the ventilation in most types of buildings has to be controlled before the installations are taken into operation and then regularly at recurrent inspections.

OVK - Compulsory inspection of ventilation systems

The inspection shall control that the systems meet requirements as at time of construction – not today's requirements.

Ventilation shall be controlled in all buildings except:

- One and two family houses with natural ventilation
- One and two family houses with only exhaust air
- Agricultural buildings and buildings for the forestry industries
- Industrial buildings
- Secret defense installations.

Which means: all the other are included!

Regular inspection intervals

The stipulated inspection intervals depend on the type and use of the building and type of ventilation system:

Type of building and ventilation system	Inspection intervals
Day nurseries, schools and hospitals	3 years
Block of flats and offices with FT-ventilation	3 years
Block of flats and offices with F-ventilation	6 years
Block of flats and offices with S-ventilation	6 years
One and two dwelling-houses with FT-ventilation	only first inspection (new buildings)

FT = Supply and extract

F = Extract

S = natural ventilation

AMA

General Material and Workmanship Specifications

A SIXTY YEAR OLD SYSTEM FOR SPECIFYING QUALITY

- AMA is a tool for the employer (developer/future proprietor) to specify his demands on the new building and its installations
- The demands are specified in measurable units and in such a way that the tenderers and contractors understand them and are able to calculate a price.
- Swedish ventilation products manufacturers are normally, in their catalogues and otherwise, referring to the quality requirements stated in VVS AMA (HVAC AMA, marked with the red ring above).

AMA is always used – by all!

- The AMA requirements are made valid when they are referred to in the contract between the owner and the contractor.
- Practically all buildings and their installations in Sweden are performed according to the quality requirements in AMA.
- Designers refer to the AMA quality requirements regarding product characteristics in their building specifications for HVAC systems and the installers (have to) follow these product and system requirements.
- It is based on accepted demands – these are regularly updated in accordance with technology development and (LCC-)costs.

Examples of AMA ventilation requirements

- **Tightness** of ductwork with components – Class C
- **Material**: Corrosivity classes C1 – C5 and protection
- **Tightness** of Air Handling Units – Classes L1 – L3
- **Fans** – bearings (min 40000 h), balancing (< 4.5 mm/s RMS), safety devices
- **Heat exchangers** – all types, tightness control, etc.
- **Air filters** – G1–F9/H10-U17, final pressure drop, collecting efficiency, etc.
- **Humidifiers** and dehumidifiers
- **Dampers** – pressure classes, tightness classes, control
- **Noise attenuators** – tightness, material, installation
- **Ductwork** – material, installation, hangers, circular and rectangular ducts
- **Insulation** of ductwork – materials, installation methods, covering, etc.
- **Control and reports** – noise, tightness of ductwork and AHUs, airflows, etc.
- **Airflow adjustment** – methods and reports
- **As-built drawings**, manuals, etc.

AMA vs. Authority regulations

- The AMA requirements cannot change, but are complementary, to statutory rules, regulations and specified building standards laid down by the authorities.
- There is a difference between the two: Authorities are mostly focussed on reducing the risk of injuries to people while
- AMA (not having to deal with that) is instead focussed on reducing property damages and LCC-costs.
- Common interest areas for both are to achieve sustainability and low energy use.

CONCLUSION

The quality of ventilation systems in residential buildings must correspond to demands on air quality, thermal climate, low noise levels, low energy use and sustainability.

In order to make this possible we need to supervise the quality of systems and components, check the workmanship during installation, control by commissioning that the installations are following the intended design and – if not – are changed to fulfill the contract conditions and our demands.

But a well performed work is not worth the money invested in the system unless it is taken care of by a well-suited maintenance that that makes it possible to maintain the quality during the coming years.

What will happen in the near future?

- The awareness of the importance of having a well-functioning domestic ventilation system has increased in the latter years due to information from authorities, trade organizations and companies – but more could still be done.
- According to the Swedish national environmental legislation: "in the year 2020 all buildings shall be healthy and have a good indoor environment".
- One of the intermediate goals within the frame of good indoor climate is that: "all buildings where people stay often or during a longer time shall 2015 at the latest have been proven to have a functioning ventilation system".

Table 1: Quality of residential systems

Topic	Major causes of quality problems	Existing quality schemes or incentives
Product	Designed and specified products are changed to other than specified	Follow the specification or be aware of the consequences, AMA
Design	Design for simple installing, maintenance and future exchange	None in use
Installation	Lacking quality control; specifications are not followed	Control and measure that you have got what you pay for, AMA
Commissioning	Too fast and not detailed	AB and AMA; OVK
Maintenance	It is missing; manuals missing, unskilled personnel	Control and plan the maintenance and need of renovation and exchange
Inspections	There aren't any; supervision instruments are missing	Regular OVK inspections, energy auditing, authority demands on functioning ventilation