# OPTIMAL AIR TIGHTNESS LEVELS OF BUILDINGS

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## 1. Introduction

The air tightness of building has been a serious problem over the last 30 years. In 1979 the international Air Infiltration Centre (AIC) was erected within the International Energy Agency (IEA) platform. Infiltration of cold air into buildings needs to be heated to reach to a comfortable indoor climate. But the energy penalty due to that should be minimized. The AIC (later AIVC) had as one of their tasks to find solutions for good air tight buildings and to promote the knowledge about building construction to reach acceptable level of air tightness of buildings. Many publications were produced. The slogan was and is “Built tight and Ventilate right” The problem of air tightness is still important in the building practice of these days. Last year in 2010 TightVent Europe was formed to cope with the problem of air infiltration due to building leakages in low energy buildings. The big question is are buildings still too leak ? To find an answer on the above question the reasons for airtight buildings should be considered.

## 2. Why air tightness of buildings

The air tightness of buildings is necessary because several aspects are influenced by uncontrolled leakage of air through buildings. The most important aspects are:

- Health
- Building damages
- Comfort
- Disturbance of ventilation
- Energy

### *2.1 Health*

From the health point of view a building must be heated at least at a level that the heating system in the building may reach temperature by which people can perform normal tasks. This is partly a design problem for the heating system but to high local leakages may cause problems of to cold areas in buildings. In the developed countries of the world nowadays the level of air tightness of buildings may not any longer cause problems of to cold areas in buildings. But in very cold climate eastern countries this effect is still eminent.
Uncontrolled infiltration of outside air has as unavoidable effect also exfiltration of warm some times humid air through the building fabric. Microbiological growth of all kind of species can take place in the building construction itself. Because the wind direction on

buildings is not constant and may vary after some time the spread of the microbiological species into a building may happen due to a period of infiltration of air. See figure 1.

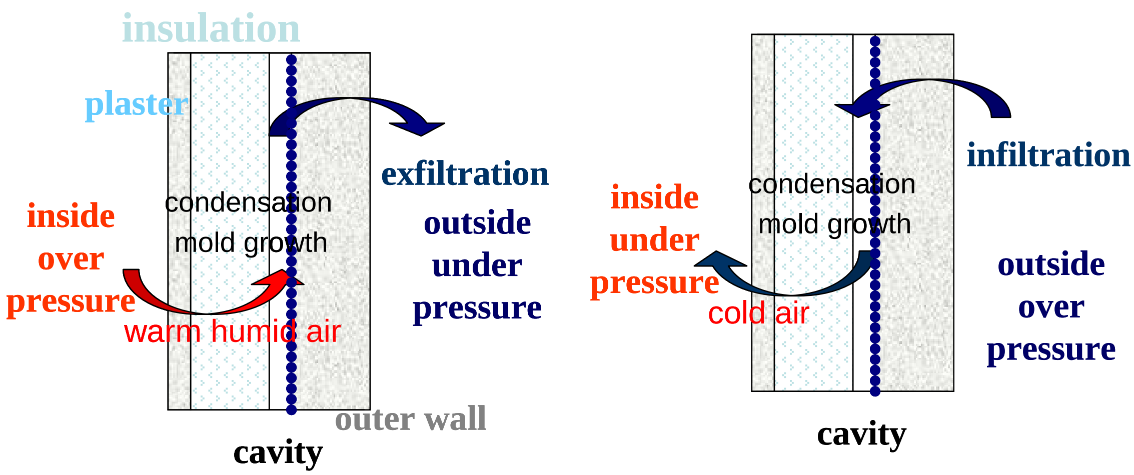


Figure 1 Infiltration and exfiltration related to mold growth

Some people have the hypothesis that this effect is one of the reasons for lung related health problems by sensitive persons such as young children.

### *2.2 Building damages*

The same phenomenon as mentioned above namely condensation in the building construction may cause detrimental effects on the building structure itself. The construction may loose its function and may in extreme cases collapse. Especially in roof constructions in very cold climates this may happen and is a very serious reason to protect the construction for condensation in voids spaces such as cavities.

### *2.3 Comfort*

The distribution of the air leakage over the building envelope play an important role related to comfort. Although the whole building may have achieved a reasonable air tightness level during its construction, local leakages in such cases may cause comfort problems. A cold air stream is coming through seems or joints in the construction a persons in the room are complaining about draught problems. Some times this phenomenon appears even through electrical sockets. A hole of about 4 mm and a jet of relatively cold air is blowing along the neck of a sitting person.
As described in paragraph 2.1 under health infiltration of could air may also case in less extreme cases comfort problems because the distribution of heat is disturbed.

An completely other aspect of comfort the hindrance due to too high under pressures in case the exhaust system is working but the designed supplies are closed. A inhabitant may experience this in two hindrances:

1. noise problems such as whistling and fluttering sound through the building envelope
2. to high under pressures in the building and as a cause of this, slamming doors.

### *2.4 Disturbance of ventilation*

In case the infiltration is so high through one façade that the incoming flow rate is higher than the exhaust fan capacity exfiltration may occur. Exfiltration always means an energy penalty. Some rooms in the building may have due to this phenomenon during a lot of hours bad indoor air quality conditions. Polluted air from windward situated rooms is transported to leeward side rooms. The supply of outside air which was intended with the designed ventilation system is completely disturbed.

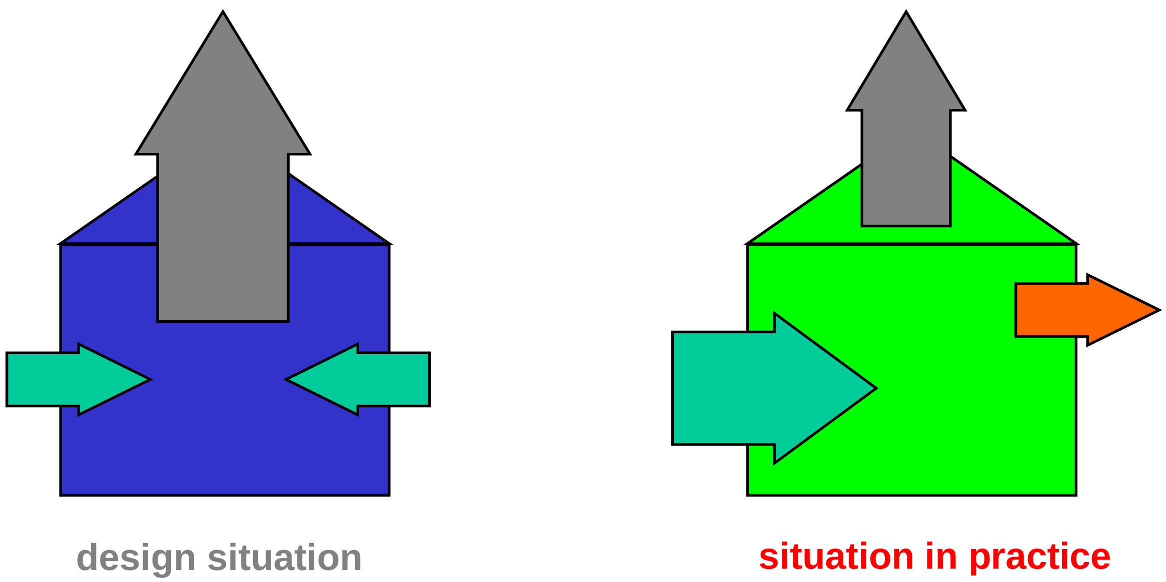


Figure 2 Disturbance of infiltration on the designed ventilation

### *2.5 Energy*

It is quite clear that the lower the air tightness level of a building the higher the energy use for heating. (see figure 3) Because the cold incoming air will be heated to a temperature at which the occupants experience thermal comfort.

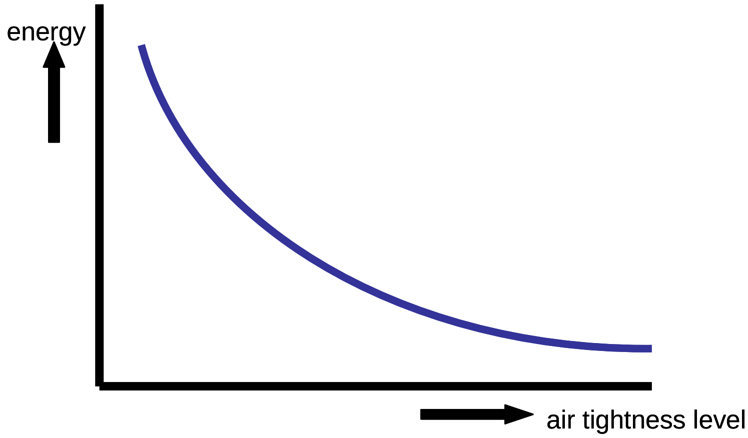


Figure 3 Relation energy use for heating and air tightness level of buildings

Nevertheless not all infiltration may be seen as a loss. In some demand controlled ventilation systems with for instance $CO_2$ control part of the infiltration may be used to dilute human effluents for which $CO_2$ is used as a marker. The $CO_2$ sensor may not see the difference of purposed provided air through the ventilation system and the infiltrated air through leakages in the building. So the question here is how much of the required air should come from the ventilation system and how much is allowed to come through leakages.

So there must be an air tightness level above which it is not any longer very efficient to make a building airtight.

All electrical and electronic appliances in homes have a lot of led signals which are burning and cannot be switched off. So they are using electrical energy 24 hours a day and 365 days a year. In homes the number of this signal leds of electronic equipment may be about 30 to 40 using in some cases together more than 7 to 10 W. Why should you take a lot of effort to increase the air tightness level of your building while all electronic equipment is using is using even more energy?

3. **Is there an optimum ?**

Considering the cost for energy and the cost to make building better air tight, there should be an optimum. Indeed normally people don't know about exact data for the relation given in figure 3 nor about the relation between the costs to realize the air tightness level of a building.

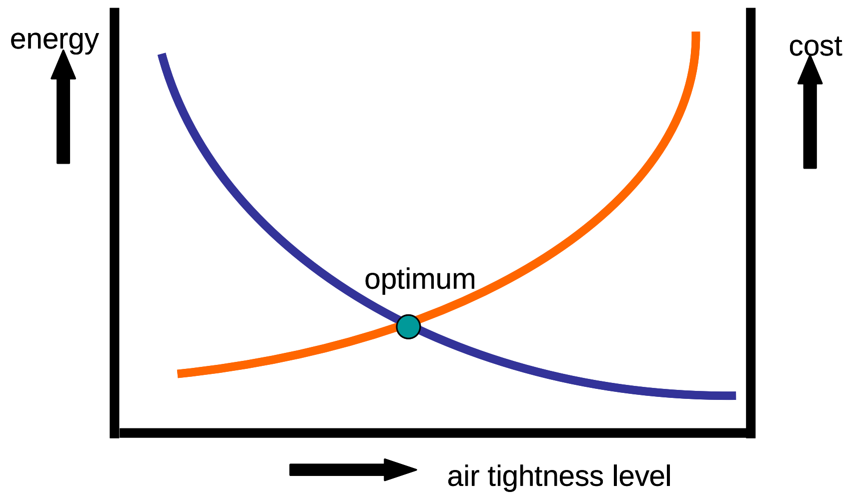


Figure 4 Possible optimum for air tightness of buildings

4. **Discussion**

- To find an optimum for air tightness of buildings you need good and precise data for the relation with energy and for the relation with cost to realize the air tightness. This data is generally lacking. More information is needed. Who is starting gathering this information? There is a need to come to defendable levels of air tightness

- For passive housing a $N_{50}$ value of 0.6 ACH is often used or even required. Without the knowledge of the relations given in figure 4 is looks strange to put forward such high levels of air tightness. What can be realized during building construction practice may not automatically be the target figure for all low energy buildings.

- Who is able to justify these high levels of air tightness? The building and energy sector are waiting for a real rational and a good motivation.