Airtight duct systems
[a simple way of improving a building's energy efficiency without increased investment]

Toni Nicolas Salame[1], Rodrigo Sanz[2], Santiago Pascual[3]

1 Industrias Gonal, S.L.
Can Macia, 2
Les Franquesas-Spain

2 Industrias Gonal, S.L.
Can Macia, 2
Les Franquesas-Spain

3 Industrias Gonal, S.L.
Can Macia, 2
Les Franquesas-Spain

ABSTRACT

Against the background of increased global demands for energy efficiency, property owners should raise the standards of ductwork systems for ventilation, heating and air conditioning. This would not only save energy, but also mean lower installation costs, shorter assembly times and better air quality thanks to less leakage.

The importance of energy-efficient buildings will increase in the future, not only due to rising electricity prices, but also due to increased environmental awareness. One example of this is the Kyoto Agreement, which indirectly forces countries to review their energy use with the aim of reducing carbon dioxide emissions. A current example of the latter is the energy directive from the EU, which basically increases the demands on energy planning and on the energy performance of buildings. One way of satisfying the stricter energy rules can be to make demands of airtight ductwork systems for ventilation.

KEYWORDS

Ductwork, Ventilation, air tightness, rectangular duct, leakage,

1. INTRODUCTION

Ductwork systems for ventilation, heating and air conditioning can be divided into four air tightness classes. The most airtight class is D, and the least airtight duct system is categorised in the A class. Most modern systems rarely achieve air tightness class B. Thus, there is much potential for improvement here. In Europe, more airtight systems would mean an annual energy saving of approx.10 TWh, which is comparable to the annual production of three nuclear power plants.

2. ADVANTAGES

2.1 Lower investments costs

At present ventilation ducts are usually rectangular or circular. There are ductwork systems with integral sealing systems that can guarantee the highest air tightness class, D. A ventilation system often consists of a mixture of circular and rectangular ducts, in which the latter often find it more difficult to satisfy strict demands on air tightness. If we strive to ensure that as much of the duct system as possible consists of ductwork systems with integral sealing systems of air tightness class D, the whole system can ultimately achieve, savings to the order of 10 TWh.
We should therefore as far as possible replace standard ductwork with ductwork systems with integral sealing systems. The total cost of purchasing material and assembly is lower than a standard solution, meaning that the payback is immediate. This also means that no payback calculation is necessary.

Figure 1: Round metallic ductwork

Figure 2: Round thermoplastic ductwork

2.2 Shorter assembly time

If you have an integral ductwork sealing system, the assembly time is approx. 80% shorter, because no tapes and or sealants needed. The conclusion is therefore that the total investment for an airtight class D system is lower than for the poorer quality class A system. System planners should strive for a solution that is integral ductwork sealing system, and in some cases this may also produce new, innovative alternatives and close interaction with the architect about the installation areas.

Figure 3: Rectangular thermoplastic ductwork assembly

2.3 Smaller fans

In order for the right flow (and air conditioning effect) to reach the ventilated areas, the fans must transport the total flow, i.e. not only the air that passes to and from the
various areas in the building, but also the air expelled out of or drawn into the ventilation system. A system that leaks a lot thus requires larger, more expensive fans and more space in the building.

2.4 Improved health and internal environment

Besides the purely financial benefits of more efficient ventilation based on a integral sealing ductwork system, there can also be a positive effect on people's health. This is because a higher-quality duct system creates the conditions for buildings being well ventilated with the lowest possible energy use. Much current research indicates that the air quality in our buildings has a major impact on people's health and well-being. Improved air quality reduces absence through illness and increases productivity. And if the air is supplied in an energy-efficient way, this reduces the impact on the external environment.

3. APPLICATION

3.1 Act now

Stricter demands on duct systems thus produce nothing but positive effects. We should therefore define the requirements for air tightness as soon as possible, as early as the planning stage of a property. Otherwise we can expect unnecessarily high and escalating energy costs!
System planners should strive for a solution for air tightness, and in some cases this may also produce new, innovative alternatives and close interaction with the architect about the installation areas.

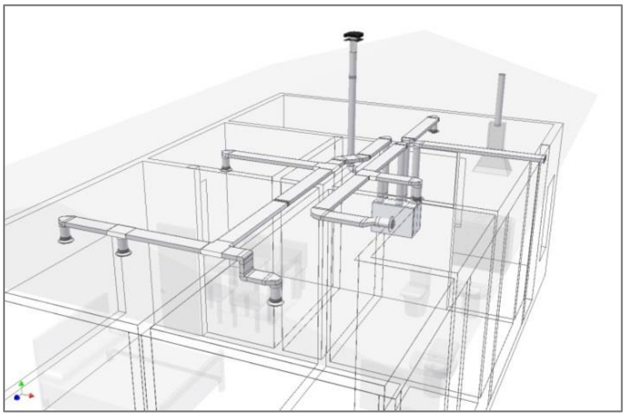

Figure 4: Rectangular thermoplastic ductwork application

3.2 Why is air tightness important?

If the ventilation system is not airtight, the leakage must be compensated with an increased fan flow. This requires an over-dimensioning of the unit's parts such as fans, filters, heater/cooling-coil batteries, heat exchangers, etc. All of this causes increased
energy consumption and hence increased costs and a greater impact on the environment than necessary. It is also not entirely uncommon for the leaking air to cause a disturbing hissing sound.

3.4 Air tightness to the surroundings

Leakage is a function of the system's size and of the pressure difference. A large system leaks more than a small one. Higher pressure also entails greater leakage. Leakage is specified in the unit l/s. The leak factor incorporates the system's size by specifying the leakage per unit of area. This is calculated as the system's total leakage
divided by its total casing area, and is written (l/s)/m². One complication is that it is not the system's area that leaks, rather its joints and connections etc., which is why systems with unusual ratios between components and ducts can produce peculiar results. The pressure difference is retained as a separate parameter. The diagrams that are used have the leak factor on one axis and the pressure difference on the other.

Figure 5: Ductwork Leakage Tester

3.5 Different types of air tightness

Air tightness is divided into the classes A, B, C and D, where class D is the most airtight. It is three times as airtight as class C, which in turn is three times as airtight as class B, and so on. Classes A–C were first defined in the publication EUROVENT 2/2.

The classification is intended for entire ventilation systems. In other words, it is not meant to be applied to individual products.

Testing air tightness normally takes place at a 400 Pa pressure difference. This is not a requirement, however, so testing may take place at any suitable pressure difference(s).

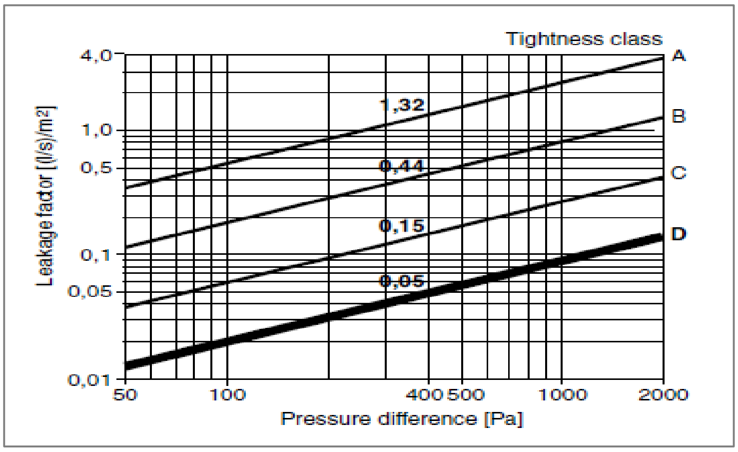

Figure 6: Tightness class according to EN 12237

3.3 Reduced comfort

If the leakage is not compensated with an increased flow, the consequence will be reduced comfort combined with poorer air quality and the wrong temperature. Furthermore, the planned air flows will not be achieved.

3.6 What can go wrong?

The most common causes of leaks are incorrect assembly, reduced product quality and products that have been reused.

4. PRODUCT

4.1 General

Inaccessible points are often leakage points. This is due either to the fact it has not been possible to access these points to screw in properly, or that the product must be specially built at the installation location in order to be assembled.

Components that have been reused or moved/turned often have old, non-airtight holes created by screws or adhesive tapes. These holes cannot be seen from the
outside of the system, but require an internal inspection in order to be discovered.

Components that are "produced" or adjusted/converted at the actual installation location often leak.

Quite naturally, components that are used outside of their intended function have difficulty remaining airtight. For example, where 60° bends are used where there is a 45° change of direction.

You should stipulate that the manufacturer of the products you use reports which air tightness class they satisfy – this means less worry for you.

4.2 Installation

Air tightness class D places high – very high – demands on the installation and on the fitters. Follow our installation instructions.

Screw holes must be sealed if components and ducts have been reused or moved. Otherwise the result will be leaking screw holes.

Installation using blind rivets that are not airtight must be avoided. The rivets' pull-stems can otherwise fall out of the rivets, resulting in leaking holes. This happens
particularly with low-price blind rivets.

Self-tapping screws are occasionally tightened so hard that they lose grip and simply spin around. They are then not so airtight.

Knives are often used as a guide when aligning the components in the ducts. There is then a risk of causing indentations on the ends of the components, resulting in leakage.

5. CONCLUSION

It is important to minimise the leakage in the system. Leakage has different consequences, and a majority of them in the end lead to increased costs:

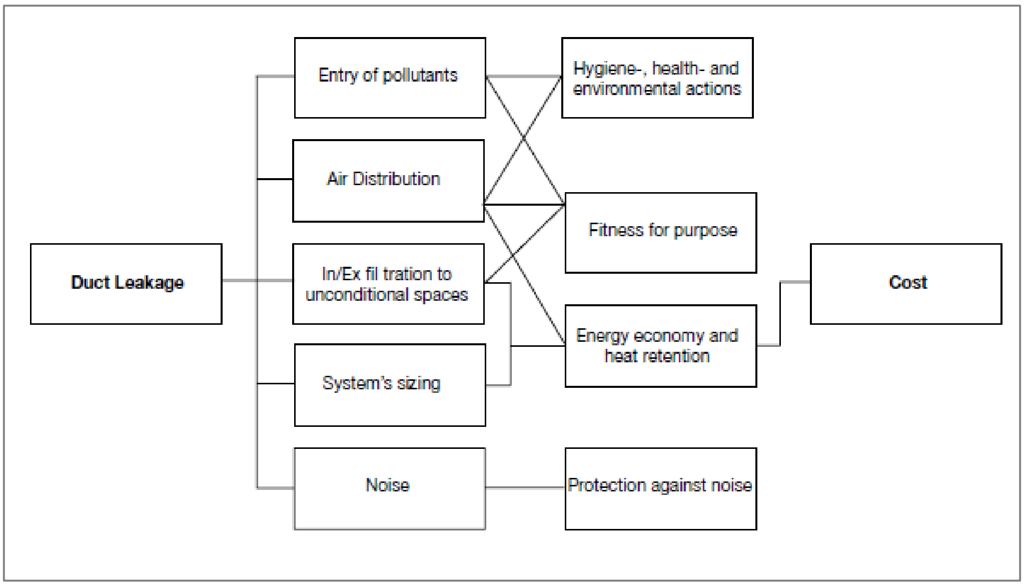

Figure 7: Leakage consequences

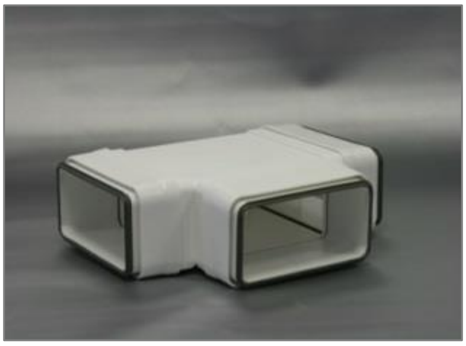

Figure 8: Rectangular thermoplastic ductwork

Figure 9: Rectangular thermoplastic ductwork

Checklist for an Adequate Ventilation System

To construct a proper ventilation system you should be able to tick all the boxes in the checklist below:

Good indoor climate

- Lack of draft
- Low noise level
- Appropriate temperature
- Good air quality

Low energy use

Simple adjustments

Low life cycle cost (total cost)

- Material cost
- Installation cost
- Heating/cooling cost
- Fan electricity cost

Easy to operate and maintain and equipped with detailed instructions.

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