Development of an Energy Labelling for Ventilation Units

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ABSTRACT

The actions to limit the energy consumption and the electricity demand lead in Europe and in France to think about the energy labelling of the consumption of the fans used in ventilation systems. This is a complicated task as it has to take into account the multiple possible operating conditions, the eventual presence of a regulation system and the type of use.
A study supported by Ademe has been carried out in order to propose a method for labelling of the ventilation units. This study was divided in four phases. First phase consisted in a review of the available characteristics of the products present on the French market completed by tests on different representative products. Second phase was concerned with the development of representative criteria to define the electrical consumption. The third phase consisted in measurements of the consumption in real operating conditions on site in order to bring validation elements to the results of the second phase. The fourth phase consisted in the study of the possibility of the extension to the Europe of the method developed.
This paper is rather focused on the method developed to calculate for each type of fan unit the criteria of electrical consumption and the comparison with consumption measured in real conditions on site.

KEY WORDS

Ventilation, electrical energy consumption, labelling, classification

INTRODUCTION

This study is concerning energy labelling for ventilation systems. It has been supported by Ademe, the French agency for environment and energy savings.
The ventilation products taken into account are the fan units used in France in the residential buildings, including single dwellings and multi-family buildings, and also the centrifugal fans used in non residential buildings.
After collecting data available concerning the performances of these products, an analysis has been operated to determine which running parameters have to be considered in order to define a criteria that is both representative of the running conditions on site and allows to establish a classification in terms of electrical energy consumption.
To verify the relevance of the criteria defined, tests of energy consumption in real working conditions on site have been performed on different types of ventilation systems. Moreover, in the perspective to have a common definition of the energy consumption classes for these products in Europe, an enquiry has been realised, implying experts in ventilation systems of different European countries.

This paper presents the method developed for labelling, the results of the tests realised on site and the analysis of the possibility to adapt the method in Europe.

METHOD OF LABELLING

Choice of the running parameters

The energy consumption taken into account only includes the electrical energy necessary to the operation of the fan. All the energy consumption due to air renewal is not considered in this method.

Depending on the type of systems, the parameters to retain are :

- The representative running point (s);
- The duration of running at each possible speed;

They are defined after an analysis of the design and usual operation of the different ventilation systems considered in this study.

Residential buildings

For ventilation systems used in single dwellings, the representative running points chosen correspond to the minimum and maximum speed of the fan for the maximum size of dwelling that the system is designed for.

For the ventilation systems used in multi-family buildings, two representative running points are chosen, one for the maximum air flow rate and one for the minimum air flow rate. For a system without any electronic control device, these points are taken on the maximum speed characteristic curve of the fan. The point corresponding to the maximum air flow rate, $Q_{v\ max}$ is determined according a reference total pressure $P_{vmc\_réfQv\ max}$ that is necessary to achieve in order that the ventilation system runs properly. This includes the pressure drop of the ductwork and the pressure to maintain for the operating of the exhaust terminal device. For ventilation systems using pressure controlled air exhaust devices, $P_{vmc\_réfQv\ max}$ varies according the air flow rate range of the fan unit. (see ranges in table 1). For ventilation systems with humidity controlled exhaust air terminal devices, $P_{vmc\_réfQv\ max}$ is 160 Pa. The point of minimum air flow rate $Q_{v\ min}$ is corresponding to a proportion of the maximum air flow rate. This proportion is chosen as 50 % in the case of a ventilation system using pressure controlled exhaust air terminal devices and 40% for a ventilation system with humidity controlled exhaust air terminal devices.

TABLE 1
Reference total pressures for pressure controlled exhaust devices

Air flow rate ranges (m^3/h)	0 - 1000	1000 - 3000	5000 - 8000	> 8000
Reference total pressure available, $P_{t\ réf}$ (Pa)	100	150	200	250

For a fan unit equipped with a constant pressure control device, the running point for the maximum air flow rate is determined in the same way as described here above. For this kind of fan unit, the running point for the minimum air flow rate is located at ($Q_{v\ min}$, $P_{vmc\_réfQv\ max}$) where $Q_{v\ min}$ represents 50% of $Q_{v\ max}$ for a system with pressure controlled exhaust terminal devices and 40% for a system with humidity controlled exhaust terminal devices. Figure 2 illustrates the positioning of the running points for the constant pressure fan unit. Figure 1 illustrates the positioning of the running points corresponding to the maximum and minimum air flow rates.

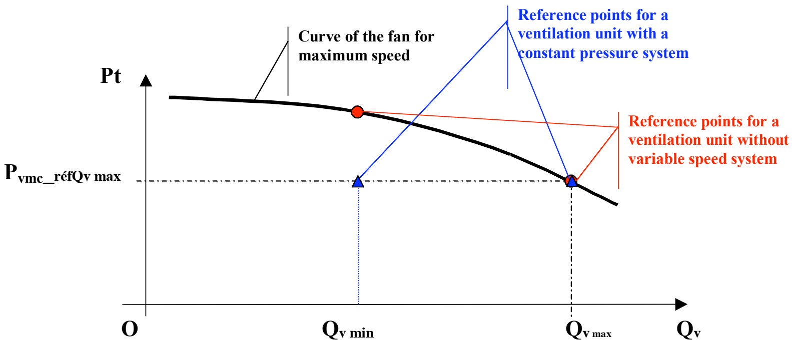

Figure 1 : Running points chosen for a fan unit without control system and for a fan unit with constant pressure control system

For a fan unit equipped with a constant air flow rate control device, the maximum air flow rate taken into account is always $Q_{v\ max}$ defined above, The running point for $Q_{v\ min}$ is taken at the cross between the fan curve for $Q_{v\ min}$ and the pressure drop curve going throw the point ($Q_{v\ max}$, $P_{vmc\_réfQv\ max}$). Proportion between $Q_{v\ max}$ and $Q_{v\ min}$ is the same as defined here above. Figure 2 illustrates the positioning of the running points for the constant air flow rate fan unit.

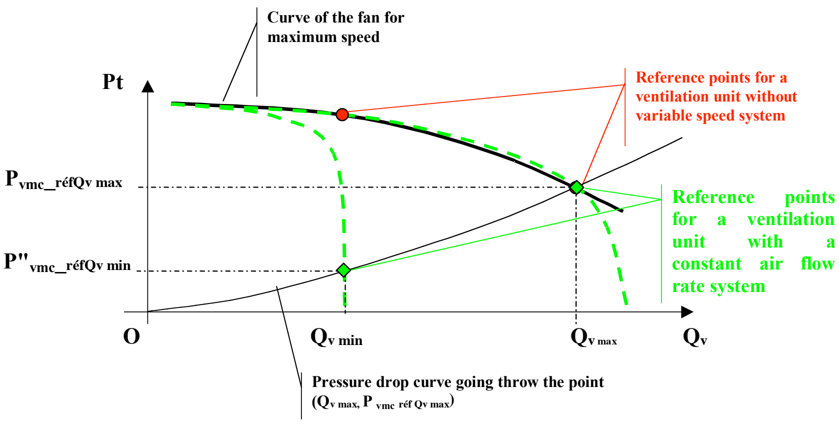

Figure 2 : Running points chosen for a fan unit without control system and for a fan unit with constant air flow rate control system

The duration of running at the minimum and maximum speed are defined according the French Building Thermal Regulation. This repartition corresponds to 23/24th of time at the minimum speed (minimum air flow rate) and 1/24th of time at the maximum speed (maximum air flow rate) if the ventilation system includes a device limiting time running at the maximum speed, or 11/12 th of time at minimum speed and 1/12 th of time at maximum speed without such a device.

Non residential buildings

For the centrifugal fans units used in non residential buildings, only one running point is considered. This point is corresponding to the maximum air flow rate, $Q_{v\ max}$ where the reference total pressure $P_{vmc\_réfQv\ max}$ is reached The values of reference total pressure $P_{vmc\_réfQv\ max}$ are the same as the ones used for multi-family buidings ventilation systems.
If an electronic control device to keep the pressure level constant is associated to the fan, then the electrical power to take into account is the one of the running point with the same reference total pressure and an air flow rate equal to 75% of $Q_{v\ max}$. For the fans equipped with an electronic control device to keep the air flow rate constant, the electrical power to retain is the one of the running point located at the cross between the fan curve for a constant air flow rate of 0,75 $Q_{v\ max}$ and the pressure drop curve going throw the point ($Q_{v\ max}$, $P_{vmc\_réfQv\ max}$). In any case the air flow rate to use for the calculation of the specific fan power is the maximum air flow rate $Q_{v\ max}$.
Figure 3 illustrates the positioning of these points for the different type of systems.

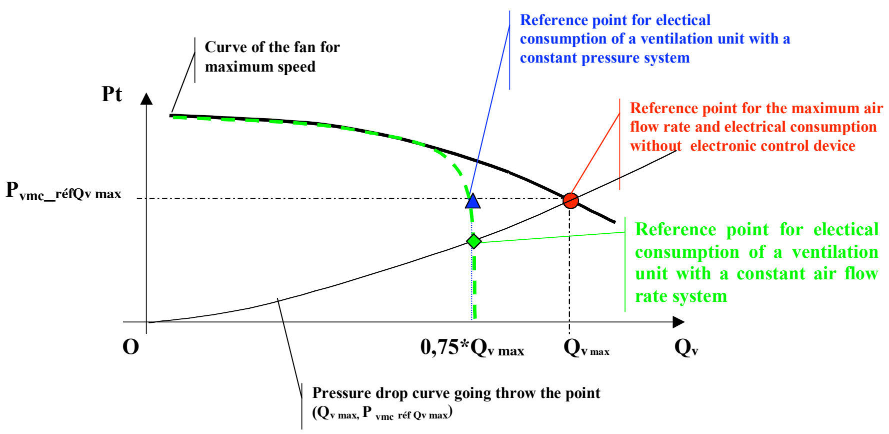

Figure 3 : Running points to consider for non residential centrifugal fans

Criteria and energy classification

Once the running points have been chosen, it is possible to calculate the specific fan power (SFP). For residential systems, weightings corresponding to the running duration have to be used to calculate the average SFP, corresponding to the average of the electrical energy divided by the average air flow rate. SFP is retained as the criteria defining the electrical energy consumption of the ventilation fan units.
Analysing the data collected about fan units characteristics and applying the rules defined here above to calculate SFP, showed that a same classification could be used for residential and non residential fan units. This classification is

given in table 2. In figure 4, the position in the electrical energy classification of the different fan units considered in this study is presented.

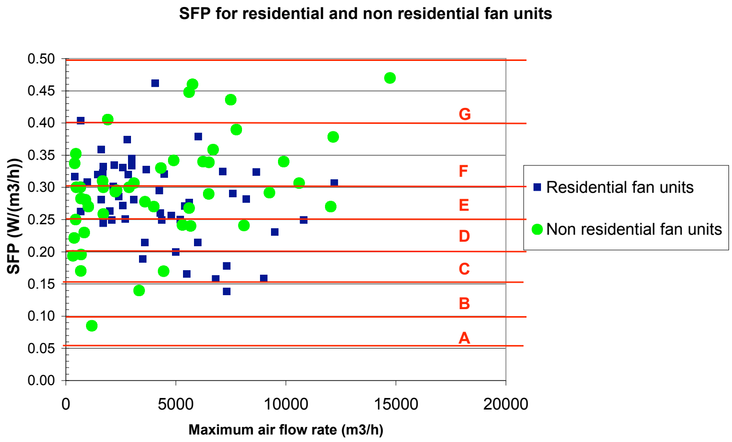

Figure 4 : SFP for residential and non residential buildings

TABLE 2
Energy classification limits

Electrical energy classification	A	B	C	D	E	F	G
Specific Fan Power limits (W/(m^3/h))	0.05 - 0.10	0.10 - 0.15	0.15 - 0.20	0.20 - 0.25	0.25 - 0.30	0.30 - 0.40	0.40 - 0.50*

- : a fan unit with a SFP greater than 0.5 W/(m^3/h) is not classified

COMPARISON WITH MEASUREMENTS ON SITE

On site measurements concerned electrical consumption of fans in two residential multi-family buildings and two office buildings. In the residential buildings the exhaust ventilation systems are humidity controlled. On the residential site 1, the exhaust in the kitchen for ventilation is combined with the exhaust of the flues of the domestic gas boiler. In the non residential site 1, the ventilation system is balanced, while it uses mechanical exhaust in non residential site 2.

The tests performed have concerned the measurement, over a period of three to four weeks on each site, of the air flow rate, the total pressure available at the fan and the electrical energy used. Then the SFP has been calculated for each system, using both the method presented here before with the characteristics given in the manufacturers documentations and the real data collected during the tests on site. The results of these calculations are given in table 3.

The comparison of the SFP planned and measured shows a rather good agreement, except for the residential site 1. This difference is due to the fact that on this site the ventilation system has been disturbed by the company in charge of the maintenance of the boilers, who has forced the position of the exhaust device on the big aperture. The consumption of the ventilation system is thus increased, which explains the difference observed with the consumption planned.

TABLE 3
Energy classification planed and measured

Site	SFP Planned (W/(m^3/h))	SFP Measured W/(m^3/h))	Classification Planned W/(m^3/h))	Classification Measured W/(m^3/h))
Residential 1	0.39	0.59	F (0.30 - 0.40)	Out of classification. because > 0.50 W/(m^3/h)
Residential 2	0.30	0.31	F (0.30 - 0.40)	F (0.30 - 0.40)
Non residential 1	0.49	0.44	G (0.40 - 0.50)	G (0.40 - 0.50)
Non residential 2	0.30	0.28	E (0.25 - 0.30)	E (0.25 - 0.30)

EXTENSION TO EUROPE

The analysis of the results of the enquiry about the use of mechanical ventilation systems in Europe (type of systems, number of speeds and time of running duration for each speed) has shown differences over the different countries. In consequence, the method developed in this study, suitable for the French ventilation systems, is not directly applicable in Europe. The establishment of standard running parameters for Europe is necessary. Especially the reference total pressure for the determination of the running point of multi-family buildings or non residential ventilation fan units needs to be dealt with. Considering the levels of SFP in the classification proposed by the method, they are covered by the pre-existing classifications defined in the European Standard project prEN 13779, "*Ventilation for non-residential buildings — Performance requirements for ventilation and room-conditioning systems*". The classification proposed is also compatible with the rules defined by the Swedish organism Boverket and used in Nordic countries.

CONCLUSION

A method has been developed to give the necessary elements to establish a labelling of the electrical consumption of ventilation fan units used in residential and non residential buildings in France. The method consists in the definition of the running conditions to consider for each type of fan in order to calculate the consumption criteria that is the specific fan power, SFP. An associated classification of electrical energy consumption is also proposed. The validity of this method has been verified on different type of ventilation systems operating on site in real conditions. The extension of this method to Europe is not directly applicable, but seems possible according adaptations for the choice of the running parameters taken into account.