Filter fans in series or in parallel

The filter fans are products used for cooling electrical cabinets, through ventilation air flow. In particular, they can only be used in environments where the temperature never reaches **35° C** (optimal temperature for electrical cabinets). It is essential that the air used for cooling always has a lower temperature than the one desired inside the electrical cabinet. Moreover, the lower the maximum temperature that can be checked in the installation environment, the lower the ventilation flow required for cooling the electrical cabinet (for a defined power output due to the Joule effect). The **filter fan** consists of:

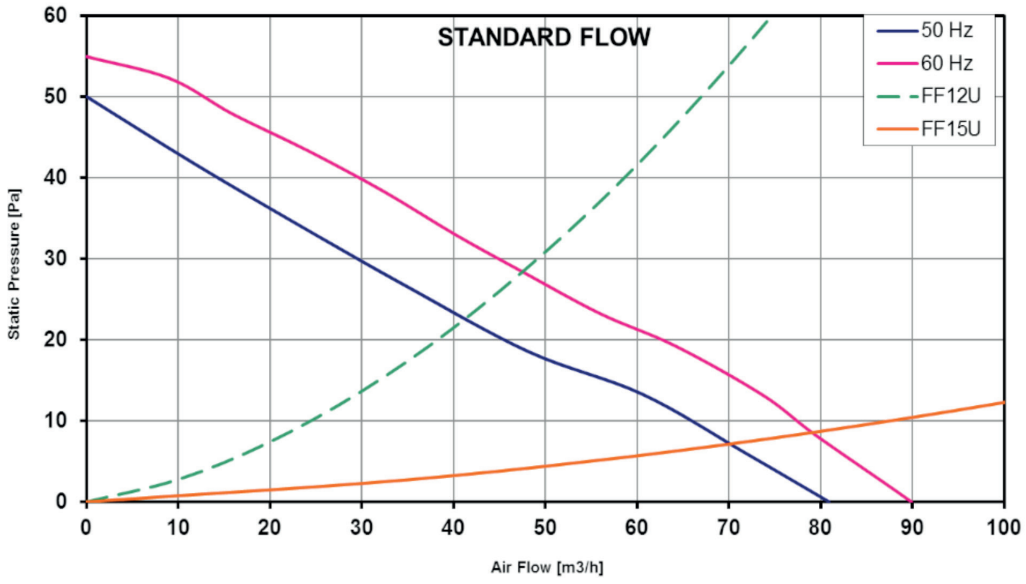
- a fan, which generates the ventilation flow;
- a filter media coupled to the fan, to prevent dust and substances in the installation environment from being drawn into the electrical cabinet;
- additional components necessary for assembly of the filter group.

The filter fan (fan + filter) has a characteristic curve, which defines the volumetric flow rate of the air [m3/h] as a function of pressure [Pa]. If you decide to install a filter fan on a wall of the electrical cabinet, on another wall or on the ceiling, a filter media must be installed, to ensure the mass balance on the electrical cabinet:

MASS INCOMING FLOW = MASS OUTGOING FLOW

The intersection between the working curves of a filter fan and the load loss curves due to the single filter, identify **working points**, i.e. the ventilation flow rates and the guaranteed pressures on the electrical cabinet.

As an example, the chart of an exhaust filter + filter fan is shown below:



Curve characteristic of the filter fan and exhaust filter curves

The graph shows that the sample filter fan powered at 50Hz and coupled to a filter media FF15, identifies a working point of about **[70m3/ h; 8PA]**.

In some special cases, when the power to be dissipated is very high, it may not be sufficient to install a single filter fan on the electrical cabinet: the filter fans available on the market have limited and sometimes insufficient ventilation flow rates to fully provide cooling.

So, in these cases, it is possible to think of two alternative solutions:

1. Serial installation of two or more filter fans;
2. Parallel installation of two or more filter fans.

In the 2 following paragraphs the two types of solution mentioned are analysed.

Filter fans in series

Two or more filter fans are called in series if they are arranged one after the other:

- Direct flow filter fans installed in the lower area, on the cabinet walls;
- Reverse flow filter fans installed in the upper area, on the cabinet walls.

It is preferable to install reverse flow filter fans on opposite walls to where direct flow filter fans are installed.

The main consequence of choosing the series arrangement is an increase in the **total pressure generated** by the ventilation system:

$$P_T = P_s + P_d$$

Where:

- P_s “Static pressure”, is the pressure exerted by the fluid on the walls of the pipe or container in which it is included;
- P_d “dynamic pressure”, is the pressure corresponding to the part of kinetic energy possessed by the fluid, therefore linked to its speed;
- P_T “total pressure”, is the algebraic sum of static and dynamic pressures.

Through the coupling of two filter groups in series, the main effect is the increase in pressure: the resulting characteristic curve is obtained by summing the ordinates (pressures) of the curves of the individual filter fans.

This solution is particularly indicated when the objective is to obtain high pressures. However, the increase in the working point in terms of flow rate is **NOT** satisfactory, the overall working curve could include unstable operating areas and possible pumping phenomena. The working point must be avoided in these areas.

Parallel filter fans

Two or more filter fans are said to be arranged in parallel if they are coherently aligned in the direction of the air flow and with an equal number of individual exhaust filters arranged on the opposite wall.

The consequence of this type of solution is the increase in the total flow generated by the ventilation system. The resulting characteristic curve is obtained by summing the abscissas of the curves of the individual filter fans (flows).

This method is particularly suitable when:

- Filter fans draw from the same place and unload in the same direction;
- Large flow rates are required.

Furthermore, filter fans in parallel do not have destructive problems of the same magnitude as the probable ones with a series arrangement.

The most suitable solution for electrical cabinets

When it comes to the topic of electrical cabinets, it is important to bear in mind the main function for which the filter fans are designed: to produce an air flow sufficient to cool the electrical panel. The generation of pressure is a secondary and unavoidable effect, since the fan is a fluid operating machine. It may be useful to keep the electrical cabinet under pressure to favour the flow of air through it, but it is not the main objective: the purpose is to cool the electrical panel, guaranteeing the necessary ventilation flow rate with a slight overpressure with respect to the installation environment.

Therefore, when only one filter fan is not sufficient to guarantee the cooling flow rate, it is preferable to apply the second solution, which involves the use of several filter fans in parallel and the same number of filter cloths on the opposite wall. To find the new working point it will be necessary to calculate the global characteristic curve of the filter fans, as described in the previous paragraph.

Davide Rocca
Alberto Tonietti