The SFP value of an air handling unit and how to calculate it

1. What is the SFP value?

SFP (Specific **F**an **P**ower) = specific electrical power, i.e. the power taken from the electrical network required to transport one air cube meter through a building per second. It includes the total electrical power taken from the mains by all the supply and exhaust fans of the entire building (the exhaust can also be a roof extractor) divided by the treated air flow. The divider is always the higher airflow (inlet or outlet).

SFP = P network/ qV max

The SFP value is power divided by air flow:

(SFP) = kW/m^3/s

What is the **SFPv-** value?

This is the specific power requirement for one fan, or one machine used by the Swedish Ventilation Association (Föreningen V), calculated in the same way as in the SFP value.

Note! In the RECAIR dimensioning program, the SFPV value is used in connection with one fan section, e.g. we will provide an SFP value for the entire inlet-outlet machine!

2. How to calculate the SFP value

2.1 Fan power requirement

The electrical power requirement of the fan is calculated by considering the efficiencies of all components and dividing by the **total electrical efficiency** obtained from these, the theoretical airflow of the fan x the fan total pressure.
Note! When the term 'fan total efficiency' is used in fan technology, it means the ratio of the theoretical power demand calculated from the total fan pressure to the actual power delivered to the fan impeller.

The total fan efficiency based on shaft output also includes bearing losses! In the Recair dimensioning program, the total fan efficiency is defined according to the shaft output.

Calculation formula for electrical power need:

$$\textbf{Pelectricity} = \frac{\textbf{qVfan X PtF}}{\textbf{ntFA X nbeltk X nmotorX nfrequency changer}}$$

P electricity= electrical power taken by the motor from the mains (kW)

qVfan = the airflow of the fan (m^3/s)

ptF = the total pressure of the fan (Pa)

ntFA = the total efficiency of the fan according to the shaft output

^{n}beltk $^=$ belt drive efficiency

nmotor= motor efficiency

^{n}frequency changer$^=$ frequency changer efficiency

The SFP number of the inlet/outlet machine combination is calculated by dividing the total electrical power taken from the network by the higher value of the machine airflows.

The calculation formula:

$$SFP = \frac{\text{Ppower in+ P power}}{\text{qVmax}}$$

SFP = specific electric power of the inlet exhaust machine (kW/m^3,s)

^{P}power in= the power taken by the inlet fan from the mains (kW)

P outlet power= the power taken by the exhaust fan from the mains (kW)

qVmax = the larger of the machine air flows, inlet or exhaust (m^3/s)

2.2 Total fan efficiency (according to shaft output)

The total fan efficiency is defined in the Finnish fan standard (SFS 5147) as follows:

- Fan airflow x total fan pressure divided by the mechanical power applied to the impeller. This efficiency does not include bearing losses!

The Recair dimensioning program uses the total efficiency calculated according to the fan shaft power, which includes the fan bearing losses.

In a direct-drive chamber fan, the fan impeller is mounted directly on the shaft of the electric motor, in which case there are no bearing losses in the fan. Losses are included in the electric motor values.

2.2.1 Connection losses and how to handle them in the dimensioning program

In dimensioning programs, the fan efficiency is calculated with the manufacturer's DLL module, which calculates the total efficiency for the fan according to the shaft output. This efficiency is the result obtained from laboratory measurements, which is measured by a test arrangement according to the measurement standard (AMCA standard 210, figure 12) and thus representing the best possible efficiency.
In a real situation, a fan mounted in a housing and connected to a duct or chamber will not achieve this efficiency because there are disturbances on the suction and pressure sides of the fan that degrade the performance of the fan. These flow disturbances are collectively referred to as connection losses. These connection losses impair the fan pressure rise and thus, the efficiency.

The connection losses for the suction side are for example:
-belt drive in the fan inlet
-a fan housing that is significantly narrower than the test chamber
-function parts before the fan (bent part, silencer, etc.)

The connection losses for the pressure side are for example:
-blastto the chamber
-blastto the air balancer
-blastto the channel
-blastto the curve

In the Recair dimensioning program, connection losses are taken into account as follows:

- direct-drive chamber fans are selected for each machine size so that there are no connection losses on the pressure side

2.3 Electric motor efficiency

Electric motors are classified into different efficiency classes (eff1, eff2, eff3), for which minimum efficiencies have been defined for each motor power. The efficiency of the motor depends to some extent on the number of poles, but the most commonly used 2- and 4-pole motors (3000 rpm and 1500 rpm) in air handling units are of the same value in efficiency, however, there are differences between manufacturers depending on the motor size.

The efficiency of the motor is most affected by the physical size of the motor, because with a small motor, both electrical and mechanical losses reduce the efficiency relatively more.
Motor manufacturers report efficiency at rated power. At partial power, the efficiency deteriorates quite sharply when the load drops below 50%. The rated power efficiency can be used as the value of the efficiency ratio when the motor shaft output is> 50% of the rated power.

The declared efficiency tolerance for motors below 50 kW is according to the following formula:

dnmo = -15 (1-nmo)%

For example, if the declared efficiency of the motor is 85%, the nominal efficiency specified by the motor manufacturer may be used in the calculation of the SFP value.
In addition, it should be noted that in frequency changer operation, the motor efficiency is not the same as when supplied directly from the 50 Hz mains, but lower.

2.4 Frequency changer efficiency

Equipment manufacturers report drive efficiencies of 95 ... 97% at rated load

3 Pressure drop of the filters when calculating the SFP value

In the Recair dimensioning program, the SFP value is calculated with clean filters.