Axial Fans - Basic principles

Expertise, performance, innovation
Axial fans
The truly space-saving axial fans from ebm-papst are used to exchange hot and cold air in all sorts of devices and systems. Their outstanding features include a shallow installation depth, a low noise level and excellent efficiency, making them particularly suitable for conveying air through heat exchangers. In combination with GreenTech EC technology they also provide an intelligent means of saving energy in a whole range of different applications.

The facts at a glance:

– Compact dimensions
– Choice of GreenTech EC or AC technology
– Many different designs, sizes and air performance levels
– Optimum efficiency and minimal noise generation thanks to aerodynamically optimized fan blades
– Highly efficient, energy-saving versions with GreenTech EC technology and standardized integration of control functions and sensor signals
– Wide range of guard grills, basket guard grills and fan housings as accessories
– All axial fans are dynamically balanced on two planes in accordance with DIN ISO 1940
– Numerous approvals including VDE, UL, CSA, CCC and EAC
– Areas of application: Ventilation, refrigeration, air conditioning, automotive industry, wind power plants and the machinery/equipment industry

Axial fans
Axial fans
Performance ranges

Optimum usage range
To the right of the dip (right section of the air performance curves):
- Maximum efficiency
- Minimum noise
To the left of the dip (left section of the air performance curves):
- Stalling
- Falling efficiency
- Abrupt increase in noise

The optimum usage range of the fan is highlighted in green in the adjacent illustration.
Selection of fans

The product catalogs contain all the relevant information on

- **Product designation**
  The header defines the technology (AC or EC), the type (centrifugal, axial, ...), the series (e.g. S series), the impeller diameter and other features of the product.

- **Product description**
  Depending on the product, the following items of information are presented here:
  Material, number of blades, airflow direction, direction of rotation, degree of protection, insulation class, installation position, condensation drainage holes, mode of operation, bearings, technical features, EMC, touch current, motor protection, electrical hookup, cable/terminal box design, protection class, capacitor, conformity with standards, approvals and options.

- **Nominal data**
  AC products (up to motor size 074) and EC products (with DC supply):
  Free air/with minimum back pressure AC products
  (as of motor size 094) and EC products (with AC supply):
  At the operating point with maximum load

- **Order designation/type**
  An explanation of the order designation and type is given under Type code.

- **Product drawing**

- **Operating points**
  The operating points with information on speed, power consumption, current draw, sound power level or sound pressure level and overall efficiency of the impeller are listed in the adjacent Operating point table.

- **Curves**
  The air performance curves for the product are shown in the graph.

- **Accessories**
  The appropriate accessories (e.g. inlet rings, guard grill, fan housings) and further information (e.g. the connection diagram) can be found on the page numbers given.
Technical features:

- Design: See connection diagram P. 132 ff.
- Finish: According to EN 61000-6-2 (industrial environment)
- Interference emission according to EN 61000-6-4 (industrial environment), according to household appliance standard on request
- Touch current: <= 3.5 mA according to IEC 60990 (measuring circuit Fig. 4)
- Electrical connection: Via terminal box
- Protection class: I (with customer connection of protective earth)
- Conformity with standards:
  - A: EN 61800-5-1, EN 60335-1, CE
  - B: EN 61800-5-1, CE
  - C: EN 61800-5-1, EN 60335-1 in preparation, CE

Approvals:

- A: EAC, UL
- B: EAC, UL on request
- C: UL, CSA
- D: UL, CSA planned

### Dimensions

<table>
<thead>
<tr>
<th>Type</th>
<th>Diameter (mm)</th>
<th>Width (mm)</th>
<th>Height (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A3G 500-BM06-H1</td>
<td>ø 250</td>
<td>203</td>
<td>163</td>
</tr>
<tr>
<td>A3G 500-AM06-H1</td>
<td>ø 300</td>
<td>203</td>
<td>163</td>
</tr>
<tr>
<td>W3G 500-GM06-H1</td>
<td>ø 400</td>
<td>203</td>
<td>163</td>
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<tr>
<td>W3G 500-GM03-M1</td>
<td>ø 500</td>
<td>203</td>
<td>163</td>
</tr>
<tr>
<td>W3G 500-GA74-21</td>
<td>ø 600</td>
<td>203</td>
<td>163</td>
</tr>
<tr>
<td>W3G 500-GD59-01</td>
<td>ø 700</td>
<td>203</td>
<td>163</td>
</tr>
</tbody>
</table>

Weight:

- Without attachments
  - A3G 500-BM06-H1: 4.8 kg
  - A3G 500-AM06-H1: 5.7 kg
  - W3G 500-GM06-H1: 6.0 kg

- With guard grille for short nozzle
  - A3G 500-BM06-H1: 9.8 kg
  - A3G 500-AM06-H1: 11.3 kg
  - W3G 500-GM06-H1: 12.3 kg

- With square full nozzle
  - A3G 500-BM06-H1: 11.1 kg
  - A3G 500-AM06-H1: 12.2 kg
  - W3G 500-GM06-H1: 12.2 kg

- With square full nozzle and attachment
  - A3G 500-BM06-H1: 9.8 kg
  - A3G 500-AM06-H1: 11.3 kg
  - W3G 500-GM06-H1: 12.3 kg
Axial fans
Impellers

HyBlade
Unique hybrid structure, combination of aluminum base material and glass-fiber reinforced plastic covering, aerodynamically optimized shape, all versions available with diameters from 200 mm to 990 mm.
The outstanding features are a sophisticated aerodynamic design and low weight. Since its market launch (2007), the product range has been successfully used in all sorts of applications from deep freezing at -40°C to hot and humid conditions as in evaporative condensers and even desert climates.

AxiBlade
The AxiBlade range combines the innovative, successful materials of the HyBlade product range with the latest aerodynamic developments (e.g. blade design, wingtip, ...), with certain versions also featuring innovative peripheral components such as guide vanes, diffuser and Flowgrid. The AxiBlade product range gets more out of the standard market footprint than any other axial fan.

S series
Sickle-shaped metal blades (sheet steel or die-cast aluminum). Extremely well suited to all applications where plastic is not an option.

Airflow directions
The airflow direction is always given as follows.
The airflow direction is determined when viewed toward the rotor end face. Memory aid:
If, when looking at the rotor housing of the axial fan, the air blows towards you, this direction of air flow is given the designation "A" (otherwise "V").
Product ranges

- **A product range – Axial fan**: Impeller with motor. Mounting on motor flange/stator bushing
- **S product range – Axial fan with guard grill**: Impeller with motor and guard grill. Mounting on guard grill (vertical or horizontal mounting lugs).
- **W product range – Axial fan with fan housing**: Impeller with motor, guard grill and fan housing. Mounting on fan housing

Fan housings

- **Full nozzle**: From an aerodynamic point of view, a full nozzle is the optimum solution. Whenever possible it should be given preference over other nozzle geometries.
- **Short nozzle**: Short nozzles are used if the nozzle forms part of the housing of the customer device.
- **Double flange**: Nozzles with a double flange permit the mounting of inlet rings or integration into a duct system.
Axial fans
Fan housing and nozzle

Effects of installation in fan housing or opening
Installation in an optimally designed fan housing can greatly increase the air performance and efficiency of an axial fan.

1. Fan housing
2. Opening

Effects of axial position in fan housing
The air performance and efficiency of an axial fan are also influenced by its axial position in the fan housing.

1. Intake side projecting
   $x / D = 7\%$
2. Intake side flush
   $x / D = 0\%$
3. Intake side recessed
   $x / D = -7\%$
Effects of fan housing geometry with axial fans

Effects of width of air gap between fan housing and blade with axial fans

In addition to the shape of the fan housing, the centrifugal air gap between the fan blades and the fan housing also has a significant influence on the technical characteristic values.
Effects of guard grill with axial fans
Fitting a guard grill reduces the air performance of an axial fan.

The pressure loss in Pa can be roughly calculated using the following equation:

\[
\zeta = \frac{s}{(1 - \frac{s}{l})} \cdot 0.8
\]

\[
\Delta \rho = \zeta \cdot \frac{D}{2} \left( \frac{q v}{\pi \cdot D} \right)^{\frac{1}{2}}
\]
Effects of guard grill with axial fans

Fitting a guard grill increases the noise level of an axial fan. The catalogs list intake-side sound power values with full nozzle or in a fan housing without guard grill. The use of a guard grill alters the noise level on account of the flow noise. The total sound power may increase by up to +6 dB(A) over the catalog values.

The purpose of guard grills is to prevent contact with rotating parts and the ingress of foreign matter into the fan. Guard grills do however create additional aerodynamic resistance. For this reason, the design process does not just ensure conformity with safety clearances in accordance with DIN EN ISO 13857, it also takes aerodynamic influences into account to keep the negative effects to a minimum. We nevertheless only recommend the use of guard grills in cases where it is not possible to fit other types of guard.
Effects of intake obstructions

Intake and outlet side obstructions reduce the air performance of axial fans.

Effects of air-inlet guard

Additional noise occurs if the inflow of air into the fan is obstructed, as is the case with asymmetric intake for example. The turbulence directly impacts the rotating impeller blades, giving rise to what is known as propeller noise or blade passing frequency.

The FlowGrid – the air-inlet guard on the intake side – lessens the effect of inflow obstruction and so reduces the turbulence that causes noise. This reduces the sound pressure over the entire frequency range and in particular the disturbance caused by the blade passing frequency in the low frequency range.

FlowGrid for axial fans
Guide vanes can double the fan throw for a comparable air flow.
- More even distribution of cold air in cold stores
- Simple retrofitting of guide vanes
- Guide vanes are easily detached for cleaning

Guide vanes can double the fan throw for a comparable air flow.

Guide vanes (AxiCool)

Guide vanes
A diffuser significantly improves efficiency and operating noise levels. As it has the effect of increasing pressure, it also minimizes outlet losses and permits better adaptation of the fan to commercially available heat exchangers.

**Effects of a diffuser on axial fan curves**

Comparison of curves:
- W3G 800-HU23-71 (with diffuser) vs. W3G 800-GU25-01 (without diffuser)

**Measured values**

<table>
<thead>
<tr>
<th>n in rpm</th>
<th>$P_a$ in W</th>
<th>I in A</th>
<th>$L_{WA}$ in dB(A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1020</td>
<td>1461</td>
<td>2.33</td>
<td>81</td>
</tr>
<tr>
<td>1020</td>
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<tr>
<td>1020</td>
<td>2056</td>
<td>3.21</td>
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<td>1020</td>
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<tr>
<td>1020</td>
<td>2368</td>
<td>3.52</td>
<td>88</td>
</tr>
</tbody>
</table>

- With diffuser, with protection against contact
- Without diffuser, with protection against contact
- Without diffuser, protection against contact
Flow losses are based on dissipation, which means that the kinetic energy of the flow is converted into heat that cannot be put to any further technical use. With the AxiTop diffuser, a great deal of the dynamic kinetic energy can be converted into static pressure by slowing down the air flow. This re-conversion boosts the pressure increase of the impeller.

**Reduced energy consumption and noise generation**
For the same operating point, energy savings of up to 27% and a 7.2 dB(A) reduction in noise generation are possible, depending on the application. (Measurement based on size 800 mm).

**Increased air flow**
When operating at maximum speed, the output can be increased by up to 9% and noise generation reduced by as much as 4.9 dB(A), depending on the application. (Measurement based on size 800 mm).
We hope that this brochure was able to provide you with an in-depth insight into our technologies, our product applications and important basic principles. Please do not hesitate to contact us should you have any further questions on specific applications. Our specialists will be delighted to help.