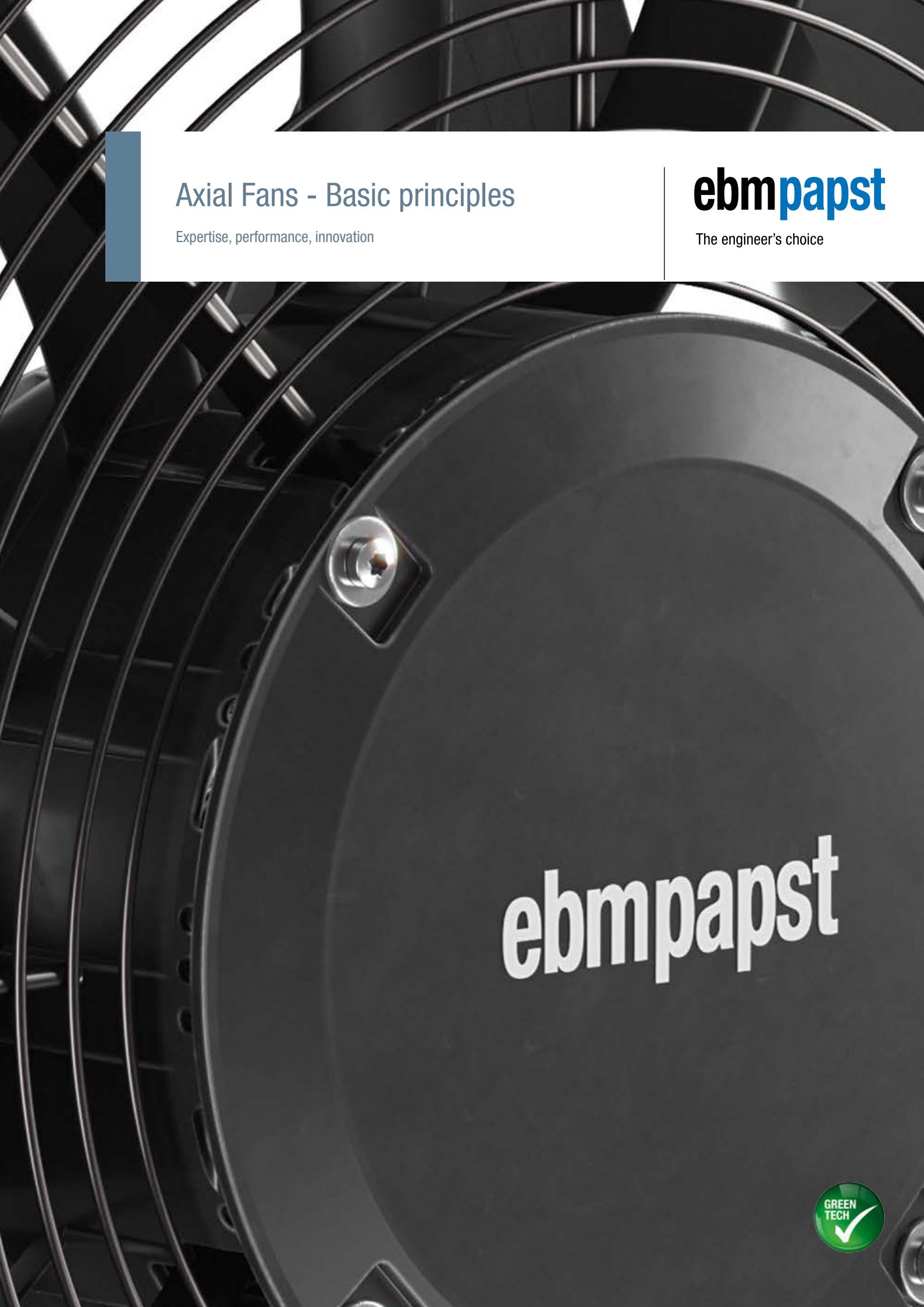
Axial Fans - Basic principles

Expertise, performance, innovation

ebmpapst

The engineer's choice



Axial fans

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

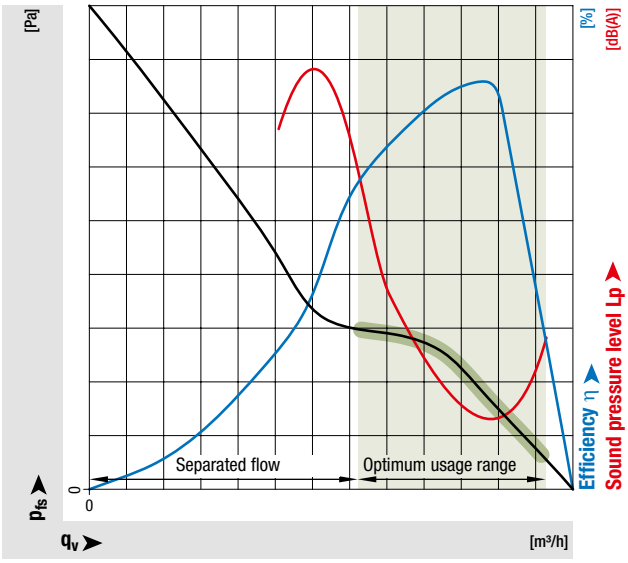
To the left of the dip (left section of the air performance curves):

– Stalling

– Falling efficiency

– Abrupt increase in noise

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



– Fan curve
– Efficiency curve
– Noise curve
– System or device curve
• Operating point
▮ Usage range

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**

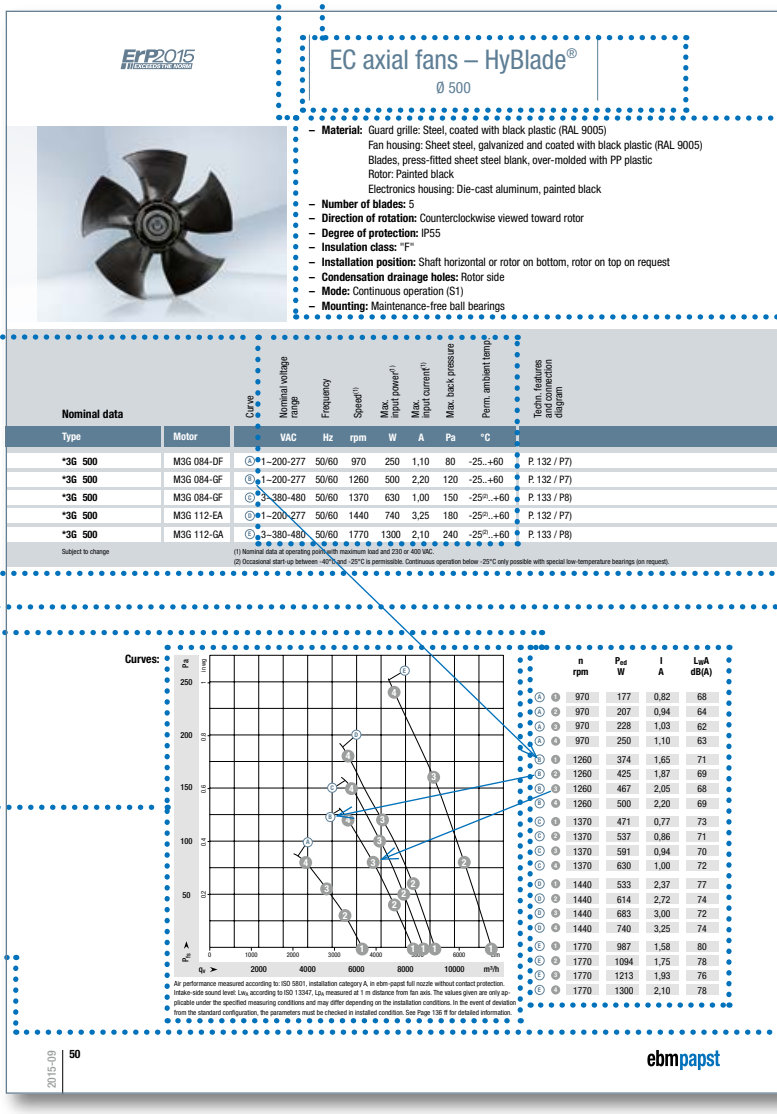
The operating points with information on speed, power consumption, current draw, sound power level or sound pressure level and overall efficiency of the impeller are listed in the adjacent Operating point table.

– **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.



ErP2015 ready

EC axial fans – HyBlade®

Ø 500

– **Material:** Guard grille: Steel, coated with black plastic (RAL 9005)
Fan housing: Sheet steel, galvanized and coated with black plastic (RAL 9005)
Blades, press-fitted sheet steel blank, over-molded with PP plastic
Rotor: Painted black
Electronics housing: Die-cast aluminum, painted black
– **Number of blades:** 5
– **Direction of rotation:** Counterclockwise viewed toward rotor
– **Degree of protection:** IP55
– **Insulation class:** "F"
– **Installation position:** Shaft horizontal or rotor on bottom, rotor on top on request
– **Condensation drainage holes:** Rotor side
– **Mode:** Continuous operation (S1)
– **Mounting:** Maintenance-free ball bearings

Nominal data

Type	Motor	Curve	Nominal voltage range	Frequency	Speed[1]	Max. input power[1]	Max. input current[1]	Max. back pressure	Perm. ambient temp.[2]	Techn. features and connection diagram
			VAC	Hz	rpm	W	A	Pa	°C	
*3G 500	M3G 084-DF	A	1~200-277	50/60	970	250	1,10	80	-25..+60	P. 132 / P7)
*3G 500	M3G 084-GF	B	1~200-277	50/60	1260	500	2,20	120	-25..+60	P. 132 / P7)
*3G 500	M3G 084-GF	C	3~380-480	50/60	1370	630	1,00	150	-25[2]..+60	P. 133 / P8)
*3G 500	M3G 112-EA	D	1~200-277	50/60	1440	740	3,25	180	-25[2]..+60	P. 132 / P7)
*3G 500	M3G 112-GA	E	3~380-480	50/60	1770	1300	2,10	240	-25[2]..+60	P. 133 / P8)

Subject to change

(1) Nominal data at operating point with maximum load and 230 or 400 VAC.
(2) Occasional start-up between -40°C and -25°C is permissible. Continuous operation below -25°C only possible with special low-temperature bearings (on request).

Curves:

		n rpm	P_{ed} W	I A	L_{pA} dB(A)
A	1	970	177	0,82	68
A	2	970	207	0,94	64
A	3	970	228	1,03	62
A	4	970	250	1,10	63
B	1	1260	374	1,65	71
B	2	1260	425	1,87	69
B	3	1260	467	2,05	68
B	4	1260	500	2,20	69
C	1	1370	471	0,77	73
C	2	1370	537	0,86	71
C	3	1370	591	0,94	70
C	4	1370	630	1,00	72
D	1	1440	533	2,37	77
D	2	1440	614	2,72	74
D	3	1440	683	3,00	72
D	4	1440	740	3,25	74
E	1	1770	987	1,58	80
E	2	1770	1094	1,75	78
E	3	1770	1213	1,93	76
E	4	1770	1300	2,10	78

Air performance measured according to: ISO 5801, installation category A, in ebm-papst full nozzle without contact protection. Intake-side sound level: L_{WA} according to ISO 13347, L_{pA} measured at 1 m distance from fan axis. The values given are only applicable under the specified measuring conditions and may differ depending on the installation conditions. In the event of deviation from the standard configuration, the parameters must be checked in installed condition. See Page 136 ff for detailed information.

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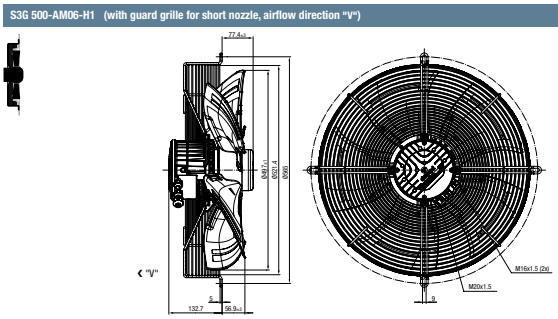
- **Technical features:** See connection diagram P. 132 ff.
- **EMC:** Immunity to interference according to EN 61000-6-2 (industrial environment)
  Circuit feedback according to EN 61000-3-2
  Interference emission according to EN 61000-6-4 (industrial environment), according to household appliance 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:** Ⓐ Ⓑ EN 61800-5-1, EN 60335-1, CE
  Ⓒ Ⓔ EN 61800-5-1, CE
  Ⓓ EN 61800-5-1, EN 60335-1 in preparation, CE
- **Approvals:** Ⓔ EAC, UL; Ⓐ Ⓒ EAC, UL on request
  Ⓓ UL, CSA; Ⓕ UL, CSA planned

Airflow direction	‹ "V" without attachments	Weight without attachments kg	‹ "V" with square full nozzle	Weight with square full nozzle kg	‹ "V" with guard grille for short nozzle	Weight with guard grille for short nozzle kg
"V"	A3G 500-BK07 -G1	4,80	W3G 500-GK07 -G1	11,30	S3G 500-AK07 -G1	7,40
"V"	A3G 500-BM06 -H1	5,70	W3G 500-GM06 -H1	12,30	S3G 500-AM06 -H1	8,30
"V"	A3G 500-BM03 -M1	6,00	W3G 500-GM03 -M1	13,30	S3G 500-AM03 -M1	9,50
"V"	A3G 500-BA74 -21	7,40	W3G 500-GA74 -21	14,40	S3G 500-AA74 -21	10,70
"V"	A3G 500-BD59 -01	8,90	W3G 500-GD59 -01	15,90	S3G 500-AD59 -01	12,20

Airflow direction "A" on request

S3G 500-AM06-H1 (with guard grille for short nozzle, airflow direction "V")



Inside diameter of fan housing min. 503 mm

Axial fans
Impellers

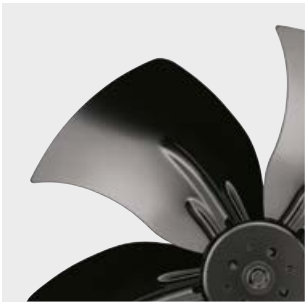
HyBlade

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.

HyBlade ›

HyBlade



S series

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.

AxiBlade ›

S series

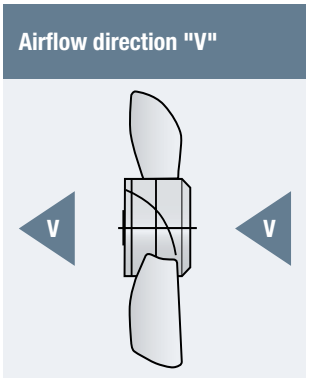
Sickle-shaped metal blades (sheet steel or die-cast aluminum). Extremely well suited to all applications where plastic is not an option.

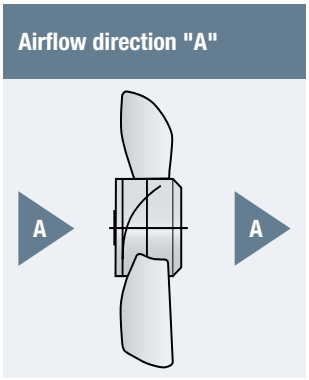
Airflow directions

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**").



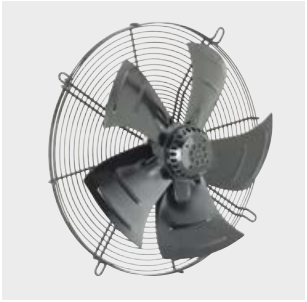


Axial fans
Versions

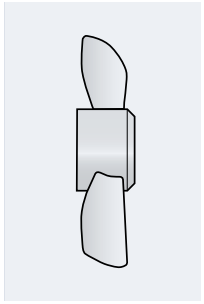
Product ranges

- **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

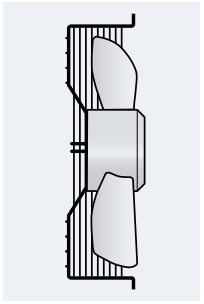
A product range



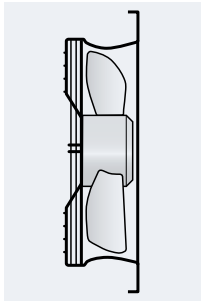
S product range



A product range



S product range



W product range

W product range

W product range with guard grill

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.

Full nozzle

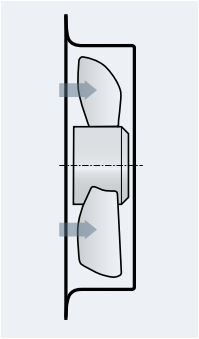
Double flange

Axial fans
Fan housing and nozzle

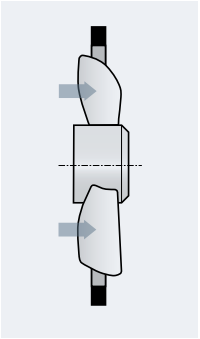
Effects of installation in fan housing or opening

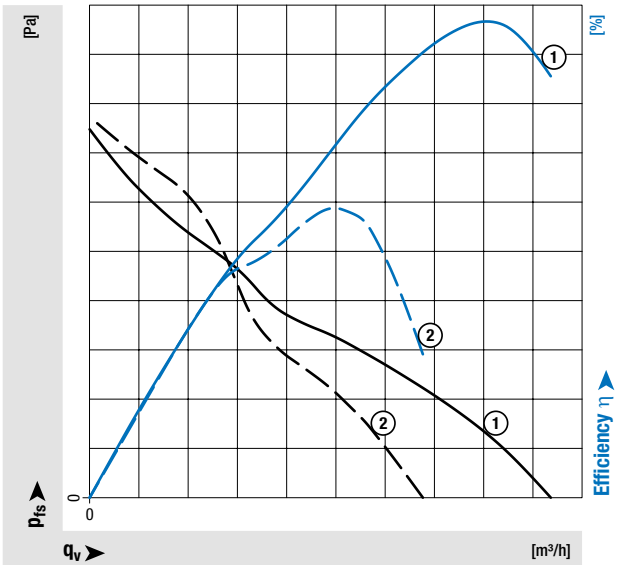
Installation in an optimally designed fan housing can greatly increase the air performance and efficiency of an axial fan.

① Fan housing



② Opening





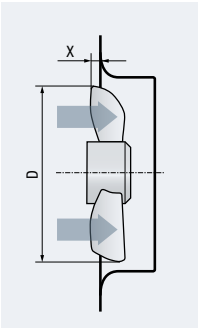
— Fan curve

— Efficiency

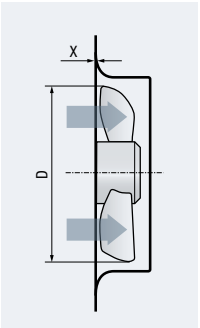
Effects of axial position in fan housing

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

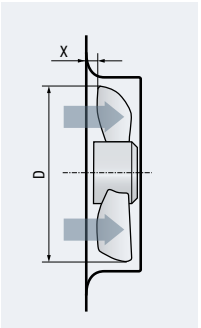
① Intake side projecting
x/D = 7%

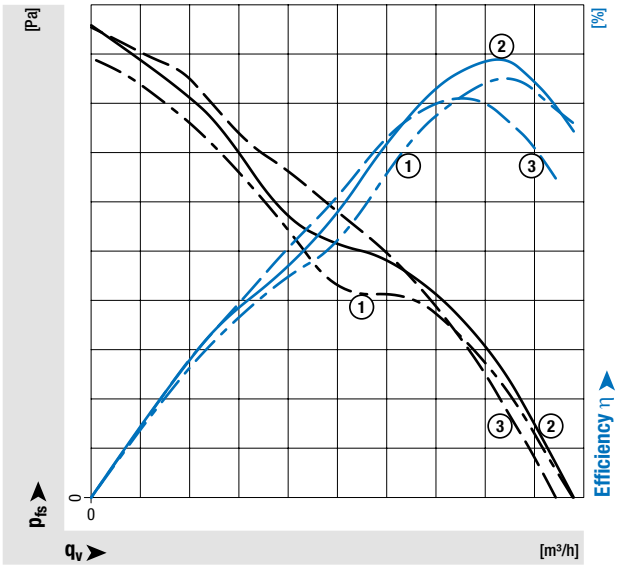


② Intake side flush
x/D = 0%



③ Intake side recessed
x/D = -7%



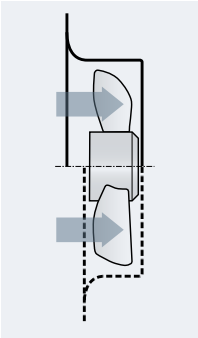


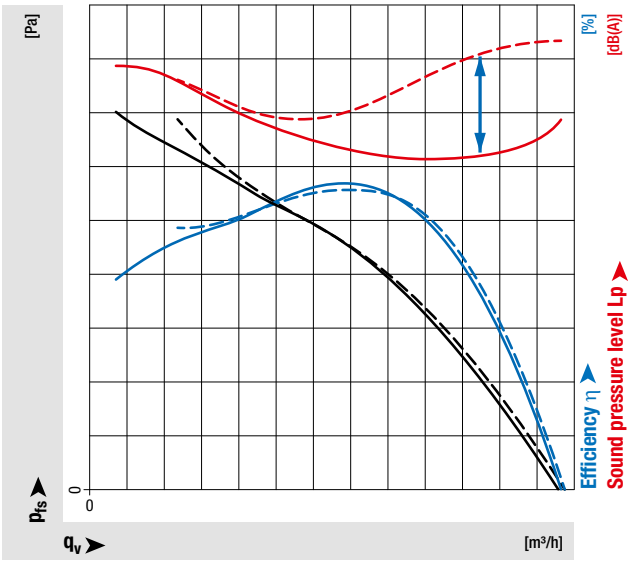
— Fan curve

— Efficiency

Axial fans
Fan housing and nozzle

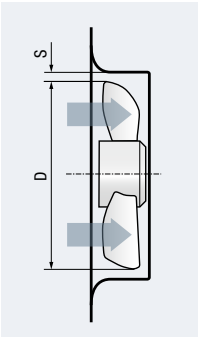
Effects of fan housing geometry with axial fans

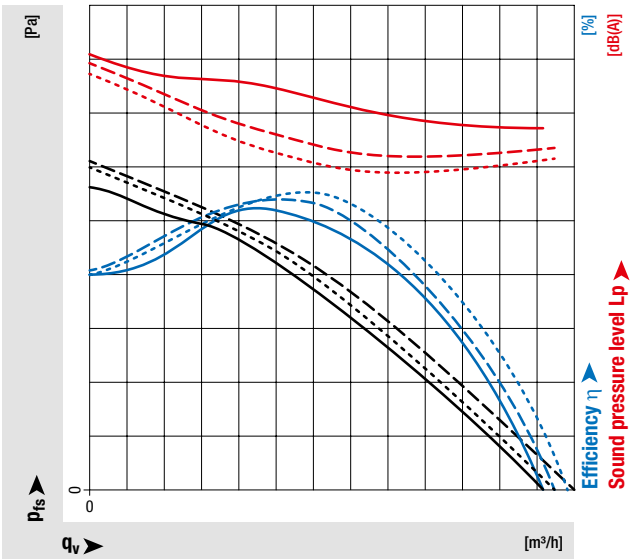




Effects of width of air gap between fan housing and blade with axial fans

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.



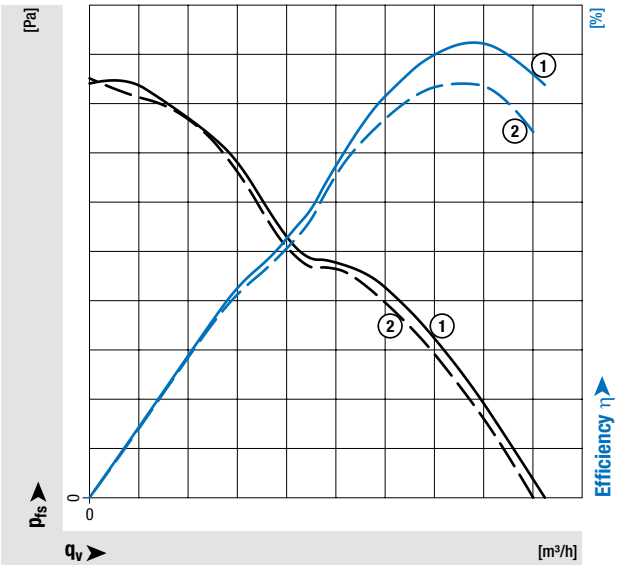


— s / D = 0.70%
- - s / D = 0.44%
· · · s / D = 0.19%

Axial fans
Guard grill

Effects of guard grill with axial fans

Fitting a guard grill reduces the air performance of an axial fan.

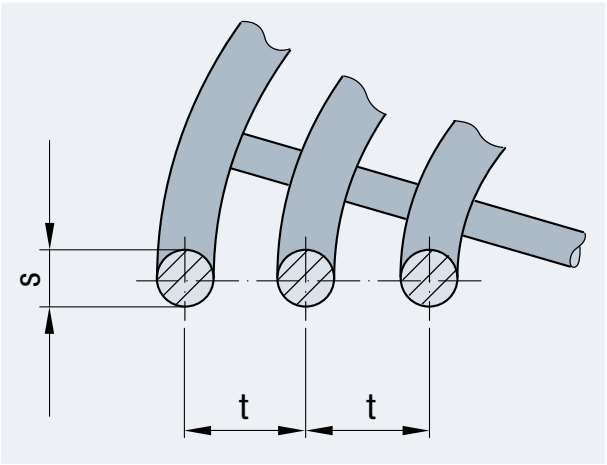


① without guard grill ② with guard grill

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

$$\zeta = \frac{\frac{s}{t}}{(1-\frac{s}{t})^2} \cdot 0.8$$

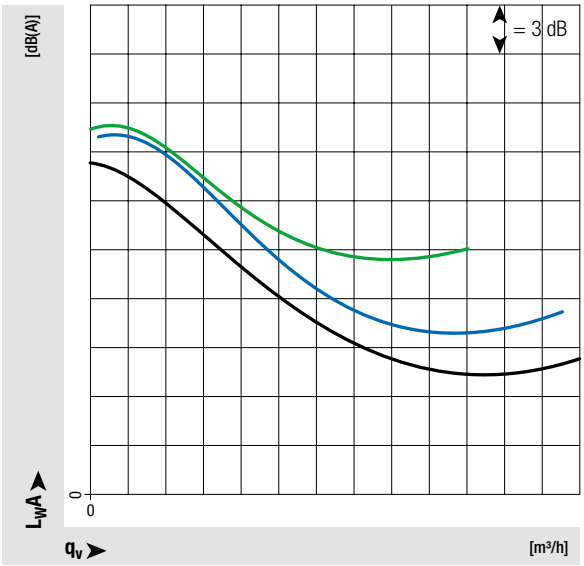
$$\Delta p_v = \zeta \cdot \frac{\rho}{2} \cdot \left(\frac{qv}{\frac{\pi}{4} \cdot D^2}\right)^2$$



Axial fans
Guard grill

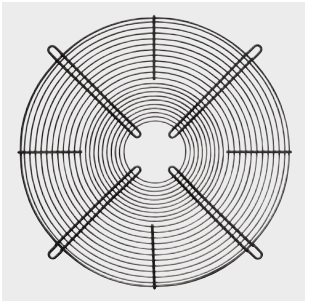
Effects of guard grill with axial fans

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.



– Catalog values
– Fan with guard grill (laboratory)
– Fan with guard grill (application)

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.



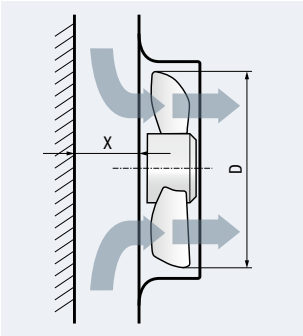
Guard grill

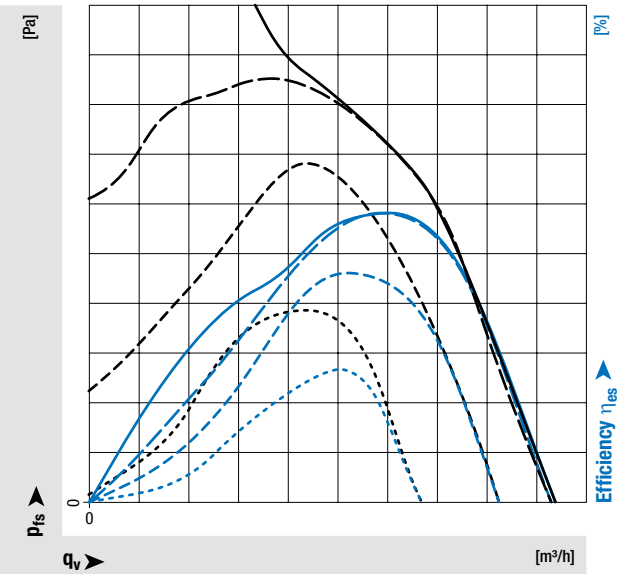
Guard grill with fan housing

Effects of intake obstructions

Effects of intake obstructions

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





— x / D = ∞ - - - x / D = 20%

– – x / D = 40% · · · x / D = 15%

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.

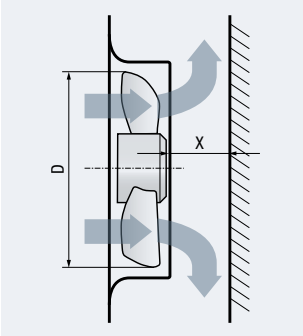
The FlowGrid – the air-inlet guard on the intake side – lessens the effect of inflow obstruction and so reduces the turbulence that causes noise: This reduces the sound pressure over the entire frequency range and in particular the disturbance caused by the blade passing frequency in the low frequency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

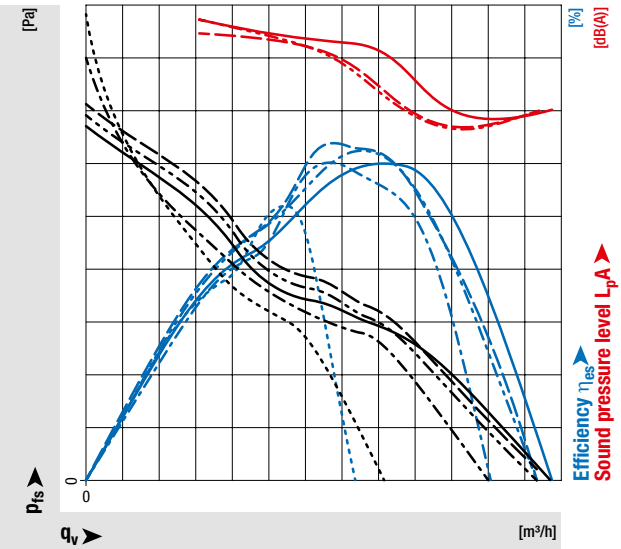
FlowGrid ›

FlowGrid for axial fans

Effects of outlet obstructions

Effects of outlet obstructions





— x / D = ∞
- · · - x / D = 75%
– – x / D = 50%
- · - x / D = 25%
· · · x / D = 10%

Guide vanes can double the fan air 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
(AxiCool)

Guide vanes

Axial fans
Diffuser

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.

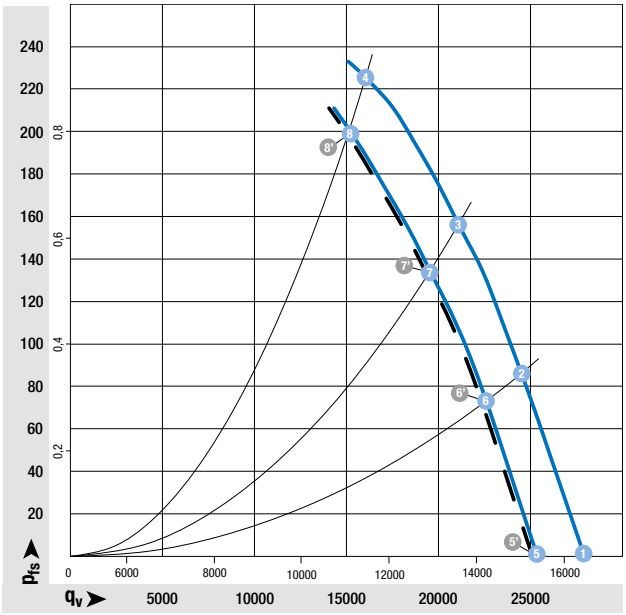
Diffuser ›

AxiTop for axial fans

Effects of a diffuser on axial fan curves

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

Comparison of curves (air performance 50 Hz)



— With diffuser, with protection against contact

— Without diffuser, protection against contact

Measured values

1 - 8 With diffuser, with protection against contact

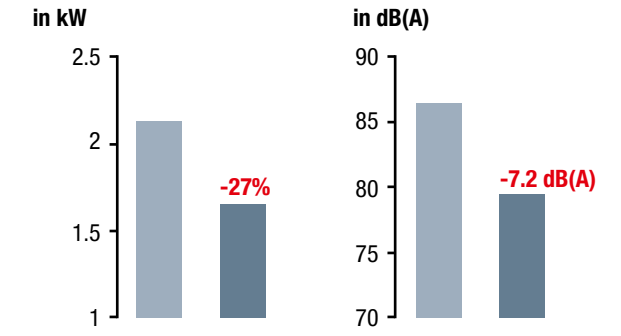
5' - 8' Without diffuser, with protection against contact

	n in rpm	P_e in W	I in A	L_WA in dB(A)
1	1020	1461	2.33	81
2	1020	1817	2.85	80
3	1020	2056	3.21	81
4	1020	2325	3.50	84
5	925	1091	1.74	79
6	940	1432	2.23	78
7	945	1634	2.55	79
8	960	1953	2.94	83
5'	1020	1667	2.48	87
6'	1020	1897	2.82	85
7'	1020	2090	3.11	85
8'	1020	2368	3.52	88

Axial fans
Diffuser

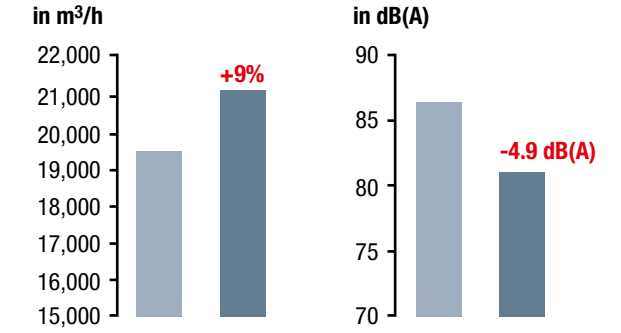
Reduced energy consumption and noise generation

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).

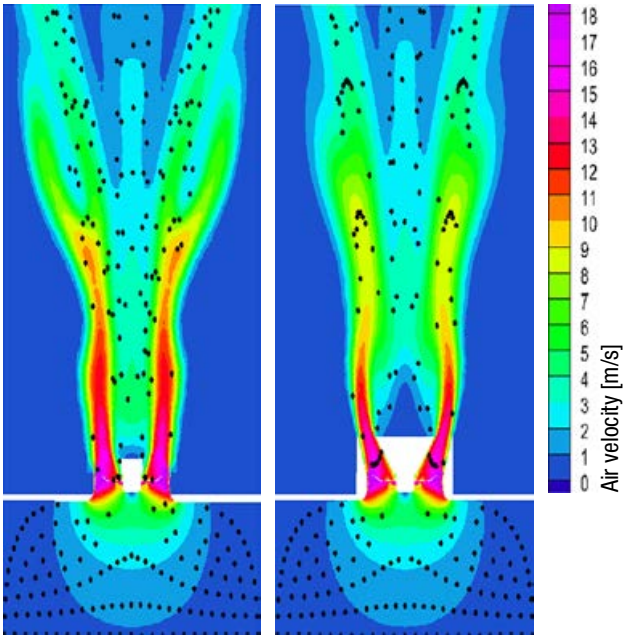


Increased air flow

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).



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.



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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.

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