Double Inlet Centrifugal Fans (Forward Curved)

BAT Series

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Blowtech Air Devices Pvt. Ltd. was founded in 1988 and quickly established itself as a leading manufacturer and exporter of HVAC fans and ventilation products in India. The company has excelled in the design, development and manufacture of the following high quality product line for a wide range of HVAC&R applications:

- Centrifugal and Axial Flow Fans and Impellers
- Inline Duct Fans
- Cabinet Fans
- Commercial Kitchen Ventilation Fans
- Fan Filter Units
- Evaporative Coolers & Scrubbers
- Energy Recovery Ventilators (ERVs)
- Air to Air Plate Type Heat Exchangers

The company’s 40,000 sq. ft., state of the art manufacturing facility near New Delhi (India) incorporates the most modern equipment & machines, a skilled workforce & over twenty-two years of rich experience. The production process is supported by a complete in house design and development facility and a full fledged tool room. All tools, jigs, fixtures and special purpose machines (SPMs) are designed and developed in house. All fan components are manufactured exclusively with the aid of precision tools and dies. This ensures inbuilt quality and consistency in fan performance fan after fan, year after year.

Blowtech is a ISO - 9001 - 2015 certified company and is a member of the Air Movement and Control Association, Inc. (AMCA). Consistent with its objectives of designing for optimum quality and performance, the company has its own Fan Test Laboratory which houses a Multiple Nozzle Test Chamber as per International Standard AMCA 210. The line of products including centrifugal fans, tube axial fans, kitchen exhaust fans, cabinet fans, direct driven fans, fan blades and impellers are tested in this in-house laboratory for performance evaluation and design validation.

To ensure long life and vibration-free operation, each impeller is first checked for eccentricity and run-out. Only after passing this quality check, the impeller is ready for balancing on computerized dynamic balancing machines. Balancing is done as per balance quality grade G 4.0 of the International Standard ISO 1940.

On the basis of advanced management ideas and perfect quality systems, Blowtech constantly strives to absorb and adopt latest technologies, precisely control the quality in each of its working processes and actively promote its products to keep it at the leading position in the HVAC&R industry in India. Our stakeholders’ and affiliate relationship networks ensure that we remain at the forefront of industry knowledge and future technology trends. Our skills, infrastructure and experience are trusted by our customers to optimize performance, minimize costs and increase efficiencies of their products. Our people ensure the success of our company, bringing the best in commercial understanding, technical capabilities and market know-how to bear on our customers' business.
BAT Series

Double Inlet Centrifugal Fans with Forward Curved Wheels

Blowtech Air Devices Pvt. Ltd. certifies that the BAT Series Fan Models 9x9, 10x10, 12x12, 15x15 & 18x18 shown herein are licensed to bear the AMCA Seal. The ratings shown are based on tests and procedures performed in accordance with AMCA Publication 211 and AMCA Publication 311 and comply with the requirements of the AMCA Certified Ratings Program.
**BAT Series - Double Inlet Forward Curved Centrifugal Fans**

The BAT Series is made of Double Inlet Double Width (DIDW) Centrifugal Fans with Forward Curved Impellers. These fans are suitable for supply and exhaust applications in commercial and industrial heating, ventilation and air-conditioning (HVAC) systems. Typical applications include evaporative cooling units, air handling units, indoor units of packaged air-conditioners, fresh air supply units, exhaust units and general ventilation and pressurization. The superior design of the Blowtech BAT series fans – optimum blade curvature, width and angle, aerodynamically shaped inlets, matching of the inlets to the wheel and optimum design of cut-off – has resulted in them being one of the most efficient fans. The BAT series is an economic choice for low to medium pressure range applications requiring high air volume and quiet operation.

BAT Series fans are available in 9 sizes from wheel diameters of approximately 7" to 18". The Air Volume capacity of BAT fans ranges from 1000 m³/h to 15000 m³/h. The performance of sizes 7x7, 9x7, 12x9 and 15x11 are not licensed by AMCA International.

The BAT series is available in type S, R and twin version T2 as shown below.

**Type S** are supplied with mounting feet and can be mounted in 3 different fan orientations. The wheel-shaft assembly is supported in bearings which are mounted to the fan housing using specially designed brackets.

**Type R** has rectangular side frames made from Galvanized Steel sheets which are bolted to the Fan Housing. This improves rigidity and strength and allows easy mounting of the fan in various orientations. The wheel-shaft assembly is supported in bearings which are mounted to the fan housing using specially designed brackets.

**BAT Twin (T2)**: BAT Series fans are also available in TWIN version where two double inlet fans are mounted on a single common shaft. These fans are ideal for applications where height is a limitation. The following factors need to be applied to obtain the performance of a twin fan from the performance of the corresponding single fan.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Multiplier</th>
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<tbody>
<tr>
<td>Pressure</td>
<td>x 1</td>
</tr>
<tr>
<td>Air Volume</td>
<td>x 2</td>
</tr>
<tr>
<td>Shaft Power</td>
<td>x 2.15</td>
</tr>
<tr>
<td>Speed (RPM)</td>
<td>x 1.05</td>
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<tr>
<td>Sound Level</td>
<td>+ 3 dB</td>
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</table>

Performance of BAT twin fans calculated as shown above is not licenced by AMCA International.
Fan Construction Specifications

Impeller (Wheel)
The BLOWER WHEEL is made from high quality rust resistant galvanized sheet steel and has forward curved blades.

A large forged steel or die cast aluminium hub with a precisely machined bore and a key way is fitted to the wheel backplate. Use of precision tooling for the punching and assembling of wheel components results in extremely low levels of eccentricity and run out. The wheel is statically and dynamically balanced on computerised dynamic balancing machines to balance quality grade G 4.0 of ISO 1940 and AMCA 204 standard.

Housing
The FAN HOUSING is also made from high quality rust resistant galvanized sheet steel with the housing wrapper fixed to the side plates using electric spot welding for sizes upto 10” and using ‘Pittsburg Lock’ for sizes from 12” to 18”. Side plate profiles are cut on precision machines which results in proper centering of the Impeller – Shaft assembly and precise overall fan dimensions for quiet performance. Aerodynamically shaped inlet venturies form an integral part of the side plates.

Shaft
The FAN SHAFT is manufactured from high quality EN9 carbon steel with keyways at both ends (for pulleys) and at the centre (for wheel hub) and is ground to close tolerance for precision fit.

Bearings
The WHEEL – SHAFT ASSEMBLY is supported at both ends in imported pre-greased permanently sealed ball bearings with an eccentric locking collar.

Each bearing sits inside a moulded rubber housing which in turn is mounted on to the fan housing using a set of 4 specially designed die-formed sheet steel brackets on each side.

Frames
In type ‘R’ the frame is manufactured in Galvanized Steel sheets.

Accessories such as Casing Drain Plug, Outlet Flange, Inspection Door and inlet and discharge guards are optional and can be supplied on request.
Fan Rotation and Orientation

Standard fans are supplied with both shaft ends prepared to fit a pulley. They can be used with either Clockwise (CW) or Counter Clockwise (CCW) rotation. All BAT 'R' Series fans can be easily turned to install them in any one of the four orientations 0°, 90°, 180° and 270° as shown below. On BAT 'S' series fans, the mounting feet can be relocated to install the fan in any one of the 4 orientations. The direction of rotation (CW or CCW) is specified by looking at the wheel from the motor end.

<table>
<thead>
<tr>
<th>CW 0°</th>
<th>CW 90°</th>
<th>CW 180°</th>
<th>CW 270°</th>
</tr>
</thead>
</table>
| ![Diagram of CW 0°](image)
| ![Diagram of CW 90°](image)
| ![Diagram of CW 180°](image)
| ![Diagram of CW 270°](image)

<table>
<thead>
<tr>
<th>CCW 0°</th>
<th>CCW 90°</th>
<th>CCW 180°</th>
<th>CCW 270°</th>
</tr>
</thead>
</table>
| ![Diagram of CCW 0°](image)
| ![Diagram of CCW 90°](image)
| ![Diagram of CCW 180°](image)
| ![Diagram of CCW 270°](image)

Motor Selection

The shaft power (H) lines shown on each performance curve indicates the input power at the fan shaft in kW.

To determine the minimum motor power required to drive the fan, this fan shaft power H has to be multiplied by a safety coefficient which accounts for power losses in belt drives and a reasonable safety margin. The recommended values for the safety coefficient as are under:

Safety Coefficient = 1.20 for H ≤ 3kW  
1.15 for 3kW < H ≤ 10 kW  
1.10 for H > 10 kW

The reasonable safety margin mentioned above takes care of any small change in the operating point or fan speed, which may be due to possible minor inaccuracies in calculation of system pressure drop or a pulley ratio slightly different from the design value.

For conversion to horsepower (hp), 1 hp = 0.746 kW.

With motors larger than 7.5 kW (10 hp), the use of a star/delta (Y/Δ) starter is highly recommended.

Fan Pressure under Free Outlet Conditions

The outlet velocity V and velocity pressure Pv shown on each performance curve has been determined under ducted outlet conditions, i.e. with an outlet duct having a cross section area equal to fan outlet area. When operating under “free outlet” conditions (no outlet duct connected), the outlet velocity and the resulting velocity pressure is higher (due to a smaller outlet area produced by the presence of the cut-off baffle). Thus the available static pressure, which is the difference between fan total pressure and fan velocity pressure, will be lower under “free outlet” conditions.
The velocity pressure under free outlet conditions can be reasonably estimated by multiplying the velocity pressure \( P_v \) from the performance curves by the following correction factor \( K_v \).

\[ \text{Kv} = 1.67 \]

Fan performance calculated with this correction factor is not licensed by AMCA International.

**Interpretation of Fan Sound Power Levels**

The sound power levels \( L_{wi}(A) \) shown on the performance charts are at fan inlet for installation type “free inlet ducted outlet” in accordance with AMCA standard 301. The single total A-weighted value has been calculated by summing the measurements over the 8 octave bands using the following A-weighting correction factors:

- Octave band mid-frequency (Hz) 63 125 250 500 1000 2000 4000 8000
- A-weighting correction (dB) -26.2 -16.1 -8.6 -3.2 0 +1.2 +1 -1.1

Since what humans hear are sound pressure levels (and not power levels), an approximate value of the Sound Pressure Level \( L_{pi}(A) \) can be obtained from the power levels \( L_{wi}(A) \) shown on the curves using the following formulae:

a) **In spherical free field:** \( L_{pi}(A) = L_{wi}(A) - 20 \log_{10}(d) - 11 \)
b) **In room conditions:** \( L_{pi}(A) = L_{wi}(A) - 20 \log_{10}(d) - 7 \)

where \( d \) = distance between the fan and the microphone in meters.

It should be noted that the sound power level of a fan, as installed in practice, could be significantly higher than that measured in laboratory conditions, due to a host of factors such as vibrations in the drive motor, stiffness of fan installation, air leakage through the connections, or turbulence produced by guards, diffuser grids or transition pieces. Also the above equations to estimate sound pressure levels must be used with extreme caution. The sound pressure level depends not only on the distance ‘\( d \)’ but also on the acoustic properties of the enclosure in which the fan is installed. The above equations are only valid for theoretical acoustic environments. In real life situations, the actual pressure levels may be significantly different.

**Fan Laws**

These are laws governing the performance of a fan and are used to convert the performance of a fan from one set of variables viz. size, speed and air density to another. Thus, if the performance of a fan is known for a given size, rpm or air density, its performance for another size, rpm or air density can be computed.

- **Air Volume:** \( Q_2 = Q_1 \times (N_2/N_1)^{1} \times (D_2/D_1)^{3} \)
- **Pressure:** \( P_2 = P_1 \times (N_2/N_1)^{2} \times (D_2/D_1)^{2} \times (\rho_2/\rho_1)^{1} \)
- **Absorbed Power:** \( W_2 = W_1 \times (N_2/N_1)^{3} \times (D_2/D_1)^{5} \times (\rho_2/\rho_1)^{1} \)
- **Sound Power:** \( L_{w2} = L_{w1} + 55 \log_{10}(N_2/N_1) + 70 \log_{10}(D_2/D_1) + 20 \log_{10}(\rho_2/\rho_1) \)

Where
- \( N \) = Fan Speed (RPM)
- \( D \) = Fan Size (Impeller Diameter)
- \( \rho \) = Air Density
For application of fan laws to size, the fans must be “geometrically similar”. Fans are geometrically similar if

- The number of blades and vanes are the same.
- All angular dimensions are the same.
- All linear dimensions change in proportion to the wheel diameter.

The efficiency of a fan does not change with rpm or air density. However, there is a minor increase in efficiency for larger sizes due to what is known as “size effect”.

Fan laws apply to all types of fans and therefore the fan law equations are a very powerful tool for both fan designers and system engineers. The fan designer can accurately predict the performance of a larger or smaller geometrically similar fan if the performance of a given size fan is known.
Example of BAT Fan Selection using the Performance Charts:

Ideally, for a given duty (flow rate and system pressure drop) a fan should be selected so as to operate near the point of maximum efficiency. This will result in the lowest energy cost to operate the fan and also lead to acceptable noise levels.

The selection process consists of 2 steps:
1. To determine the right size of the fan and
2. To determine the operating parameters e.g. speed (RPM), shaft power, outlet velocity, efficiency, velocity pressure and sound power level.

Most designers limit the outlet velocity of a fan within a band usually from 8 m/s – 12 m/s. The size of a fan for a given duty can be narrowed down to 2 or 3 sizes to suit this requirement. Once a size is chosen, one can go to the performance chart for this size to determine the operating parameters.

Example

Required:

Volume Flow Rate 'Q' = 9360 m³/h
Static Pressure Drop (Ps) = 400 Pa
Air Density (ρ) = 1.2 kg/m³

Determine:

Fan Size = BAT18x18
Outlet Velocity (V) = 9.53 m/s
Velocity Pressure (Pv) = 54 Pa
Total Pressure (Pt) = 400 + 54 Pa
= 454 Pa
Fan Speed (N) = 700 RPM
Shaft Power (H) = 1.81 kW
Sound Power Level = 79.5 dB(A)
(LωA)
Total Efficiency (η) = 65%
Wheel Diameter 241mm

BAT 9-7

Density ρ: 1.2kg/m³

Total Efficiency (%) - 39, 45, 56, 63, 61, 48, 32

Total Pressure Pt (Pa)

Volume Q (m³/s)

Outlet Vel. V (m/s)

Outlet Pressure Pv (Pa)

- Performance certified to for installation Type B - Free inlet, Ducted outlet. Power rating kW does not include transmission losses.
- Performance ratings do not include the effects of apparatuses (accessories).
- The A-weighted sound ratings shown have been calculated per ASHRAE International Standard 37.1, Valuers shown are for inlet.
- LwA sound power levels for installation Type B free inlet ducted outlet.
- MODEL BAT 9-7 NOT LICENSED TO BEAR THE AMCA CERTIFIED RATINGS SEAL.

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Wheel Diameter 271mm  

**BAT 10-10**  

**FEG 75**

- Total Efficiency (%)
- Density ρ: 1.2kg/m³

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<tr>
<th>R</th>
<th>40</th>
<th>48</th>
<th>62</th>
<th>60</th>
<th>52</th>
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</table>

- Speed N (rpm)
- Volume Q (m³/s)
- Outlet Vel. V (m/s)
- Vel. Pressure Pᵥ (Pa)

- Shaft Power Pᵥ (kW)
- Sound Pressure Level (dBA)

- Performance certified & for installation type B - Free Inlet, Ducted outlet. Power rating kW does not include transmission losses.
- Performance ratings do not include the effects of appurtenances (accessories).
- The A-weighted sound ratings shown have been calculated per AMCA International Standard 501. Values shown are for inlet.
- Sound power levels for installation type B (free inlet, ducted outlet).

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Dimensions:

**BAT 'S'**

![Diagram of BAT 'S' dimensions]

**BAT 7x7 - 10x10 'S'**

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All dimensions are in mm.

**BAT 'R'**

![Diagram of BAT 'R' dimensions]

**BAT 12x12 - 18x18 'R'**

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All dimensions are in mm.
Dimensions:

BAT 'T2-S'

BAT 7x7 - 10x10 'T2-S'

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All dimensions are in mm.

BAT 'T2-R'

BAT 12x12 - 18x18 'T2-R'

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All dimensions are in mm.
### Operational Limits - BAT Series

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