

Whitepaper



Universal Blowers - the technology behind Cleaning Applications



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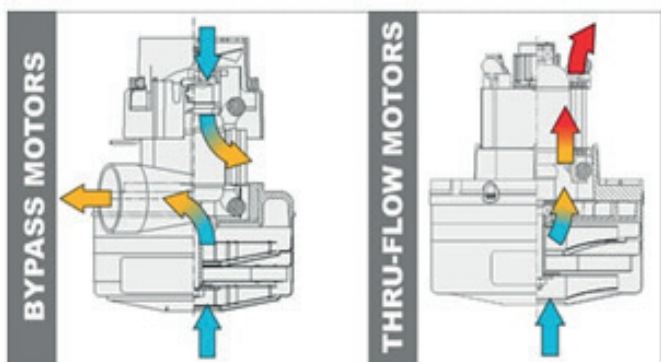
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Universal motor-driven blowers have been a staple in many industries for years. Whether it's for vacuum cleaners, scrubbers, extractors, central vacuum systems, material transport, animal dryers, foggers or sprayers, these brushed motors are considered critical because of their versatility, durability, and dependability.

Although the universal motor itself is a very mature device, many cutting-edge technologies and ongoing researches have spurred evolution in brushed blowers. Over the last 30 years, they have become smaller, lighter, and faster. Additionally, there has been a significant improvement in component designs. Bearings can now reach 50,000 to 70,000 RPMs, while commutators, brushes, and fans are capable of operating at higher speeds without impacting working life. .

In this article, we'll look at:

- » [What makes brushed vacuum motors unique](#)
- » [Bypass vs. thru-flow motors](#)
- » [Considerations for application design](#)
- » [Moisture protection](#)



What are Brushed Universal Motors?

Brushed universal motors are based on a universal motor design, which use a wound rotor and stator in series with one another. A commutator and carbon brushes serve as a high-speed mechanical switching system to serially distribute current to the rotor or armature coils and produce torque as they interact with the magnetic field produced by the stationary field coils.

In addition to the air-moving applications previously mentioned, universal motors are commonly found in smaller, corded appliances, and have high speed and excellent starting capability. Their speed-torque characteristics make them ideal for driving fan loads. They speed up non-linearly as load decreases, and partly compensate for clogging filters in vacuum cleaners, delivering sustained performance. The workhorses of many applications, these motors are economical, having a high power-per-kg ratio and are less costly than their brushless counterparts.

Design and Speed

When it comes to a precise application, several objectives must be considered - vacuum or pressure, airflow, cost, lifetime, noise and many more. Brushed motors are less expensive than their brushless counterparts. However, they do not provide the same features or lifetime expectations as brushes are consumable items.

Many brushless blowers offer additional technical features such as speed control, tach out signals, and programmability. Brushed motors are more basic but deliver a lot of performance relative to their acquisition cost.

The output power of a motor is the product of torque and speed at a given point. Or:
 $P \sim T \times N$

By taking speeds up, torque requirements are reduced at the same power level. And torque is proportional to the copper and steel content of a motor. Fans are smaller and faster. So, smaller faster motors allow similar air performance (output power) in a smaller, lighter, and less expensive package.

In terms of speed, brushed vacuum motors are fast now. Historically, their standard speed was 15,000 to 25,000 rpm. This has been limited by component reliability. In recent years, however, developments in material design has allowed speeds to increase to 30,000 to 40,000 rpm in many models. Some designs routinely run 40,000 to 45,000 rpm, while others exceed even 50,000 rpm.

On the other hand, smaller and faster motors present challenges to rotating components, which prompted manufacturers to make further developments:

- » Bearing manufacturers improved their designs with new greases and glass-filled nylon ball cages.
- » The commutator manufacturers improved their bar anchoring systems, developing internal reinforcing rings and better phenolics.
- » Carbon brush manufacturers developed additives to their molded brushes to promote good filming at high speeds and reduce friction wear and arcing.

Applications – Managing the Air Path

Vacuum blowers come in two basic styles, called thru-flow and bypass, referring to the relative paths of the working and cooling air. Each has advantages depending on the application.

Thru-Flow Motors

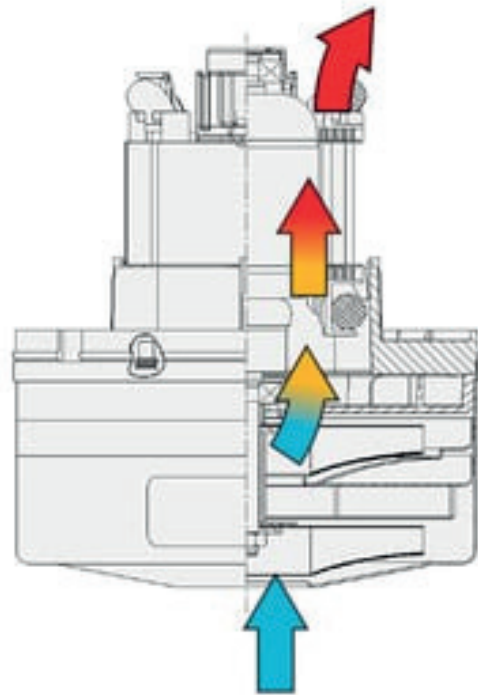
With Thru-Flow motors, the dry, filtered working air is passed through the fan system and exits directly via the motor windings.

The working air provides the cooling air for the motor.

For thru-flow motors:

- » Working air = cooling air
- » Restriction in working air restricts cooling ability of the motor. Thermal protection is often required

Thru-flow motors come in single- or two-stage configurations. Adding multiple fan stages allows pressure to build with each stage, delivering higher vacuum or pressure to the application. Single stage systems tend to provide better airflow at lower pressure/vacuum.



Bypass Motors

In bypass motors, the working air is independent from the cooling air. A separate fan is used to direct cooling air over the windings. A bypass design is used when it is important to ensure that the cooling air does not mix with the vacuum or blower working air. Since the working air is not passed across the motor windings, bypass motors are a great option for scrubbers, carpet extraction, and other wet pickup applications as debris and moisture will not contact the windings directly. The working air should still be filtered. However, they are not designed to pump water.

When using a bypass motor in their system, OEMs must take care of the following:

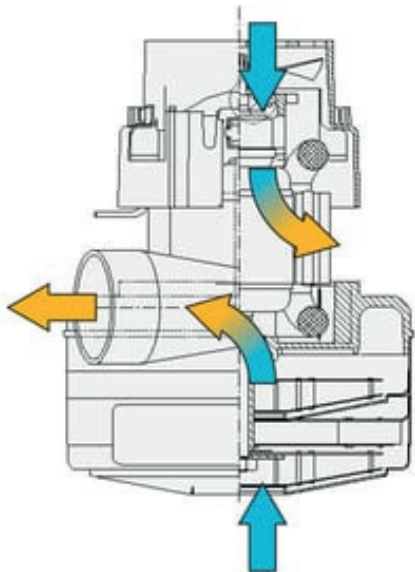
- » The working and cooling air systems must be separated from each other – they operate at different pressure levels and mixing them can disrupt the cooling flow.
- » The cooling air path should be baffled to separate the cooling inlet from the cooling exhaust. Failure to do so can cause recirculation with increased heating of the air and poor cooling performance.

Bypass motors come in peripheral and tangen-

tial discharge configurations and are available in single or multiple stages. Again, the purpose of the stages is to create more pressure or vacuum.

For bypass motors:

- » Working air \neq cooling air
- » Separate cooling fan
- » Separate paths; can safely handle moist working air (not liquids)
- » Working air discharge can be tangential or peripheral



How to Determine the Ideal Design for Brushed Vacuum Motors

Since there are a variety of brushed vacuum motors available, there are questions to be considered when determining the ideal design for an individual application, for example:

- » **What type of air will be picked up?** Do you need a motor that has to pick up dry or moist air?
- » **What are the cooling requirements?** Figure out whether external cooling will be necessary or if there is enough working air flow for cooling. Will some sort of thermal protection be required?
- » **What will be the operating point?** Determine what kind of airflow rate, pressure or suction, current draw or input power will be necessary

perform the intended task.

» **What type of voltage?** Understand the available operating voltage. Is an alternating current (AC) or direct current (DC) motor needed? Will it use line voltage or batteries? Or some other power supply? Universal motors can run on AC or DC, but they are sensitive to voltage and must be designed for the operating voltage. What is the operating voltage level?

» **What other features are needed?** Does the application require thermal protection, serviceable brushes, air discharge (tangential, peripheral or thru-flow), bearing protection or specific life-time?

» **Are there regulatory agency requirements?** Is there a need for specific insulation classes or thermal protection for locked rotor in unattended installations? Will there be end-product agency requirements like blocked inlet protection?

By taking the time to think about these questions and collaborating with experienced sales engineers, on the supplier's side, the ideal universal blower can be determined to fulfill the application requirements.

Protecting Bearings Against Moisture

MAE universal blowers safely protect the bearings from moisture damage, as our engineers have developed several solutions to protect bearings in moist applications and qualify their designs by using a specialized life test to ensure optimal moisture protection. The test exposes the bearings to detergent suds to prove the effectiveness of the bearing protection. Precision ball bearings with specialized greases and seals guarantee the required additional protection.

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