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TRANSFORMER TECHNOLOGY^{MAG}

Overheating & Creative Solutions Cooling

Transformers Are Cool - But Are They Really?

High-Performance Fans for Liquid-Cooled Transformers

The Power of Coatings - Keeping the World Connected

TRANSFORMER TECHNOLOGY^{MAG}



**HIGH-
PERFORMANCE
FANS**

FOR LIQUID-COOLED TRANSFORMERS

Liquid-cooled transformers are ideal for handling high loads and are in growing demand to support the modernization of the power grid around the world. These liquid-cooled transformers are typically used for power generation, transmission and distribution applications and axial fans are an essential component for managing the thermal load. The airflow profile of an axial fan is ideal for dissipating waste heat to prevent damage associated with overheating and to ensure safe operation of these power transformers.

As an industry leader in ventilation and drive engineering, ebm-papst Inc. manufactures axial fans with either AC motors or innovative, highly efficient, Green Tech EC (electronically commutated) motors for demanding liquid-cooled transformers. The fans are reliable, quiet and energy-efficient. They are available as a complete solution including industry-leading HyBlade® impellers, innovative motors, grill guards, and venturi housings which further improve airflow performance. The fans can be mounted either horizontally or vertically, addressing customer-specific requirements with the level of quality and dependability customers have come to expect from ebm-papst.

AC Technology

Part of what makes ebm-papst fans unique is they are a complete packaged solution. They offer a portfolio of AC fans that serve as a drop-in replacement for existing transformer designs. Diameters range from 500 mm to 1,250 mm and are plug-and-play ready as a package.

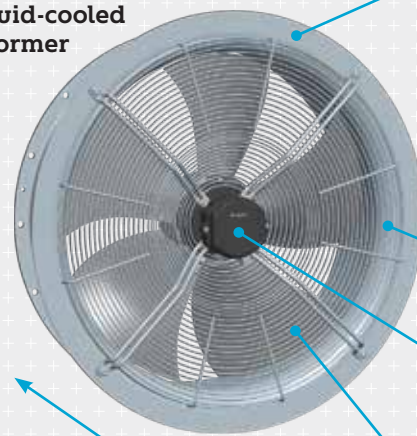
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Axial fans mounted for vertical airflow on liquid-cooled transformers

ebm-papst's AC and high-performance Green Tech EC axial fans are complete, packaged solutions that satisfy the requirements of high-power, liquid-cooled transformers.

Intake face of axial fan for liquid-cooled transformer

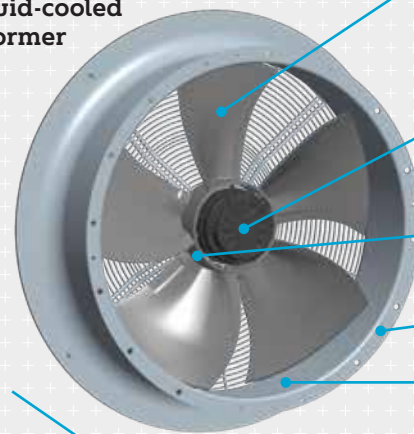


- Venturi:**
 - Galvanized sheet metal
 - Special coating for salt fog environment (withstand 720 hours according to ISO 12944 class C5M)
 - Color: "transformer grey" RAL9006
 - Mounting holes on both sides (450 mm fan only has mounting holes on one side)
- Air inlet:**
 - Harmonized with the impeller for highest aerodynamic efficiency level
- Terminal box:**
 - Aluminum die-cast
 - Special coating for salt fog environment (withstand 720 hours according to ISO 12944 class C5M)
- Fan guard:**
 - Galvanized steel
 - Special coating for salt fog environment (withstand 720 hours according to ISO 12944 class C5M)
- External rotor motor allows positioning of the motor directly in the airstream for a very compact design with high power density.**

Air flow direction



Exhaust face of axial fan for liquid-cooled transformer



- Impeller:**
 - HyBlade® composite design allows great flexibility in blade shape and winglet geometry for optimizing air performance and acoustic noise behavior.
- External rotor motor cooled by air stream. Die-cast aluminum housing with special coating for salt fog resistance.**
- Motor impeller statically and dynamically balanced on two planes to balancing grade G 6.3**
- Bolt circle for customer mounting on exhaust side**
- Exhaust side fan guard available as an option**

Air flow direction

HyBlade® Impellers

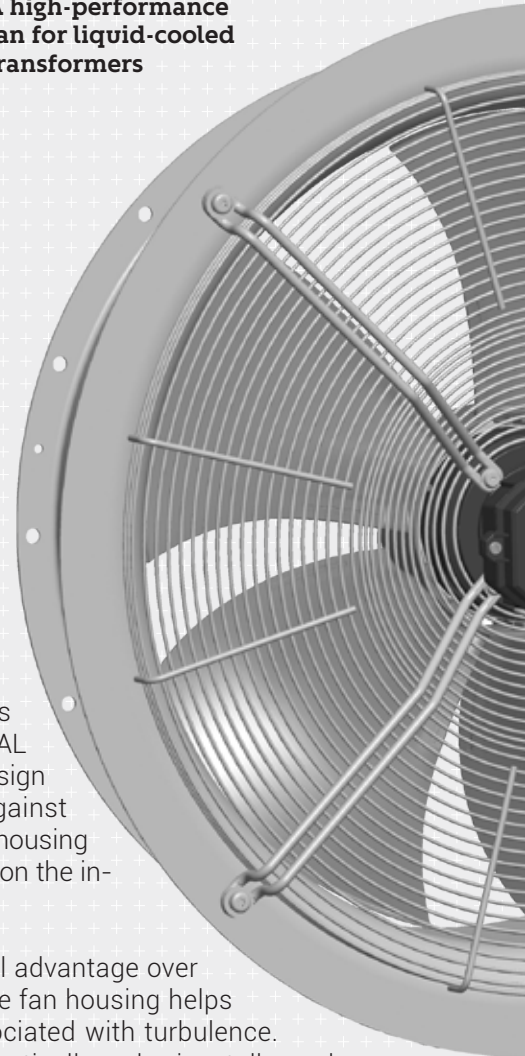
HyBlade® impellers provide for weight reduction, noise reduction and significantly improve fan efficiency. They feature a strong aluminum core with an external sheath of fiberglass-reinforced plastic with a profiled blade geometry and winglets. The aerodynamically optimized plastic blade shape provides performance and noise benefits, while the corrosion-resistant aluminum core ensures a permanent connection with the rotor. The fan blades are UV-resistant, lightweight and built to last.

Balancing Quality

To prolong the life of the fan while ensuring consistency and reproducibility, ebm-papst dynamically balances its fans in two planes to quality grade level G 6.3 according to DIN ISO 1940.

The company's standard balance quality grade, G 6.3, allows for a vibration velocity of no more than 6.3 mm per second, which meets industry requirements for industrial fans, flywheels and aircraft gas turbine rotors. Should a higher balancing quality level be required, ebm-papst can dynamically balance fans to suit the needs of specific applications by request.

A high-performance fan for liquid-cooled transformers



ebm-papst's EC motors operate well above efficiency requirements of super premium efficiency (IE4) motors, and they carry certifications for worldwide use.

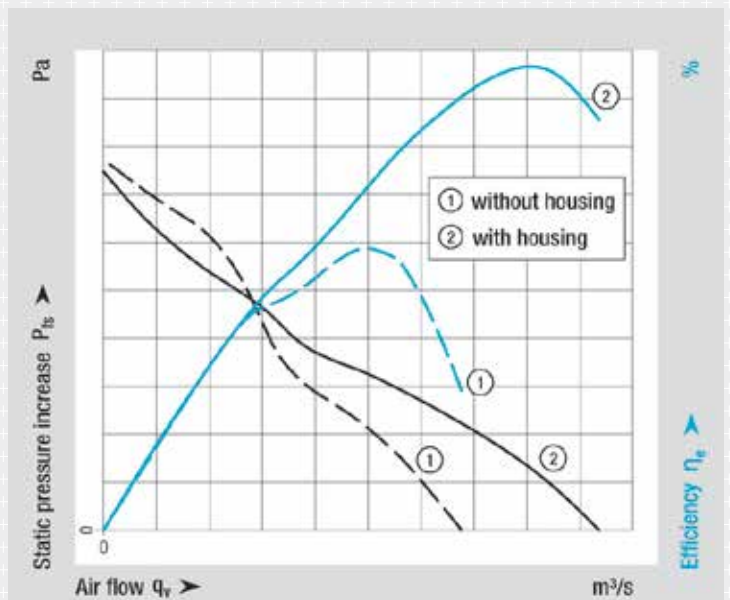
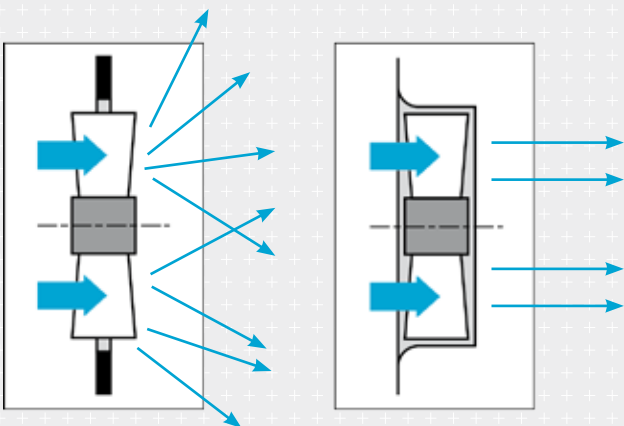
Venturi Housing

The rugged housing design consists of hot-dip galvanized sheet steel with a durable coating that is resistant to salt spray as per DIN EN ISO 12944, class C5M (color RAL 9006: transformer grey). The overall design has an IP55 rating for top protection against low-pressure water jets and dust. The housing also features an integrated venturi nozzle on the intake that improves airflow performance.

The venturi housing provides for a crucial advantage over fans operated with only a basket grill. The fan housing helps by reducing air performance losses associated with turbulence. The housed fans can also be installed vertically or horizontally, and may be mounted by either the intake or outlet side of the housing depending on the desired airflow direction. The fan housing also provides for easy handling and storage during transport.

Installing the axial fans in a housing is a perfect way to significantly increase air performance.

The venturi housing improves air performance and increases system efficiency.





Green Tech EC Technology

In addition to traditional AC induction motor technology, ebm-papst offers highly efficient Green Tech EC motor technology, which addresses a gap in the liquid-cooled transformer market.

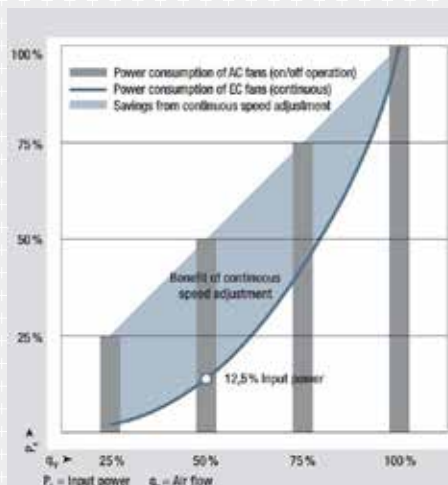
Green Tech EC motors are grid-powered, permanent magnet, synchronous motors with electronic commutation that are similar to brushless DC electric motors. An integrated electronics unit performs power conversion/inversion with frequency and amplitude modulation to provide precise adjustable speed control.

The EC fans are optimized for partial-load operation down to 10% of their rated speed. Continuously adjustable speed control is possible via open loop control using a 0 to 10 V DC analog input, pulse-width modulation (PWM) or Modbus RTU serial protocol.

ebm-papst Inc. transformer fans also feature external rotor motors, where the spinning rotor with permanent magnets is on the outside of the stator and coils. A fan using an external rotor motor with standard ferrite magnets can attain higher torques and levels of efficiency in a shorter package than an internal rotor motor of greater length using rare-earth magnets. The ability to attach the impeller directly to the rotor of the external rotor motor results in this space savings and allows the entire rotating assembly to be balanced in a single procedure.

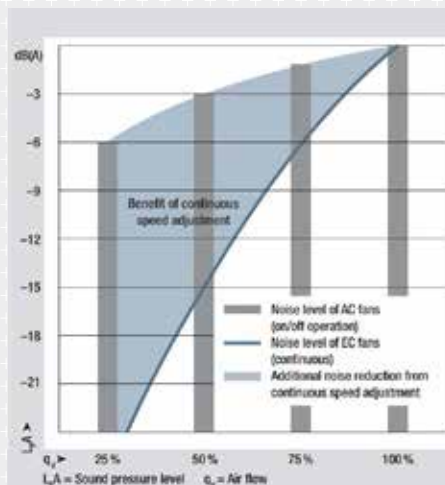
The EC motors operate well above efficiency requirements of super premium efficiency (IE4) motors. They carry certifications for worldwide use (e.g., UL, CSA, Eurasian Conformity, China Compulsory Certificate). Power supply requirements are 380 to 480 V AC, 50/60 Hz. ebm-papst Green Tech EC axial fans are universally deployable with simple commissioning. They are a dependable forced air cooling solution with air performance of up to 27,500 cfm.

Possible energy savings and noise reduction with continuous speed adjustment in part load operation



Reduced energy consumption

The bars show the power consumption of fans that are switched on stepwise as needed. Air performance is reduced by 50% when half of the fans are switched off. The blue line shows the power consumption of all fans with smooth speed adjustment at the required air flow (50% air flow = only 12.5% input power).



Lower noise generation

While switching off half the fans (50% decrease in air flow) only reduces noise generation by approx. 3 dB, a speed reduction resulting in 50% less air flow achieves an improvement of 15 dB.

Energy Savings and Noise Reduction

Transformers are increasingly used near residential areas, where strict requirements related to noise must be met. During peak demand times, all fans must typically run at rated speed to handle the thermal load of transformers working at full power. During off-peak times when cooling requirements drop, systems using conventional AC induction fans traditionally switch some of them off.

The fans which are still running continue to work at full power; this is not ideal for overall system efficiency or lifetime. This is where EC technology has a significant advantage.

Green Tech EC fans provide the more effective option of keeping all fans in operation at reduced speed while maintaining a high motor efficiency — even down to a fraction of the rated speed. Keeping all fans running results in a more uniform air flow through a transformer's radiators while still providing both a larger power reduction and a larger noise reduction than is achieved by on/off fan operation. Transformer hot spots created where fans are turned off are eliminated. Overall, it is a more economical system of operation that results in improved transformer and fan service life. The diagrams below illustrate the potential energy savings and noise reduction in comparison to on/off operation.

An added benefit to using an EC speed controllable fan is that fan selection may be made with the intention of having an air flow reserve should cooling demand exceed typical peak requirements (transformer overload) or to compensate for a failed fan. To avoid wasting power, the fans may be set below their rated speed during normal operation and only boosted to maximum speed for these atypical situations.

Rugged Design

ebm-papst fans have a long service life and are suitable for deployment in high salinity coastal areas. The incorporation of a hot-dip galvanized sheet-steel housing with a salt-spray resistant coating, UV-resistant composite blades and an extremely durable motor with an IP 55 rating provides for an extended service life even when subjected to harsh environments.

Liquid-Filled Transformer Market Requirements

Global Market Insights Inc. reports that the liquid-filled transformer market was valued over \$33 billion in 2017 and is set to witness the annual installation

of 600,000 units, with the anticipated market size to exceed \$45 billion by 2024. The adoption of distributed and renewable energy networks along with the subsequent upgrading of existing power networks will drive market value, while non-remote residential installations will force manufacturers to address noise requirements.

Conclusion

ebm-papst's AC and high-performance Green Tech EC axial fans are complete, packaged solutions that satisfy the requirements of high-power, liquid-cooled transformers. Innovative EC technology addresses a gap in the market place, fulfilling a need for noise reduction, extended service life and efficiency gains, while their AC fans are a drop-in replacement for existing transformer designs. ebm-papst can also devise customized solutions.



the engineer's choice

ebm papst

100 Hyde Road
Farmington, CT 06034
Tel: (860) 674-1515
www.ebmpapst.us

ABOUT EBM PAPST INC.

ebm-papst is an innovator and market leader in ventilation and drive engineering technology. Our core competencies in motor technology, aerodynamics, and electronics make ebm-papst a much sought-after engineering partner in many industries. With around 20,000 products, we provide solutions to a wide range of markets including Air-conditioning and Ventilation, Appliance, Automotive, Commercial Refrigeration, Heating, Industrial, IT/Telecom, Lighting, Medical, Transportation and more. We have placed the highest emphasis on economy and ecology for many years. We believe the consistent further development of our highly-efficient GreenTech EC technology provides our customers with the best opportunities for the future in industrial digitization. With GreenIntelligence, ebm-papst already offers intelligent networked complete solutions that are unique anywhere in the world today and that secure our customers a decisive advantage.



H-J

USA & Canada:
Ed Smith
Sales Manager, USA & Canada
(+1) 314-413-3421
edsmith@h-j.com

Mexico, Central America,
the Caribbean, and South America:
Diana Marcela Diaz
Sales & Commercial Operations
Director for Latin America
(+57) 316-440-8359
dianam@h-j.com

ABOUT H-J

We have combined ebm-papst's knowledge and technology about fans with The H-J Family of Companies technical and commercial experience in the specific market of power and distribution transformers. This partnership brings this technology's benefits even closer to the manufacturers and end-users of transformers through personalized technical support in North America, Central America and the Caribbean, and South America.