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Motor Technology

Efficient Refrigeration Fan Motors

An electric motor system and fan from ebm-papst Inc. (Farmington, CT USA) are said to benefit refrigeration equipment due to their relatively long power on-cycles.

ebm-papst brushless DC refrigeration fan motor.

Fan sizes of 12 in (300 mm) and smaller are traditionally operated with a.c. shaded-pole fractional-hp motors (SP motors) in the refrigeration industry.

According to ebm, even though the manufacturing cost of SP motors is very low, their uneconomical energy transfer is a growing problem for equipment manufacturers. More than 70 percent of electricity consumed by SP motors is said to be lost to motor winding temperature rise.

Consequently, condenser fan motors heat the air coming off the coil before it is discharged into an oftentimes air-conditioned ambient such as a convenience store, supermarket building, or residential home. "While that might be acceptable in the heating season, unnecessarily high amperage and power ratings on the equipment nameplate can affect the purchasing decision," explains Armin Hauer, product manager at ebm. "In the cooling season, the building operators suffer from additional heat loads, resulting in high electricity bills. Architectural design and construction engineers are sizing air-conditioners larger, offsetting savings from buying so-called 'low-cost' fan motors."

These efficiency problems are amplified in evaporator applications, according to Mr. Hauer. The self-heating of the motors increases the pull-down time, extends the on-cycle of the fans and compressors, and affects sizing of components.

Along with a very aggressive cost target, Mr. Hauer says the design criteria for ebm-papst's energy-saving motors (ESM) included simplicity and drop-in replacement for shaded-pole motors. The result is an a.c.-line operated brushless d. c. motor. The entire drive and control electronics (including EMI/RFI filters) are hidden in the motor enclosure, where they are sealed and protected from moisture, citric acids, and cleaning solvents.

The motor system's overload protection is accomplished electronically. "Since the ESM operates with internally rectified d.c., there will be no performance change if equipment originally designed for 60 Hz will be used at 50 Hz and vice versa," says Mr. Hauer. "Within limits, a reduction from nominal 127 V a.c. in Mexico, to nominal 110-120 V a.c. in the U.S. or Canada, results in unchanged motor output," he adds. The ESM ambient temperature range of -22°F to 122°F (-30°C to +50°C)

allows for both evaporator and condenser applications.

Mr. Hauer explains that the ESM development was based on an external rotor motor. "Instead of providing a shaft extension to apply a component impeller, fan blades can attach directly to the hub of the external rotor," he tells APPLIANCE. "Sickle-shaped blades and a plastic fan housing were optimized for the ESM performance characteristics. Five curved struts have a guide-vane effect. The combination of the high-speed ESM with the newly engineered fan provide interesting solutions to the problems of modern refrigeration equipment."

The motor's mounting details include an optional shaft extension that adapts to a wide variety of component impellers, typically made of plastic or sheet-metal. A durable ball bearing system, suitable for any shaft orientation, is also used. According to Mr. Hauer, permanent magnets, which are inherent to brushless d.c. motors, can generate a disturbing mechanical ripple, especially in vibration-prone, thin-gauge sheet-metal assemblies common in the refrigeration industry. Therefore, he says, an effective vibration isolation system has been built into the motor casing.