



BORGWARNER

A High-Voltage Cooling Fan for Electric Commercial Vehicles

BorgWarner's eFan system supports customers transitioning to electrified commercial vehicles, helping them comply with CO2 emissions targets.

The eFan consists of a large diameter open or ring fan, an electric motor to drive the fan, and an inverter to convert direct current from the battery to the alternating current required to power the motor. Depending on whether it's a battery electric vehicle or a hydrogen-powered fuel cell electric vehicle, higher performance eCVs need even more cooling capacity and airflow to cater for the size of the braking resistors or fuel cell modules used.

The eFan replicates the function of the engine-driven main cooling fan in an internal combustion engine vehicle. The fan is still needed in an eCV because despite replacing the engine with an electric drivetrain, there are several other systems that require cooling, such as the high-voltage battery, inverters and traction motors and, if installed, the braking resistors.

The high-voltage eFan demands a lot of power to operate it – anywhere from 5kW for a light truck, up to 40kW for a heavy-duty vehicle – which depletes battery capacity. As this is directly related to the distance the vehicle can travel, ways have been found to minimise energy wastage and optimise fan performance and e-motor and inverter efficiencies in a limited package in the front of the truck. A large fan and electrical motor also create noise, which must be within limits defined by noise emissions legislation. This is even more important because the whole electrified propulsion system is running on very low noise levels overall.

These challenges have been met by using computational fluid dynamics and computer-aided aeroacoustics to design a fan impeller with high aerodynamic efficiency – this has less frictional drag, saving energy. More efficient airflow allowed us to

reduce the rotational speed and power consumption of the electric motor to a level at which it develops sufficient torque to drive the fan but minimises sound pressure levels.

The eFan 40, the most powerful in the range, is particularly effective in vehicles that use multiple radiators sandwiched together. This heat exchanger arrangement harnesses the dynamic pressure developed by forward motion of the vehicle, but at standstill or low speed the throttling effect of the radiators chokes the cooling airflow. Despite its compact size, the eFan 40 overcomes the high static pressure to replace or supplement the airflow, even in a tight installation space.

Safety heads the list of OEM requirements when adopting a new product in the high-voltage range. Each OEM has its own criteria regarding protection of high-voltage power electronics installations, so the inverter concept developed for the eFan needed to meet their functional safety standards in all driving situations, including a vehicle crash. We achieved this by designing an inverter that can either be integrated into the e-motor housing or mounted externally.

The eFan makes it easier to electrify heavy-duty vehicles that otherwise couldn't be cooled cost-effectively throughout a long service life – it's helping to remove fossil fuel-burning internal combustion engines and their harmful exhaust gases from road freight transport in favour of CO2-neutral powertrains.

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