Variable speed drives and motors in car parks

Helping car parks meet the energy and CO_2 reduction challenge

In the UK, as population density increases and space becomes more of a premium, multi-storey car parks have become an increasingly attractive way of parking vehicles within towns and cities. Multi-storey car parking facilities are now common place in office buildings, shopping complexes and apartment blocks.

Car park design has also changed greatly over the years. Previously, car parks were designed as functional buildings offering little aesthetic appeal, but architects and city planners now feel the need for car parks to show more compassion to their surroundings. The result is that car parks are increasingly becoming enclosed buildings and as a consequence, natural ventilation is harder to achieve. As a result ventilation systems have become common place to provide extraction of vehicle fumes and, in the case of a fire, smoke ventilation.

Within car parks there are three methods of ventilation

1. Natural ventilation
These tend to be above ground car parks with permanent wall openings on each level equal to 5 percent of the net floor area in natural openings, 50 percent of which must be split between opposing walls. These openings provide enough ventilation for smoke clearance and removal of exhaust fumes. Designers also have to take full account of the aerodynamic effect of any barriers across the ventilation openings.

2. Assisted natural ventilation
When 5 percent open space is not achievable, but 2.5 percent of the net floor area is available to provide cross ventilation, a reduced rate of ventilation is possible. This is sufficient ventilation for smoke clearance, but in addition a mechanical extract providing three air changes per hour is needed to remove exhaust fumes.

3. Mechanically ventilated
Where natural ventilation is not possible, the only option is to provide a mechanical means of ventilation. This needs to achieve six air changes per hour for exhaust fume extract and 10 air changes per hour for smoke clearance.

Legal requirements

The ventilation system for an enclosed car park has two functions:

1. To remove vehicle exhaust fumes, mainly carbon monoxide (CO), during normal car park usage, creating an acceptably air-conditioned environment.
2. To remove the smoke in the event of a fire to assist in providing a safe means of escape.

In the UK, the design covering these two functions are set out in detail in Documents B and F of the Building Regulations for England and Wales. Similar recommendations can be found in the technical documents for Scotland.

For the UK, the standards currently are:

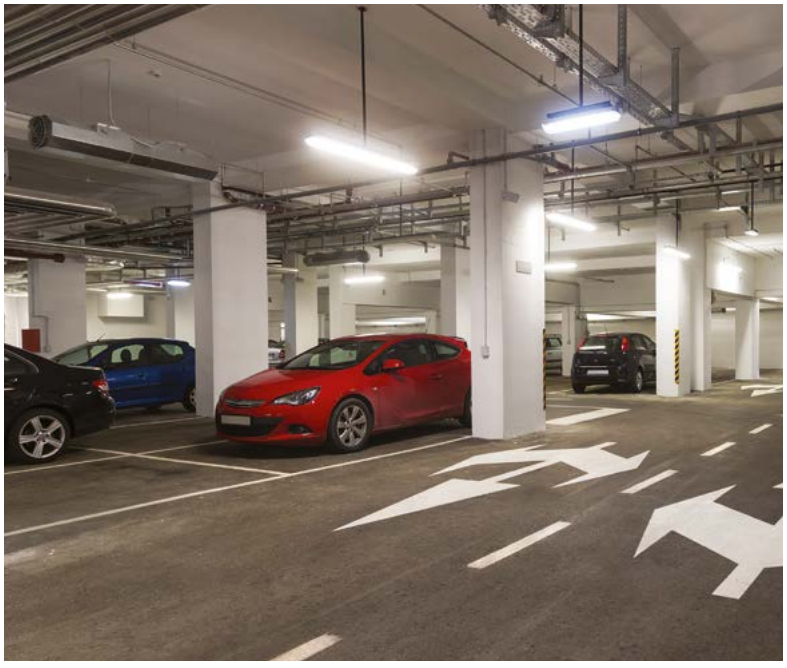
- Six air changes per hour (or ventilation to maintain the CO level < 50 ppm for fume control function)
- 10 air changes per hour, or a ventilation rate based on the requirements in BRE 368[1] for fire smoke removal
- Total ventilation duty must be divided between two fans
- Fans must be capable of surviving a minimum of 300°C for 1 hour
- Exhaust ductwork system to have extract grilles, 50 percent at high level and 50 percent at low level
- Attention has to be given to the supply of replacement air

Car park ventilation applications

Jet, impulse or induction systems
All the above are different names for the same basic system and provide car parks with ventilation by propelling a small jet of air at extremely high velocity, causing the surrounding air to be carried along with it. These systems were originally designed for the extraction of fumes from tunnels but are now commonplace in car parks as they work well in confined areas.

The system works by adding momentum to the air and directing it to a pre-designated extraction point ensuring there are no dead spots for fumes and smoke to stagnate and collect. The system offers significant space-saving benefits over traditional ductwork systems along with huge energy-saving potential, as only a small number of carefully located fans are needed to ensure air movement throughout the car park.

Advantages of jet, impulse or induction systems
- Jet fans take up less space than traditional ducted systems
- Jet systems are often combined with CO detection so the system begins to extract when pollution levels build up too high – running fans in this way saves energy
- Noise levels are significantly reduced as fans are smaller and run at lower speeds
- Jet fans cost less than ducted systems
- Easier for engineers to carry out maintenance



Jet, impulse or induction systems with variable speed drives
All car parks will have peaks in demand and consequently demands on the ventilation system will differ accordingly. In traditional systems, fans run at 100 percent at all times and are controlled by throttling arrangements, but this is extremely energy intensive. By controlling fan speed using variable speed drives, car parks can reduce their overall energy spend. This is achieved by using variable speed drives on fans to vary air flow, meeting changing load demands more precisely. Variable speed drives also allow you to adjust a real time clock, without the need for a building management control system. This helps to save money as each drive can be set up independently to activate functions at various times of the day according to the needs of the car park.

Traditional ventilation systems
Within traditional systems, ductwork is used to remove smoke from the car park. Ducts are evenly spread throughout the car park and also feature at low levels to provide extraction points. Many of these traditional systems were installed during times when vehicle pollution levels where high, yet today with the invention of the catalytic converter and the growing trend of smaller engines, many car park ventilation systems find themselves oversized and as such, can benefit from improvements in ventilation control.

Traditional systems tend to make use of vanes and dampers to restrict airflow to individual floors whilst maintaining peak flow in the central HVAC system. However this approach uses considerable energy and equipment lifetime is shortened. A much better approach is to reduce the fan speed in the ventilation system to match the needs of the building. This can be achieved by installing variable speed drives.

Variable speed drives
Car park electricity costs can be reduced by between 20 and 60 percent with variable speed drives. These devices control the flow of pumps and fans to eliminate the energy waste that is common with conventional pump and fan control methods.

How variable speed drives work
Many existing fan systems are based on throttling arrangements: the motor is driven at full speed and then the flow of air is regulated by dampers, vanes or similar throttling mechanisms. Throttling the output in this way wastes energy. A drive can increase the system's efficiency by adjusting the motor speed to the correct operation point and eliminating the need for throttling.

A small reduction in speed can make a big difference in energy consumption. A fan running at half speed consumes only one quarter as much energy as a fan running at full speed. This is because the power required to run a fan changes with the cube of the speed.

Because many fan systems run at less than full capacity for much of the time, drives can produce huge savings. If a 100 kW fan is throttled by 50 percent, for example, the investment in a drive will have a payback of only six months of continuous operation.

Variable speed drives also allow fan settings to be adjusted from a central point; if one drive is adjusted, the settings are administered throughout the car park, helping to maintain balance within the system.

Eliminating harmonic distortion
As car parks are fitted with sensitive measuring equipment, it is important that the drives cause as little disturbance as possible to the mains supply to avoid interfering with the instrumentation.

Certain drives feature a patented swinging choke that reduces the harmonic signature at low motor speeds, fulfilling the international standard IECEN61000-3-12. The choke adjusts automatically according to the electrical load and circumstances and cuts harmonics, especially at partial loads, by up to 25% when compared to traditional choke designs.

The benefits of variable speed drives

Benefits of variable speed drives

Commercial

- Reduced energy consumption – between 20 and 60 percent
- Fast payback – from six months
- Reduced CO_2 emissions
- Enhanced Capital Allowance scheme provides businesses with enhanced tax relief for investments in energy-saving equipment meeting the Government's published criteria
- Financing available through the Carbon Trust
- Fans offer best energy-saving potential in car parks e.g. applying a variable speed drive to a 75 kW motor in continuous duty can save nearly £15,000 per year
- Control panel costs can be reduced by utilising untapped features within the drive, e.g., inbuilt monitoring and timer functions, to replace external equipment such as switches, timers and lamps

Technical

- Starting, stopping and braking can easily be programmed to reduce stress on mechanical equipment
- Increases equipment life and reduces maintenance requirements for fans and motors
- Drives can be easily retrofitted into existing installations
- Real-time clock date and time stamps trips and faults, enabling end user to identify problems in the wider HVAC system
- Can be easily programmed to run fan motors at different speeds at different times or on different days
- Low harmonic solutions available as part of installation design
- Inbuilt PID control can be used to vary fan speed according to how much CO and CO_2 there is in the air. External sensors monitor the air quality. Should CO and CO_2 levels exceed predefined limits, the drive's PID control adjusts fan motor speed to regulate a flow of fresh air
- Some variable speed drives have a 'fireman's override' feature. This is a switch or input that allows the fire service to take control of drives controlling fans and turn them into smoke extraction units to maintain escape routes
- Many drives are now adopting BACnet interfaces. Giving VSDs a BACnet capability ensures they become a fully-fledged part of a BMS and can contribute their abilities to an overall control and management strategy

Help is available

ABB provides free energy assessments that detail the best applications for upgrade and show the savings that can be achieved by installing variable speed drives and high efficiency motors.

The 50-person strong Energy Assessment Team is comprised of ABB engineers and selected technical partners, all of whom have extensive practical experience of carrying out energy assessments. In just half a day, an engineer will identify the motor-driven applications at a site that offer the greatest opportunity to cut energy use. An action plan is then provided to turn those potential savings into actual savings.

Life cycle services

When you choose an ABB drive you automatically become part of the most comprehensive product life cycle management scheme in the industry. The scheme ensures that the required product support is always available and paves the way for a smooth transition to a new product at the end of the life cycle.

Pre-purchase
ABB provides its customers with help in selecting the right drives and services for their applications. Correct selection and dimensioning ensure improved performance of the entire system.

Order and delivery
Orders can be placed directly with ABB or with a member of its Authorised Value Provider network. This network ensures timely deliveries from local and central stocks.

Installation and commissioning
ABB certified engineers can advise or undertake the installation and commissioning of drives.

Operation and maintenance
ABB helps ensure a long lifetime by providing on-site preventive maintenance. Preventive maintenance consists of annual inspections and component replacements according to the drive specific maintenance schedules.

Retrofit and upgrade
ABB can advise on the latest hardware and software upgrades that can continue to maximise the performance of your drive.

Replacement and recycling
ABB can advise on the best replacement drive while ensuring that the existing drive is disposed of in a way that meets the local environmental regulations.

Value chain services
ABB offers training, technical support and service contracts throughout the life cycle value chain.

Practical application

ABB variable speed drives ensure clean air at Q-Park car park

Challenge
Q-Park's car park in Sheffield needed to achieve adequate air circulation to provide ventilation and fire safety to the car park's 531 spaces located over its six floors.

Solution
To ventilate the car park of CO and ensure that smoke can be vented in the event of fire, ABB standard drives for HVAC were fitted to two fans to provide air movement within the car park and two fans for extraction, driven by two 1.5 kW and two 4.8 kW drives respectively. The system also monitors CO levels in the car park and initiates ventilation when the level rises above recommended levels via an independent control panel providing three, six or ten changes an hour depending on conditions within the car park.

Benefits
Depending on the number of air changes needed, the drives run at 25, 30, 50, 60 or 100 percent speed. The variable speed drives enable Q-Park to reduce the speed of the fans, helping to significantly reduce energy spend. As well as the energy saving benefits of only running the ventilation when needed, the drives also have the advantage of soft start, so that the fan motors do not draw a large current on start up.

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