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As well as cutting costs around cooling, variable speed drives can cut the damaging impact of harmonics in data centres

Boosting data centre sustainability

Maria Fedorovicheva explains how ultra-low harmonic variable speed drives can help data centre operators limit energy consumption and reduce data centre carbon footprint

According to the International Energy Agency (IEA), global internet traffic grew by more than 40 per cent in 2020, driven by video streaming, video conferencing, online gaming and social networking during the pandemic.

The sector consumes more than 1 per cent of global electricity. And even though social restrictions are lifting, demand for data is continuing to grow at a tremendous rate. It is essential for data centre operators to improve their energy efficiency – meeting demand while curbing energy use and carbon emissions.

Variable speed drives (VSDs) are essential to supporting this. Their use is already well-established practice in data centre cooling to save energy.

The relationships between pump or fan shaft speed, flow rate, pressure and power are governed by the affinity laws, which show that reducing the speed of a fan or pump for example by 20 per cent can save as much as 50 per cent of energy. Data centres operate most of the time at partial loads, typically reaching peak demand in the afternoon and evening, when most people draw on services such as web conferencing and streaming. As a result, operators can easily achieve energy savings of 25 per cent and more by reducing cooling application speeds at non-peak hours.

Another important consideration is that drives don't just affect cooling system efficiency. They can also impact the overall efficiency of the electrical distribution network of a data centre. This is because, depending on the drive design, they can generate electromagnetic noise in the network called harmonics.

Harmonics result in increased line currents, and this may lead to noticeable electrical losses in cables and other power network equipment as power is lost to heat. These can be significant. For example, a standard drive might lead to about 40 per cent total harmonic distortion (THDi), making currents appear higher and resulting in about 20 per cent higher energy losses in cables.

However, it's possible to avoid this – either by adding a harmonic filter or by specifying ultra-low harmonic (ULH) drives. The ULH drives generate almost no harmonics in the first place and therefore noticeably limit losses in the network.

Less material usage

ULH drives have an important additional benefit as sustainability extends beyond efficient use of energy. Less material usage over a data centre's lifetime can also make it more sustainable and reduce its carbon footprint.

As mentioned, a typical drive may result in higher line current due to the 40 per cent harmonic distortion. It is standard practice to oversize power network equipment such as transformers, generators, switchgear and cabling to handle this current.

For example, transformers might need to be oversized by about 35 per cent when using standard drives but with ULH drives, this margin can be reduced to 10 per cent. Similar principles apply to generators, cables and other power network equipment, with the ULH drive reducing the need to significantly oversize the system.

Smaller equipment means less use and processing of raw materials and lower energy consumption during manufacture of equipment. These lead to a smaller carbon footprint for the data centre. And the business owners have a lower project cost.

Sustainability can also relate to longer equipment lifetime. Drives help with this as they eliminate mechanical and electrical stresses on systems, for example by starting and stopping cooling applications in a smooth way which eliminates high inrush currents and water hammer. Drives also help operators to avoid resonant frequencies and devastating vibrations, which can damage cooling system equipment.

In addition, they can provide data that informs operators about upcoming issues, such as a bearing failure by identifying when a drive is drawing a higher current than usual for the same load. All this leads to a longer lifetime for system equipment, eliminates unplanned outages and contributes to sustainability by using materials more wisely and repairing rather than replacing. This also contributes to reduced data centre carbon footprint.

A data centre operator in Asia is a particularly good example. When planning a new facility, it recognised the potential impact of harmonics on its energy consumption, as well as the sizing of its electrical systems.

Therefore, it is avoiding any issues arising from harmonics, having specified ULH drives for data centre cooling from the outset. The operator set the requirement to limit total harmonic distortion below 5 per cent. Further requirements included the availability of a local service centre for technical support 24/7, and ability to deliver the drives to meet the project timeline.

The operator has installed almost 100 of ABB's ACH580 ULH drives for the facility. This is a type of drive that is designed specifically for the pumps, fans and compressors as part of air-handling units, chillers, cooling towers, etc. in HVAC systems. Its built-in software includes features that are dedicated to HVAC operators for more efficient processes control. ■

Energy use in data centers
Load profile

- Data center cooling systems are designed for peak loads at worst cooling conditions.
- Data centers do not operate at design peak loads most of the time.
- The challenge is to make a data center efficient at part loads.
- Cooling system should adjust to a data center's load profile as well as to environmental conditions and maintain high efficiency even at part loads.