High-speed revolution in motors and drives

Higher speeds, lower costs and better environmental performance – these are the goals that will define how alternating current (AC) drives fare in the future. Along the way, these same AC drives will shape how industry – ever-dependent on its motors, compressors, pumps, blowers and test stands – progresses and profits. To 'fast forward' this process, ABB has launched a new range of high-speed drives it is marketing under the name HISPIN.

10-megawatt, 12,000-rpm high-speed motor from the HISPIN range

Rated from 2 MW to 15 MW, the range is aimed at replacing gas turbine drives in compressor, pump, blower and test stand applications using speeds from 3,800 to 15,000 rpm. Drives for compressors will cover a range from 5 MW/15,000 rpm to 15 MW/10,000 rpm, while the pump drives will reach 7.5 MW and 7,500 rpm.

Currently, gas turbine drives are the technology of choice in these areas, but switching to an electrical system will bring huge cost and environmental benefits.

HISPIN drive systems are made up of a high-speed induction motor and an AC drive from the ACS 6000 product family, both of which are standard components, making them easy and quick to bring to market. The key difference between the new drives and the gas turbine systems they are designed to replace is that they use magnetic rather than oil bearings.

Magnetic bearings incur negligible friction because the shaft and bearings within the system are not touching. In a gas system, these components are in close contact, being separated only by oil. The absence of high levels of friction in high-speed motor drives means they are less likely to become damaged through operational wear and tear, and are therefore more reliable. Energy losses are also dramatically reduced.

Oil-based systems are also more cumbersome, making additional supporting equipment necessary for them to function. They will need an oil unit, for instance, to ensure oil is flowing at the right rate and the right pressure to the different bearings within the machine. The unit will need redundant pumps and pipes.

These additional pieces of infrastructure translate into added weight and bulk. They make the system more costly to build, install, operate and maintain, and make the system much harder to control remotely. With oil, there is also the risk of fire.

Another benefit of using magnetic bearings is that they are controllable, can be run at optimum settings and monitored at all times. By contrast, oil bearings are passive and not controllable.

The new high-speed systems are a great deal quieter than their gas turbine equivalents, cutting noise levels by, on average, 30 decibels. They are also cleaner. Since they produce no polluting emissions like nitrogen oxide, they are emission-free at the point of operation. And, having no oil they are also free from the risk of polluting oil spills. This means they can be sited in or near urban settings.

Tests have also shown that they beat gas turbine or other oil-based electric drives on a range of important efficiency measures – offering electrical efficiency of 98.5% and motor efficiency of 96.5%. Thermal efficiency has been shown to be five percent better in the high-speed drive than in a single-cycle gas turbine.

Importantly, the new systems are much more economical to buy, operate and maintain since they are free of the supporting infrastructure and components that go with gas turbine drives. ABB estimates that annual maintenance costs for the new machines are a quarter of those for an equivalent gas turbine system.

Eco-friendliness based on LCA

There is a very important aspect of the HISPIN product development which it shares with many other ABB products – Life Cycle Assessment (LCA).

LCA is a method that describes and quantifies the environmental impact of every stage of a product's life cycle, from raw material extraction, manufacture and use, right up to the time it is taken out of service and scrapped. At ABB, LCA is used to develop environmentally compatible components and systems. These are characterized by a material content that can be reused and recycled, and by production methods which are clean and efficient. The most outstanding environmental gains are achieved, however, by designing products which have a high efficiency since – in the case of electrical products – it is the utilization phase and its associated inefficiency which usually take the greatest toll on the environment during the product's life cycle.

LCA was first used in the USA at the end of the 1980s. It is a comparative method, where a product is compared with two or several technically equal products.

A product's life cycle begins with the tapping of the raw materials and natural resources, as in mining and the extraction of oil. This is followed by processing, such as steel production from ore. The next step is the manufacture of products and systems. Next comes the utilization phase by the customer.

When the product has served its purpose, the components are reused and the material is recycled. Some material perhaps ends up on landfill sites. Transportation during and between the various life cycle phases also has an environmental impact.

When developing new products, respect for the environment is given the same priority as technology and economy, and it is done as a matter of course. The materials used should have no disadvantages, neither for the working environment nor the world in general. Rare materials should be used restrictively.

Clean manufacturing processes are the target. Products must be economical in their use of energy, and not require much maintenance during operation. Transportation must be optimized.

Good subcontractors must be appointed, since accountability does not stop at the factory gate. It must be possible to disassemble the products after use and the materials must be either recycled or used for energy production.

Meeting these demands and aiming at more environmentally friendly products requires life cycle assessment as early as the development phase. Such an assessment can also provide basic data for marketing and eco-friendly goods declarations.

LCA is an important part of ABB's environmental program and is standardized in accordance with ISO 14040.