Intelligent Systems

Technology trends in transformers and substations

One of the key priorities of power utilities is to provide reliable power to end-users. However, owing to various reasons, including an increase in load and technical breakdowns in the system, uninterrupted supply of power is often hampered. In order to tackle this, it is critical for power system components such as transformers and substations to be able to provide a high level of performance and reliability, while lowering environmental impact. A look at some of the new technology trends in transformers and substations...

Transformers

Currently, most utilities in the country deploy oil-cooled type transformers. However, the use of air-cooled transformers (dry type) is on the rise. From a safety point of view, dry-type transformers offer several advantages over oil-cooled ones. Due to the absence of oil, fire hazards are significantly reduced in these transformers. They are also non-flammable and self extinguishing. Moreover, there is no risk of leakage of insulation fluids and thus, no risk of ground water contamination. They are generally compact and hence entail reduced land costs. These transformers can also easily cater to seasonal demand peaks. Depending on the utility and its transformer failure rate, the cost savings for a utility over a dry-type transformer's lifetime could be up to 50 per cent more than that over the lifetime of a conventional transformer.

Further, with increasing awareness about the need to use environment-friendly products in the industry, companies are working towards deploying alternatives to traditional mineral oil-filled transformers. The use of esters, specifically natural esters, in transformers has thus gained prominence. Ester oil is easily biodegradable, offers superior fire performance and moisture tolerance, and is non-corrosive. It delays the ageing of paper insulation and offers ease of retrofilling.

Another important technology development has been phase-shifting transformers (PST), which regulate power flow into the grid by manipulating the phase angle difference between the nodes of the transmission system. There is also a growing focus on the use of intelligent transformers. Today, transformers are equipped with multiple intelligent electronic devices that help assess transformer conditions remotely and make recommendations based on the transformer operation data. Modelling and simulation are being applied to optimise current designs and explore new concepts that can facilitate quick system recovery. Modularised design components, standardisation and recovery concepts help improve resilience.

Substations

Substation automation solutions are gaining prominence with conventional substations making way for digital substations. The solution and architecture in digital substations are largely software based, with less reliance on hardware. The extensive self-diagnosis capability of digital devices ensures maximum uptime of the substation. Any degradation in the performance of an asset is pinpointed in real time. Inherent redundancy in the system may be employed to self-heal the operation, which permits troubleshooting without the need for any primary system outage. The intelligence within digital substations allows close monitoring of the load flow capacity of plant equipment, compared to its design ratings. A digital substation closely monitors all substation assets. Intelligent systems analyse the data and provide recommendations on the maintenance and repair actions to be conducted. This allows a shift to predictive or reliability-centered maintenance, avoiding unplanned outages and emergency repair costs. Further, interoperable solutions and the use of fibre optics instead of copper wires reduce the duration and cost of onsite work for the refurbishment of secondary equipment.

Besides digital substations, gas-insulated switchgear (GIS) substations are increasingly being used in urban areas as they require less land. The use of SF6 gas in GIS substations reduces the distance needed between active and non-active switchgear parts, resulting in smaller overall space requirements. GIS substations take only about one-tenth the space needed for conventional installations. Inclusive of land coverage and construction costs, the GIS substations are more economical, especially for high and extra high voltage applications. GIS substations provide protection against environmental processes such as salt deposits in coastal regions, industrial precipitates, sand storms, humidity and high temperatures. Moreover, these can be installed as indoor as well as outdoor solutions, and have a shorter erection time as compared to other options.

Some of the other developments in this space include the use of modular substations. Compared to the ground-up construction of a conventional substation or the arduous process of voltage conversion, a modular approach can yield an array of benefits that helps streamline the entire process from design to installation, commissioning and maintenance. A modular substation solution is traditionally an electrical power distribution substation or any other grouping of electrical equipment that is assembled on a self-supporting structural base, integrated and tested in a factory environment to enable energising upon delivery.

Going forward, the adoption of new technologies will be critical for utilities so as to reduce their distribution losses and strengthen the infrastructure. ■