Making bushing control 'green': Part 2

Last year, René Meuleman, Stanley Rutkowski and Martin Moeginger discussed how improving the design of a transformer busbar bushing can improve the system's electrical inductance and provide numerous user benefits. Ultimately, the goal is to remove as much inductance as possible from the system, come as close as possible to an ideal sinus wave form for better electrical control and optimise temperature control to increase system efficiency and improve fibre quality.

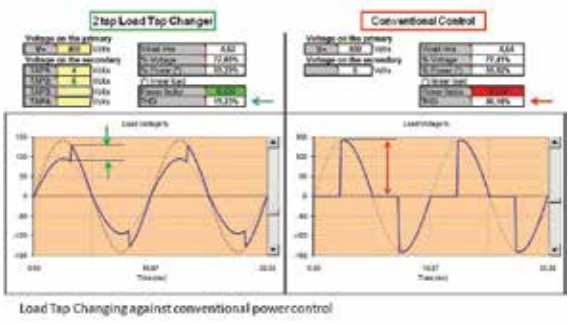
Bushing systems are traditionally designed from a mechanical point of view but electrical and magnetic aspects also need to be considered during the design phase to achieve maximum performance and efficiency from the system.

Fundamentally, running several thousand amps with sharply cut sinus waves at 50 or 60 Hz through the busbar and bushing will introduce a poor power factor, create harmonics and cause mechanical stress from unwanted vibrations. Tests have shown that better busbar design and smoother electrical control of bushings results in less bushing vibration, which is quickly shown by the way the system silences after such improvements are made; although the aim is, of course, to improve efficiency and overall bushing performance rather than reduce audible noise.

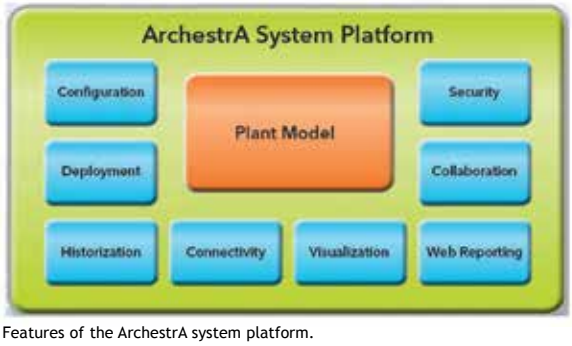
During the past two years, several successful tests using RoMan improved busbar designs and load tap changing thyristor control from the Eurotherm EPower power controller have taken place at numerous reinforcement fibre glass manufacturers located in the USA, Czech Republic and Belgium. In early 2012, UAS Germany recognised the potential of the improved designs and decided to merge these innovations with its pioneering bushing control concepts, leading UAS, RoMan Mfg and Invensys Eurotherm to discuss an innovative concept for the future of bushing control.

To accommodate the UAS improved bushing temperature control strategies, tests used the latest Eurotherm T2750 Programmable Automation Controller (PAC) system. The Wonderware ArchestrA system platform was also chosen as the supervisory control and data acquisition (SCADA) system to provide sophisticated bushing position benchmarking and performance information. To maximise flexibility and minimise downtime, UAS uses a modular system that controls four bushings from one control panel containing a dual redundant T2750 PAC, four EPower power controllers and a local panel PC HMI. Multiple of these four position bushing control cabinets are attached to a single mains power distribution cabinet to create an integrated and flexible solution, suitable for almost every fibre glass forehearth configuration.

On top of the required plant control configuration, the ArchestrA system platform accommodates UAS bushing control and management architecture to provide a single, scaleable software platform, with data storage and archiving. It further provides SCADA integration and a supervisory HMI for a unified operations management solution. >



Bushing control phase angle against load tap changing control.



Features of the ArchestrA system platform.

Eurotherm PAC and EPower bushing control line-up.

Screenshot showing the performance of all bushings.

LATVIA INSTALLATION

Joint stock company 'Valmieras stikla skiedra', also known as JSC Valmiera Fiberglass, was one of the first to adopt the UAS-RoMan-Eurotherm bushing control concept. Its glass fibres are produced from both E-glass and speciality glass fibres, such as silica glass fibres.

The system was installed and commissioned in late 2012 at Valmiera Fibreglass's 24 position bushing fibre glass manufacturing facility in Latvia. Two of the bushings are equipped with automatic load tap changing (LTC) in order to compare their performance and efficiency to the other 22 positions. The system has now been in full operation for a number of months and UAS and Eurotherm had the opportunity to attend site to perform several tests and discuss results with local plant personnel.

Fibre glass bushings are normally controlled by single, phase angle-fired thyristor controllers. This type of control suffers from relatively poor power factors unless operated above 80% power. This means that to achieve acceptable power factor and harmonics, the power control needs to be operated between 80% and 100%. In most cases, however, this limited freedom of control is insufficient to operate the bushing correctly and the only way to move the window of control is to switch off the bushing and change the thyristor transformer tap connections. The interruption to production and need to get into the intestines of the transformer to switch taps is far from ideal and these systems normally end up operating at levels far below 80%, resulting in a low power factor and high total harmonic distortion (THD).

Automatic load tap changing runs two thyristors on two different taps of the transformer. This enables the best of both worlds, with an expanded window of control for good power factor and minimum THD. The automatic LTC actually provides the operator with sufficient freedom of control without the need to worry about power factors or harmonics.

The target at Valmiera was to achieve freedom of setpoints between 50% and 90% by using an EPower power controller with two thyristor outputs running a RoMan B40525 water-cooled transformer. No other part of the installation was modified. Two zones were compared, one with and one without automatic LTC and remarkable results were seen: The LTC bushing position's power factor showed a 50% improvement, resulting in 51% reduction of apparent power against the single thyristor-controlled position. There was also 40% less root mean square (rms) current (29.7A compared with 49.6A), resulting in a dramatic reduction of harmonics.

The baseline results for the tests showed that LTC bushing position consumes only 9.6kW against the normal position consuming 10.6kW. This relates to the LTC position achieving 10.4% total power savings, which equates to a saving of €27,000 per year, based on €0.1/kWh with continually running 24 bushing. The estimated average investment for this energy saving solution is €31,500 (including the power pack and cabling costs), giving a return on investment in just 14 months.

After the test was completed, Valmiera Fiberglass indicated it was now looking to upgrade all positions to run in LTC mode. From vast bushing control experience, UAS had already anticipated this request and ensured space was available in the cabinets for a 'second' leg EPower power pack, meaning further upgrades can be performed easily and at minimal cost.

Almost all existing RoMan transformers are suitable for LTC operation, with an onsite check and ROI calculation recommended before refurbishment. If required, a test run on one bushing can also be arranged.

CONCLUSION

UAS, RoMan and Eurotherm have been serving the global fibre glass industry with specific solutions for many years. Working together, a team has been created with a dedication to providing innovative approaches to improve the overall performance of reinforcement fibre glass production. Based on each company's area of expertise and specific knowledge, each part of bushing control was discussed and improved – from the 'ears' of the bushing up to the information management system level. The team knew that overall efficiency improvement could be found in basic design issues and improved control, as well as in data collection and analyses. The resulting system provides state-of-the-art bushing control performance, including benchmarking capabilities to tweak each position in order to operate at maximum efficiency. It offers the opportunity for significant energy cost savings, improved quality and has an exceptionally fast ROI.

UAS, RoMan and Eurotherm would like to thank JSC Valmiera Fiberglass of Latvia for the company's ongoing support and allowing the publication of these test results.


The Valmiera Fiber Glass project team.

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