Finding the right balance

Electrification solution for the pulp and paper industry

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For over 30 years ABB has supplied electrification solutions to green field pulp and paper paper mills as well as to ones that have been modernized. To create the best economical and technical solution for the customer requires superior knowledge and extensive experience, both of which are in abundance at ABB. This short article gives a brief overview of how the company approaches these solutions.

A total electrification solution covers basic and detailed engineering, supply site management, supervision, erection and commissioning of the entire electrical solution. ABB's long-term and extensive experience in such electrification projects for the pulp and paper industry enables the company to implement an electricity distribution plan for a complete pulp or paper plant based on relatively limited initial data. At the very least this initial data should include lists of consumers and a plant layout. However, in reality consumer information at the beginning of a project can be extremely limited. In such cases ABB's experience in various types of pulp and paper plants can be exploited by complementing the initial data with experimental data from other projects of similar types. In addition, other technical matters related to the process in question, including power stations, should be considered.

Network calculations

Good basic skills acquired from working with electrical systems, together with an advanced network calculation program ensure a network configuration in which margins are managed, unnecessary over dimensioning is avoided and solutions that are technically the simplest are obtained. In some cases the network dimensioning is checked by using operational modes which are very different from one another. From the point of view of dimensioning, situations in which the network is at its weakest – including isolated operation – form the most challenging situations. ABB uses the *Neplan network calculation program* to carry out the electrotechnical dimensioning of a network. This program can model all the central electrotechnical parameters, and it helps engineers find the most reliable dimensioning of an entire network for various normal and abnormal situations.

ABB's extensive experience in electrification projects enables it to implement an electricity distribution plan for a complete pulp or paper plant

Energy efficiency

In addition to purchasing costs, other factors which can optimize overall costs should be considered during the design phase. Energy costs and losses, for example, are increasing all the time and in the future their share of the total costs will be even more significant. With this in mind, ABB has dedicated much R&D towards improving the efficiency of various apparatus and decreasing their losses.

Total losses are not only positively affected by the most constructive solution for an electricity distribution system, but also through basic choices such as the voltage levels used. The recent tendency towards larger units in pulp and paper plants is noticeable in the processes themselves and in the single units of process equipment employed. The use of larger units has meant that optimal voltage levels have had to increase. For example, 690 V has replaced, to a large extent, the 400 V value which was very popular as a low voltage. Due to its greater stiffness it can also replace, or at least partly, 3 kV and 6 kV as a motor voltage. In electricity distribution, a voltage of 33 kV has often replaced lower distribution voltage levels.

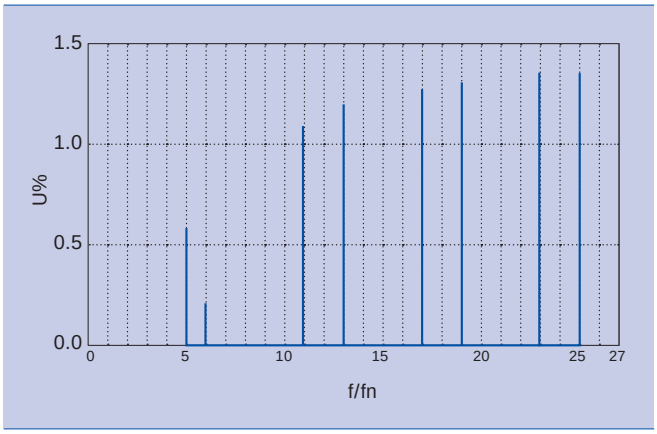
Compatibility

As a rule, a new electrical system is related to an already existing system but it has limitations or requirements imposed on it by the older system. However, the new system creates its own preconditions for future plant extensions. For this reason, the most probable scenarios for future extensions should also be taken into consideration when designing a new network. In other words, the future extendibility of a plant depends to a large extent on the basic decisions made in the current design.

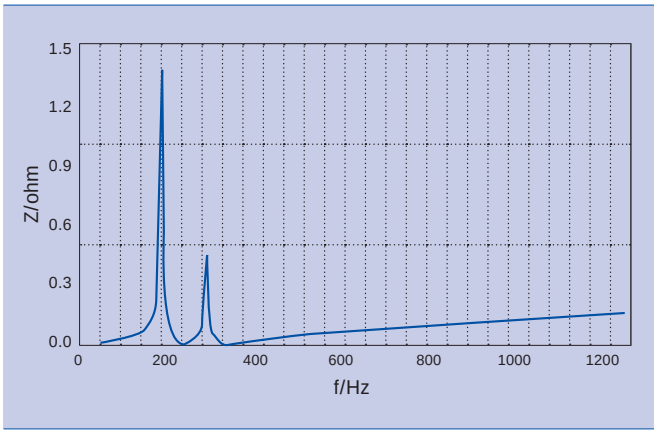
To successfully implement large systems, the quality of electricity and the compatibility of the equipment and systems are of the utmost importance. Compatibility is partly an equipment-related factor but it can also be affected through different constructive solutions of the systems to be used.

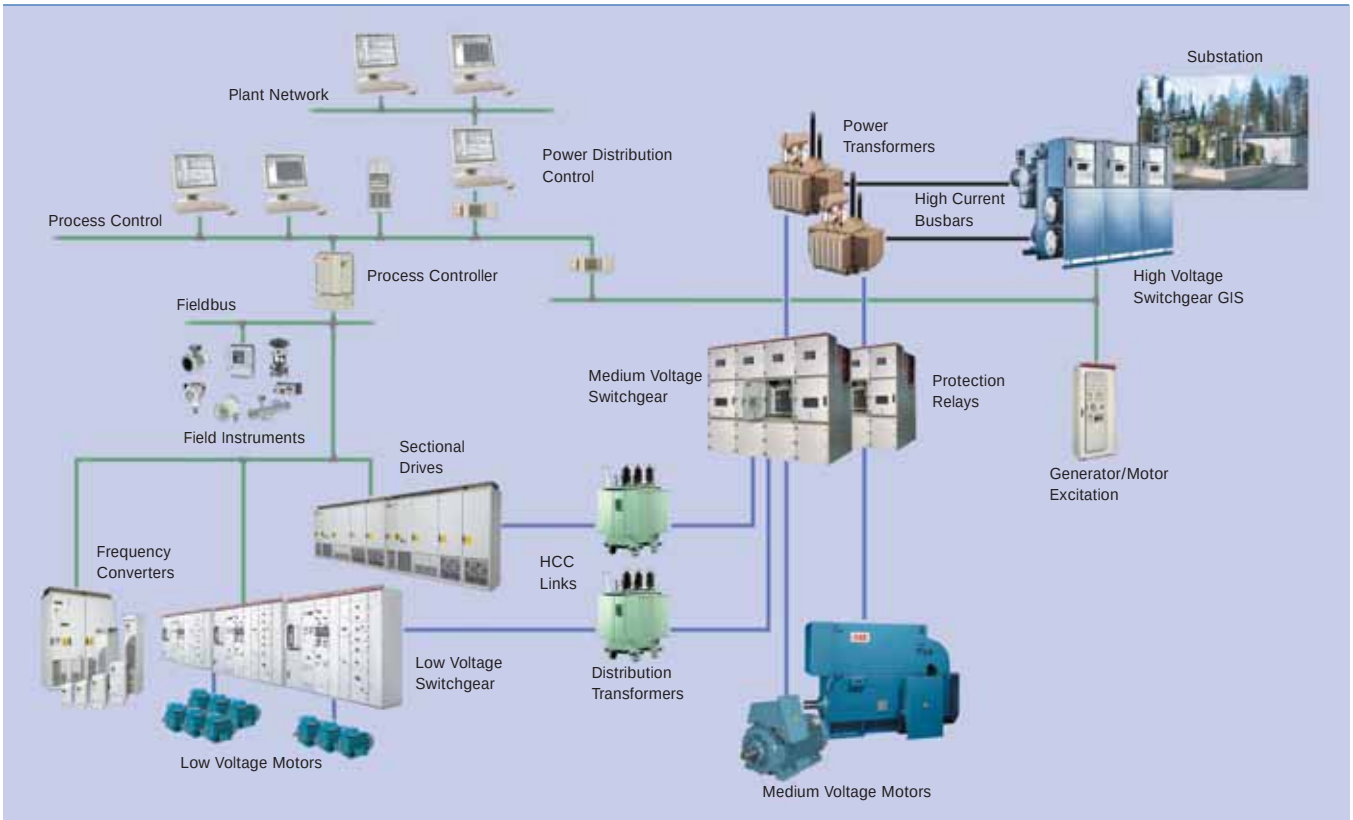
As to the compatibility of the networks in pulp and paper plants, harmonics from loads and voltage drops resulting from the starting process of motors are the most important factors. These should also be taken into ac-

Network analysis – Harmonic spectrum



Network analysis – Network impedance Z(f)





count in network calculations in addition to loading and short-circuit currents. By modelling a network accurately, it is possible to ensure (a) sufficient margins for different design parameters even in the most difficult situations and (b) sufficient compatibility for different parts of the network. However, significant cost differences may arise between various solutions. By optimally proportioning the immunity levels of the equipment and the amount of interferences generated in the network, significant savings can be obtained when compared to generous over-dimensioning. Unnecessary over-dimensioning of the quality of electricity causes extra investment costs.

The voltage drops that occur during the starting process of a motor no longer represent a limiting factor for the motor size because of modern techniques. As effective starting methods are now available, the under-voltages encountered during motor start-up can always be adjusted to acceptable levels. However, these requirements should be checked in all switching situations where start-up is required. In fact, the normal operation of the motor appears to be the only limiting factor. Motor starting is an especially demanding operation in an isolated network if the motor is large compared to the generator. In this situation the dynamic behaviour of the generator and the excitation system should also be considered. In short, the optimal choice and dimensioning of the starting arrangements of motors has an important effect on costs and availability.

There are techniques available that almost completely eliminate the large harmonic currents currents created by motors in the network. However, their elimination is not always the most optimal solution. In the end correct reactive power compensation and harmonic filtering have the most significant effect on costs.

Implementation design

The application design process also uses network modelling. It gives basic values for dimensioning parameters and determines different solutions for relay protection. In addition to basic protection functions, such as short-circuit and earth-fault protection, different kinds of advanced protection solutions, including ”load shedding” and ”islanding”, can be modelled and the operational values can be accurately determined.

The said optimized criteria are also included in project-related standards and guidelines – such as design and dimensioning instructions – which are created together with the customer. These standards and guidelines take into account ABB’s extensive experience in the pulp and paper industry, the advantages of modern solutions, the results of network modelling and the customer’s knowledge of local conditions to give the best possible end result.

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