MICHAL LODZINSKI – Although rail and tram are among the most efficient means of transport, they still consume a large amount of energy – especially when acceleration is involved. The amount of energy required to accelerate a vehicle weighing hundreds of tons up to even modest velocities is huge, so any increase in energy efficiency will have significant cost benefits. Regenerative techniques – in which braking energy is reused for acceleration – are well known but still hold much potential. ABB offers a complete suite of energy management solutions that enable braking energies to be better used, resulting in more energy-efficient urban rail transportation systems.

DC wayside products for energy efficiency in traction

Braking news
Energy efficiency is a topic important to many industrial sectors and the urban rail-based public transport network is no exception. Even though travel by rail is already much more energy efficient than by most other means, improving energy efficiency even further is important to metro, light-rail and tram operators constantly challenged to reduce operational costs and to provide mass transport in a sustainable manner. ABB offers a complete suite of products to facilitate this – especially products aimed at managing surplus braking energy.

Today, many rail vehicles recycle braking energy. Most of the time, a small portion of this energy can be used to power on-board loads and the remainder can be sent into the electrical power network for reuse by a nearby vehicle. This kind of energy transfer is called natural receptivity. If the energy cannot be recycled in this manner, the network voltage increases and the surplus energy is dissipated in on-board or wayside resistors.

However, recycling or managing the surplus braking energy intelligently can reduce overall power consumption. ABB’s ENVILINE™ Energy Recuperation System (ERS) reduces energy costs by returning vehicle braking energy to the AC network.

The ENVILINE Energy Recuperation System (ERS) reduces energy costs by returning vehicle braking energy to the AC network.
When not being used to recover energy from trains, the ERS can be employed to mitigate reactive power in the network. It can also provide active filtering, thus reducing the effect of harmonics. These functions exploit the ability of the IGBT-based inverter to shape the current waveform. This allows independent control of either the active or reactive power. The basic principle is that the DC voltage coming from the traction system is transformed by IGBT inverters to a sinusoidal output waveform. Due to the pulse-width modulation technique used, the output waveform, which is modulated at a frequency of several kHz, does not contain harmonics.

In addition, the ERS can support existing rectifiers, thanks to the active rectification made possible by the bidirectional operation of the system.
The benefits of the ESS go further: As well as helping to recycle energy, it can also be installed at a specific location to sustain the voltage where large sags occur; it can be used to augment the traction power capacity during acceleration; and the penalties or demand charges associated with high-demand peaks can be reduced by intelligent use of stored ESS power.

The ESS is compatible with existing train systems and it can be flexibly programmed to ensure optimum operation at each site. Its modular packaging allows independent sizing of power and storage. Operation is further eased by the provision of remote access with multilingual and email notification, energy metering, operational dashboards and downloadable data files. The ESS operates on 600 V and 750 V nominal lines and is expandable to 4.5 MW and 60 MJ per lineup. Parallel configurations are possible for large applications.

Opportunities beyond energy efficiency

On top of being the single best means to improve energy efficiency, the ESS can also become an off-grid traction power supply. In addition to the surplus braking energy, further energy can be added via the traction power line or a small rectifier, usually in between train arrivals. Such off-grid schemes are less expensive and more energy efficient than traditional grid-connected traction power supplies.
ENVILINE Energy Dissipation System

In certain cases, some of the regenerated energy cannot be used and must be dissipated. However, installing braking resistors on the vehicle to do this adds weight and increases maintenance effort. The ENVILINE Energy Dissipation System (EDS) provides a low-cost solution to this problem in DC rail systems. By deploying the wayside EDS instead of onboard resistors, the rail operator can reduce vehicle weight and energy consumption, eliminate heat generation in tunnels or enclosed stations and deploy a solution that is easy to access and maintain.

The EDS senses the rising line voltage caused by regenerative or surplus energy and connects an appropriate resistive load to maintain the voltage within safe operating limits, avoiding the need to use (and wear out) the mechanical brakes. The EDS consists of an indoor power control cabinet and an outdoor resistor bank. The system ensures track receptivity during regenerative braking by dissipating the surplus energy that cannot be absorbed by other onboard loads or nearby trains. The EDS is compatible with any new, or already installed, DC traction power substation. It can also operate in coordination with wayside energy storage.

Retrofit

A very important advantage of both the ERS and the ESS is that they are designed for retrofit. In refurbishment projects, all fixings and connections are predefined. This presents a tougher challenge than fitting new equipment in a new installation.

Both systems are based on a modular architecture, which allows independent scaling of power per single system. In order to achieve the best return on investment, it is necessary to evaluate the available surplus energy, estimate the power of the system to be used and choose the optimal connection points. Both products are transparent to the existing system, which means they can be isolated without interrupting normal operation.

On top of being the single largest means to improve energy efficiency, the ESS can also become an off-grid traction power supply.
Easy maintenance with remote monitoring and access
- Advanced controls with remote testing capability and programmable firing to ensure optimum performance and to avoid false triggering
- Time balancing of the GTO and resistor operation to share operational wear and maximize life expectancy.

The ENVI LINE series includes other products, such as the traction diode rectifier (TDR) used to convert AC to the DC commonly used in urban public transport infrastructures.

ABB’s long experience in traction means customers will receive expert advice in choosing the ENVI LINE solution that precisely meets their requirements – allowing them to benefit from a comprehensive, flexible and high-performance solution that will deliver cost and energy savings for many years.

For more information on ENVI LINE, see www.abb.com/enviline or write to enviline@pl.abb.com.

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