Ultracapacitors in light rail regenerative braking system

Steve Taranovich - April 30, 2013

We all want to reduce fossil fuel consumption by using a cleaner, greener technology to reduce greenhouse gases. Here is one good example of how it is being done in Oregon.

Maxwell Technologies is supplying ultracapacitors for an energy-saving braking energy recuperation system that American Maglev Technology (AMT), is installing on light rail vehicles operated by the Portland, Oregon area’s Tri-County Metropolitan Transportation District (TriMet).

TriMet won a $4.2 million grant from the U.S. Department of Transportation’s Federal Transit Administration (FTA) Transit Investment for Greenhouse Gas and Energy Reduction (TIGGER) program to improve the efficiency of its fleet of 101 light rail vehicles equipped with regenerative braking after determining that the vehicles were able to use only about 70 percent of the energy generated by braking.

**Regenerative braking**

In regenerative braking systems, the electric motor that propels an electric or hybrid vehicle also does most of the braking.
When an electric motor is run in one direction, it converts electrical energy into mechanical energy that can be used to perform work (such as turning the wheels of a car), but when the motor is run in the opposite direction, a properly designed motor becomes an electric generator, converting mechanical energy into electrical energy. This electrical energy can then be fed into a charging system for a vehicle’s batteries or stored in ultracapacitors.

In a regenerative braking system, the trick to getting the motor to run backwards is to use the vehicle’s momentum as the mechanical energy that puts the motor into reverse. Momentum is the property that keeps the vehicle moving forward once it’s been brought up to speed. Once the motor has been reversed, the electricity generated by the motor is fed back into the batteries or stored in an ultracapacitor, where it can be used to accelerate the car again after it stops. Sophisticated electronic circuitry is necessary to decide when the motor should reverse, while specialized electric circuits route the electricity generated by the motor into the vehicle's batteries or ultracapacitors. In addition, since vehicles using these kinds of brakes also have a standard friction braking system, the vehicle's electronics must decide which braking system is appropriate at which time.

Clockwise from top left: The double layer capacitor enclosure, the power control unit, and the double layer capacitor modules.

In TriMet’s system, energy generated by decelerating vehicles is fed into the traction electrification system for use by other vehicles on the system. The capacitor-equipped vehicles will be paired with non-capacitor-equipped vehicles so that the captured energy can be used to accelerate both vehicles.

The maximum energy storage capacity of each roof-mounted capacitor unit is about 1 kWh, which should be sufficient for accelerating a vehicle to 25 mph and operating it for about 2,500 feet on level track. In addition to capturing energy and reducing peak-load demand, these capacitor units reduce power substation loads and allow the light-rail system to grow in train density without installing additional substations.
References

1 How stuff works