Energy Recovery from Mass Transportation System

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Abstract

Mass transportation in New York City consumes a huge amount of energy due to its high population density. NYC Subway is the city's largest user of electricity. Reducing energy consumption for mass transportation is one of the concerns for NYC's Metropolitan Transit Authority (MTA) in the aspects of minimizing environmental impacts as well as reducing the running costs. In this study a stochastic model will be created for energy analysis of New York's transportation such as subway and train. The calculation results will be compared with data from other studies.

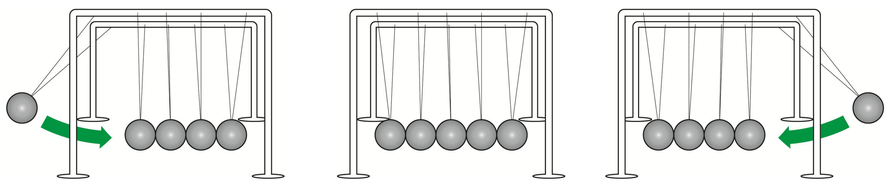
Background

The signals, station and tunnel lighting, as well as ventilation and miscellaneous line equipment are all operated by alternating currents. Direct currents operate the trains and other equipments such as water pumps and emergency lighting. About 500MW of power are needed to operate the subways system during peak hours. In a year, the NYC Subway consumes about 1.8 billion kilowatt hours, which is the same as the city of Buffalo, NY. Reducing the energy usage by the NYC Subway, could lead to significant cost savings[1].

Objectives

1. Analyzing energy consumption by mass transport in New York City.
2. Developing kinetic energy recovery system (KERS) using flywheels and comparing other recovery systems such as capacitor and battery.
3. Improving urban environment by designing the mass transport system

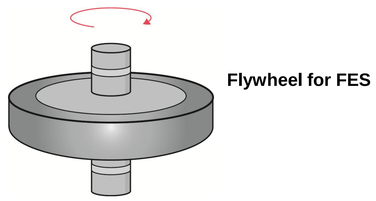
Kinetic Energy Recovery System (KERS)



Kinetic Energy Recovery System is used as an automotive system for recovering a moving vehicle's kinetic energy under braking. The recovered energy is stored in a reservoir (for example a flywheel or a battery) for later use under acceleration.

Comparing Systems

Flywheel Energy Storage System



Kinetic storages, also known as Flywheel Energy Storages (FES), are used in many applications. When inertial mass is accelerating to a very high rotational speed and maintaining the energy in the system as rotational energy. The energy is changed back by de-accelerating the flywheel. Available performance comes from the moment of inertia effect and an operating rotational speed. Flywheel mass is either mechanically driven by CVT (Continuously Variable Transmission) gear unit or electrically driven via electric motor / generator unit.[2]

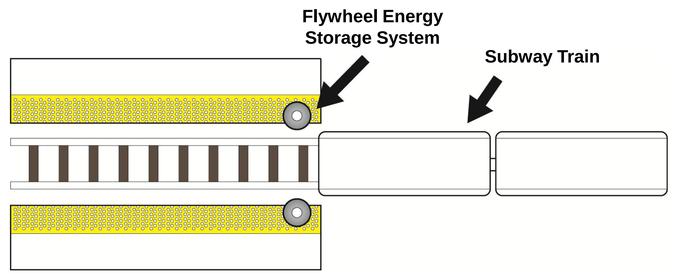
Capacitor Energy Storage System

An electric double-layer capacitor, also known as super capacitor, super condenser, pseudo-capacitor, electrochemical double layer capacitor (EDLC), or ultra capacitor, is an electrochemical capacitor with relatively high energy density. Capacitors have long life, with little degradation over hundreds of thousands of charge cycles. Due to the capacitor's high number of charge-discharge cycles (millions or more compared to 200 to 1000 for most commercially available rechargeable batteries) it will last for the entire lifetime of most devices, which makes the device environment friendly. matter of minutes — much quicker than some other forms of energy storage.[3]

Rechargeable Battery Energy Storage System

In practical batteries, internal energy losses, and limited rate of diffusion of ions through the electrolyte, cause the efficiency of a battery to vary at different discharge rates. When discharging at low rate, the battery's energy is delivered more efficiently than at higher discharge rates , but if the rate is too low, it will self-discharge during the long time of operation, again lowering its efficiency.[2]

Future Advancement



Train enters station while using (KERS)

Future Work

- Designing a prototype of the system (bench scale)
- Testing energy recovery using the prototype
- Calculating kinetic energy of the flywheel system and a train
- 3D CAD Modeling
- Simulating the interaction between the flywheel and a train

[a] Hoffman, Mary Ann "Straphanger Centennial, Part III: Lewis B. The Power to Move People " www.todaysengineer.org. Web (2004)

[2] Itankar, Piyush "Regenerative Braking Using Modern Energy Storage Devices " s.eeweb.com . Web (2011)

[3] Cibulka, J. "Kinetic Energy Recovery System By Means Of Flywheel Energy Storage" www.edu-point.org . Web. (2009)