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COMMERCIAL VEHICLE ELECTRIFICATION

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Abstract— In recent years, vehicle electrification has not been limited to passenger cars, and has been moving into the commercial, industrial, agricultural, and construction vehicle markets. Electrification of commercial vehicles offers several advantages including lower fuel consumption, less air pollution, less noise and vibration, lower maintenance costs, increased payload capability and increased reliability. There are two significant trends in the commercial vehicle electrification. The first trend is the development of electric and hybrid powertrain systems. And the second trend is the electrification of auxiliary systems, including electric power steering systems, air compressor units, transmission and engine cooling systems. In this paper, at first the electrification technologies, used in commercial and industrial vehicles, are explained. Then commercial versions of these technologies are described, and their performances are evaluated. Finally, the potential market for electrified commercial vehicles is briefly assessed.

Index Terms- Hybrid Vehicle, Electric Vehicle, Vehicle, Electric Drive, Motor, Commercial Vehicles.

Outline

- Rise and Downfall
- Vehicle electrification has been considered again. Why?
- Advantages of commercial vehicles electrification
- Trends in commercial vehicles electrification
- Electrification of auxiliary systems
- Cases studies
- Development of electric and hybrid powertrain systems
- Cases studies

- Conclusion

Early History

- 1882: Dr. Siemens demonstrated the first trolleybus in a Berlin suburb.
- in the early 1900s: It was believed that for short hauls the electric truck would prove superior to the gasoline truck.– Dr. Charles Steinmetz (the inventor of induction motor equaland circuit) : Greater use of the electric truck will mean a considerable decrease in the cost of distribution.

Rise and Downfall of the electric commercial vehicles

- 1917 : The electric truck was being used in over one hundred types of industries.
- During 1st world war electric commercial vehicles wildly used in Europe.
- late 1920s -1970s were a very lean time for the electric commercial vehicles.
- After 1970s, limited used of the electric vehicles : deliver milk, mail and other products.

Vehicle electrification has been considered again. Why?

- Breakthrough Technology
 - Using advanced and low cost CPUs and MCs accurate control of AC motors is possible.
 - Advanced CAD designed Electric Machines with and without PM materials.
 - Improved power electronics devices (IGBT, Power Mosfet).
 - Advanced batteries with high power density and high energy density.
- Stiff environmental regulations in the resent years.

Current situation of commercial vehicle electrification

• In recent years, vehicle electrification has not been limited to passenger cars, and has been moving into the:

- Commercial vehicles
 - Bus, minibus, trucks, vans
 - construction vehicles
 - Dozer, wheel loader, excavator.
 - Industrial vehicles
 - Forklifts
 - Agricultural Machinery
 - Tractor6

Advantages of commercial vehicles electrification

- Lower Fuel Consumption,
- Less Air Pollution,
- Less NVH (Noise, Vibration, And Harshness),
- Lower Maintenance Costs,
- Increased Payload Capability,
- Increased Reliability,
- Less Maintenance,
- Design Freedom

1st trend in the commercial vehicle electrification

- Electrification of auxiliary systems:
 - Variable Speed Engine Cooling Fans Run to Keep Engine at Maximum Efficiency.
 - Electric Power Steering Systems,
 - Air Compressor Units,
 - Electronic Pilot Control (EPC) – Electrical Steer-by-wire
 - Brake By Wire,
 - Electric Backup Brake System (Already Developed),

2nd trend in the commercial vehicle electrification

- Development of electric and hybrid powertrain systems
 - Hybrid Diesel-electric Busses (Hino, Fuso,...)
 - Electric Light-Duty Trucks (Hino, Smith Electric,..)
 - Hybrid Electric Refrigeration Trucks (Hino)
 - Electric and Hybrid Electric forklifts (Toyota,..)
 - Hybrid wheel loader (LeTourneau, John Deere,..)
 - Hybrid dozer (Caterpillar)
 - Hybrid excavator (Caterpillar, Hitachi, Komatsu,..)
 - Haul truck (Liebherr, Komatsu,..)

Case1: HINO Melpha Plug-In Hybrid

- The bus that can be charged externally.

Motor/Generator 175kW Wheels

- EV: Short distance (urban areas)
- HV: long-distance travel and climbing
- Maximum suppliable power 248kWh (As an emergency power source)

Case 2: Caterpillar D7E: Hybrid 235HP

Bulldozer DZ7 Operation

Diesel engine

Mechanical power

Generator

Rectifier

Power To Wheels

Motor and Gear

Controlled electrical AC power

Inverter

Case 3: LeTourneau L2350 Hybrid

Case 4: Komatsu PC200-8 Hybrid

LeTourneau L-2350: 258 tons Hybrid wheel loader

Switched Reluctance (SR) Motors and Drives

40 percent less fuel (fuel savings of up to \$100 per hour)

Longer tire life Komatsu PC200-8

Hybrid: hybrid excavator

Switched Reluctance (SR) Motors and Drives

25% less fuel than comparable non-hybrid

40% less fuel while carrying out certain functions.



Conclusion

- Vehicle electrification has been considered again because of the breakthrough technologies in several fields.
- Commercial vehicles electrification has several advantages
- Electrification of auxiliary systems is low lost but effective.
- Electrification of power train improves the performance notably..
- Several companies developing electrified system and the market is rapidly expanding.

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