HYBRID ELECTRIC VEHICLES

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History of HEVs

- 1997 – First modern HEV introduced in Japan: Toyota *Prius* (on left below)
- 1999 – First modern HEV sold in U.S.: Honda *Insight* (on right below)
What is a hybrid vehicle?

- The combination of an **internal combustion engine** (ICE) with one or more **electric motor/generators** and a **battery pack**.
HEV MODEL
HOW HYBRIDS WORK?
when a hybrid vehicle is initially started, the battery powers all the accessories.

The gasoline engine is started only when the additional power is required.
LOW SPEED

For initial acceleration, slow-speed driving and reverse, the electric motor uses electricity from the battery to power the vehicle.
During heavy acceleration or when additional power is needed, the gasoline engine and electric motor are both used to propel the vehicle.
Recaptures kinetic energy normally lost as heat during braking. Electric motor act as a generator when brakes are applied. Converts kinetic energy to electrical energy, which is stored in batteries.
When the vehicles is stopped, such as at red light, the gasoline engine and electric motor shut off automatically so that energy is not wasted in idling.
Components of hybrid electric vehicles

• Battery pack

• Motor/generator

• Power split device

• Power module
Battery package

Ni-MH Battery

‘New’ battery with metal cover removed

Photo courtesy of Cadex Electronics
INDUCTION MOTOR COMPONENTS

• Rotating components
  – [1] Shaft
INDUCTION MOTOR COMPONENTS

- Housing components
  - [5] End bells / bearing housings
  - [6] Stator housing
  - [7] Cooling fins
  - [8] Junction box
  - [9] Fan shroud
INDUCTION MOTOR COMPONENTS

• Fixed components
  – [10] Seals
  – [12] Core iron / lamination stack
MOTOR
SPEED/TORQUE CHARACTERISTICS

• High torque at low speed and low torque at high speed
Future: - Electric Drives
New Production Methods

- Traditionally:
  - Cut, stack and wind
  - Many production steps, many parts

- Today:
  - Press and wind
  - Fewer prod steps, fewer parts

- Tomorrow
  - Mould!
  - Single prod step, 1 part
Future: - Electric Drives

New Production Methods

Potential:

• Half cost
• Double performance [Nm/kg]
Power split device
POWER SPLIT DEVICE

- gearbox that hooks the gasoline engine, generator and electric motor together
- allows the car to operate like a **parallel hybrid**
- allows the car to operate like a **series hybrid**
Block diagram: New Power Module

- Controller
- Power Supply
- Gate Driver
- Protection
- Heat Sink

Input: current, voltage, temperature
Output: connected to gate driver
SKAI: Components

Cover
Driver / Controller board
Current sensors
DC Filter Capacitor
DCB /w Si devices
Heat sink

1200/600V IGBT SKAI module
Skai modules are D.C. to 3-phase A.C. conversion.

The skai technology is based on pressure contacts which replace large solder connections and associated degradation of solder joints are eliminated in this way.

Multiple pressure contacts assure low thermal and electrical resistance.
Different types of hybrid

Series hybrid
Parallel hybrid

**Series hybrid**

Series hybrid, the gasoline engine turns a generator, and the generator can either charge the batteries or power an electric motor that drives the transmission. Thus, the gasoline engine never directly powers the vehicle.
Parallel hybrid, has a fuel tank that supplies gasoline to the engine and a set of batteries that supplies power to the electric motor. Both the engine and the electric motor can turn the transmission at the same time, and the transmission then turns the wheels.
Where the Power Goes &
How Hybrid Electric System Can Help Minimize These Losses

- Engine losses
- Standby/idle losses
- Driveline losses
- Braking losses
- Electric accessories

[Diagram showing power flow and losses]
In what vehicles?

![Graph showing the relationship between relative engine power and speed variation across different vehicle types.]

- **Big**
  - **High use**
    - Heavy trucks on highway
  - **50%**
    - Cars on the highway
  - **Very useful**
    - Cars in city traffic
  - **Small**
    - Buses in city traffic

**Relative Engine power**

**Low use**

**High use**
HEV Advantages

- Reduced fuel consumption
- Excellent gas mileage
- Fewer tailpipe emissions
- Lighter batteries than electric vehicles
- Regenerative braking system stores electrical energy in Batteries
- Uses less fuel to recharge batteries
HEV Disadvantages

- Reduced, but not emission-free

- HEVs are partial zero-emission vehicles (PZEVs) – they produce zero emissions only when engine is not running

- More expensive than conventional Vehicles

- Has a payback period in average use
So, the HEVs have more efficiency, Low Fuel Economy, High Reliability and Less Air Pollution.

Optimum Utilisation of these Vehicles will yield in good Results, especially Reduction of pollution.
REFERENCES

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THANK YOU