Hybrid Vehicle Technology

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Aim of the Project

The aim of the project is to investigate the history, operational mechanisms, and future advancements of hybrid electric vehicles (HEVs), with a focus on their role in reducing carbon emissions and improving fuel efficiency.

Background

A hybrid car is a vehicle that combines the use of internal combustion engines and electric motors. Until the early 1990s, such hybrid electric vehicles were relatively rare, but the success of the Toyota Prius raised public awareness of these fuel-saving vehicles and spawned a number of similar cars from manufacturers such as Honda, like the Honda Insight. Fuel-efficient vehicles are a rapidly growing segment within the auto industry and contribute to the goal of green driving.

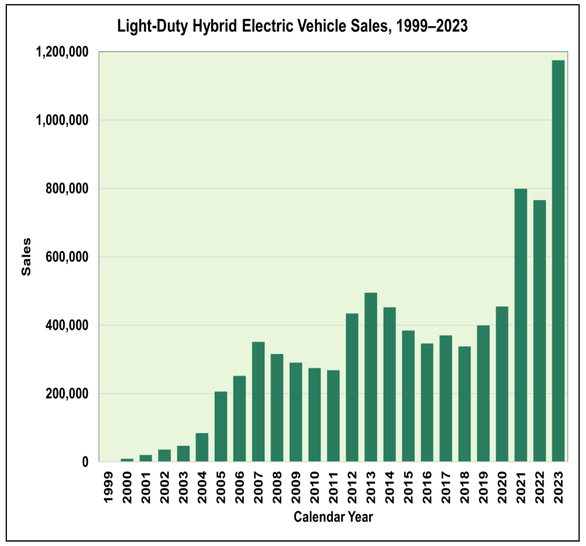

Figure1: Light Duty HEV Sales over the Years

The Toyota Prius was not the first hybrid vehicle, nor was it created in the 1990's or 2000's. It actually goes back to 1900. Porsche produced the very first hybrid car, The Lohner-Porsche Semper Vivus, in 1900 due to excessive and harmful pollution caused by internal combustion engines.

Operation

Mild Hybrid Electric Vehicles (MHEV)

Like all types of hybrid vehicles, the primary target of mild hybrid system is to reduce fuel consumption and carbon emissions. In this system 48V battery is integrated with the internal combustion engine (ICE) as an additional support. When the brakes are applied, the electric motor, which functions as a generator in this case, converts kinetic energy into electrical energy. This energy is then stored in the 48V battery. Stored energy is used to help the internal combustion engine during the first movement of the vehicle by providing more torque in low engine speeds. In this way both emissions and fuel consumption reduce 5-15% compared to a conventional ICE vehicle. Unlike fully hybrid vehicles (HEVs), mild hybrid vehicles are not able to run solely on electricity. The main power source remains the internal combustion engine. The 48V battery also supplies the on-board electrical system which leads to a reduction in fuel consumption. VW Group's 1.5 eTSI engine is a good example of daily MHEV engine.

Figure2: VW Golf Mk8 1.5 eTSI

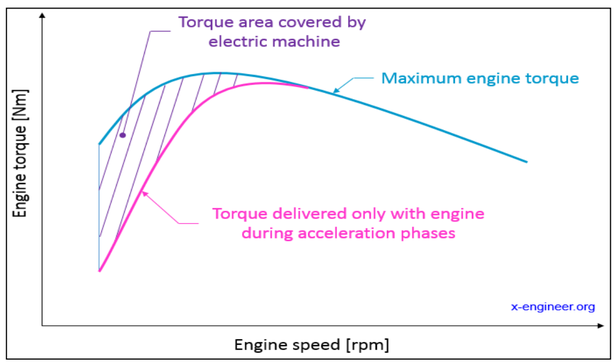

Figure3:Torque graph of MHEV

Operation

Fully Hybrid Electric Vehicles (HEV)

Full hybrids are similar to mild hybrids. The main difference between them is that the full hybrids are equipped with a larger battery and more powerful electric motors. Battery packs of full hybrids are approximately five times bigger than mild hybrids as seen in the figure 4 below. The battery is charged through regenerative braking and also by the internal combustion engine. This allows the vehicle to be driven solely by the electric motor at low speeds for short distances. HEV's are perfect for people who need both a short–range and mid-ranged travel. Full hybrid cars in general are more costly than a mild hybrid but provide overall better fuel economy and less carbon emissions. Some examples of fully hybrid EV's are the Toyota Corolla and C-HR, the Honda Civic & the Renault Clio.

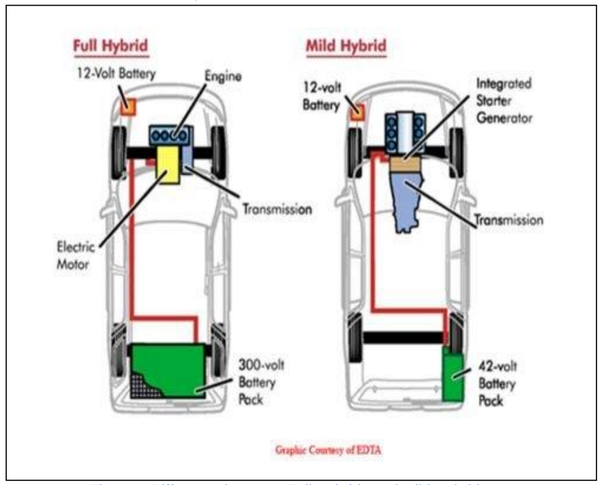

Figure4: Difference between Full Hybrids and Mild Hybrids

Figure5: Toyota Corolla Hatchback Hybrid

Operation

Plug-in Hybrid Electric Vehicles (PHEVs)

Plug-in hybrids are a transitional phase to electric vehicles. PHEVs run on either the internal combustion engine or the electric motor depending on the battery charge. Due to their large batteries, between 15-20kWh, they need to be plugged into a charge port for charging just like electric vehicles. This can be done using either a fast-charging DC station or your standard home outlet. With DC, 80% of the battery will be filled up around 30 minutes. On the other hand, the standard home outlet will charge the battery in 6-10 hours. Most PHEVs have an electric ranges of 20-70 miles. For daily driving this is satisfactory. The only disadvantage might be having to use the engine on long journeys instead of electric power. Due to battery weight, PHEVs are heavier than standard vehicles. This leads to higher fuel consumption when using the internal combustion engine. However, for the average daily drive they are very efficient.

Conclusion

Through our extensive research of all thing's hybrid, we have traced the history of hybrid vehicles from 1900's to their modern adoption. We have explored how different hybrid technologies (MHEV, HEV, PHEV) contribute to fuel efficiency and emissions reduction. With continuous advancements in battery technology and charging infrastructure, hybrid vehicles will likely play a critical role in the transition toward fully electric transportation.

References

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