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Hybrid System Development

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Contents

Introduction	2
Literature review.....	2
History of the Hybrid system	2
Lithium-ion Batteries	2
Hybrid system in Formula 1	3
Commercial use of the hybrid system	3
Future of Hybrid Systems.....	4
Discussion.....	4
Conclusion.....	4
References	5

Introduction

This report will follow the hybrid systems development from its invention in 1899 to present day, discussing the challenges that the system had and still have during its development. It will also look at how development has been sped up through environmental and political pressures. Finally, it will look at the future of hybrid systems and if they will be the choice for manufacturers.

Literature review

History of the Hybrid system

The first hybrid system was developed in 1899 by Ferdinand Porsche, the vehicle used a petrol engine to drive the front two electric wheel hub motors. The “Egger-Lohner C. Phaeton” produced almost 5BHP and had a top speed of 25 KM/h which was respectable for a car in that era. Its major flaw was its 2 Tonne weight, the lack of range and infrastructure made the vehicle impractical. Porsche re-designed the system taking out the battery supply to the wheel hubs. Instead, using the petrol engine to power it directly. This in turn reduced the weight significantly improving its performance.

Despite Porsche’s changes to the vehicle in 1900, the production of Henry Ford’s cheaper and more efficient petrol-powered cars in 1904 began, making the hybrid system redundant to the new superior way of travel. It wasn’t until 1960 when US legislation changes gave it a new lease of life with the focus moving on air quality and cleaner alternatives to using fossil fuels. (Mayk Wienkötter, 13/09/2019)

Lithium-ion Batteries

The invention of lithium-ion batteries in 1990 by Sony, had a big impact on improving the efficiencies and effectiveness of hybrid and electric-powered vehicles. Lithium-ion batteries work by lithium ions becoming free travelling to an anode through a charge gate that creates a positive current. Graphite has been the dominant anode for 25 years providing the battery with stability and long life due to the graphite’s structural qualities at its surface. It reacts with the dissolved electrolytes within the battery. There is renewed interest in solid electrolytes within the battery providing a high capacity whilst making it a safer alternative. This method can also handle higher amounts of voltage which could prove vital to the commercial car industry. Porsche had a similar problem in 1899; now technology is progressing much faster with more emphasis on greener solutions. (Manthiram, September 7, 2017)

Hybrid system in Formula 1

The hybrid system was introduced into Formula 1 (F1) at the start of the 2014 season with big regulation changes from the previous year's car. Before a full hybrid system was implemented, F1 had a test period which used the KERS system to trial the hybrid integration into racing. KERS stands for Kinetic Energy Recovery System allowing heat from the brakes to be transferred into a power source giving the driver a boost in power when needed (only 6 seconds available a lap). The trial started in 2009 that was optional for teams to implement to try and steer technological advances to a greener solution. Figure 1 shows a lap around the Jerez circuit using the KERS system, this shows that the performance over a lap is 4-tenths quicker than when not active.

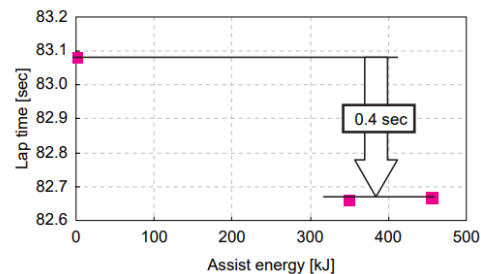


Figure 1- Lap time against energy assist

The KERS system gives an extra 60KW over a lap giving 7.1 km/h at top speed. The KERS system only existed on the V8 engine. The engine of the cars was reduced from a V8 2.4-litre engine to a V6 1.6-litre turbo hybrid in 2014.

Changes came after political pressure on engine manufacturers to produce more economical engines for commercial use. This in turn made F1 less appealing to current engine manufacturers such as Honda and Renault, as the investment into F1 was now not beneficial to the new carbon goal set out in legislation such as the net zero campaign from the EU.

This legislation deterred current manufacturers, any new engine suppliers. (Masataka YOSHIDA, 2012)

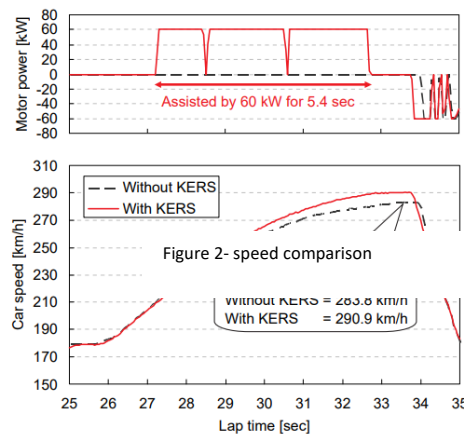


Figure 2- speed comparison

F1 recently announced new regulations to take effect in 2025, putting a greater emphasis on improving the hybrid system. This has attracted the attention of Porsche and Audi who are looking at buying teams, it has also persuaded Honda back as an engine manufacturer.

Commercial use of the hybrid system

The development of the hybrid system in commercial manufacturing has increased dramatically in the last 20 years, being one of the main ways of moving from full petrol engines to a greener more environmentally friendly ways of propulsion. Big advancements in technology through research has have led F1 to affordable and efficient implementation in the commercial industry.

Hybrid has been the choice system of moving from just carbon fuels to electric, there seem to be 2 types of hybrid systems on the market. One being a "mild" hybrid system that runs as an efficiency boost for the petrol engine taking the electrical load off the engine. The electric motor cannot move the vehicle itself. The "full" hybrid system has the capability to run off the petrol and the electric motor, working together to give the most efficient engine possible. An example of a mild hybrid is a Ford puma, it has an electric motor that charges when braking to improve the fuel efficiency of the car. (Ford, 2022) An example of a Full hybrid system is the AUDI A8 L TFSI e which runs a 17.9 kwh battery giving it 36 miles on electric power only. (AUDI, n.d.) research shows that up to 10% increase

in fuel efficiency by using a mild hybrid system using synergistic engine technologies.
(HeechangOh/JonghyeokLee/SoohyungWoo/HanyongPark, 2021)

Future of Hybrid Systems

The future of the hybrid system is strong with lithium-ion battery development, allowing more power to be stored quicker and safer than before. This makes for a strong argument, that hybrids still have a big part to play in the transition from petrol to EV. Alternative fuels are becoming a greater point of interest with biofuels and hydrogen fuels being developed by companies such as Toyota.

There are many barriers to these alternative fuels such as infrastructure and price of production; these barriers slow the implementation of these newer technologies. For example, Hydrogen engines could cost up to 100 times more than a petrol combustion engine, also infrastructure to deliver and distribute hydrogen will need to be in place. Hydrogen needs to be stored at high pressure, this means that specialised tanks need to be developed to replace the current tanks and without large government funding, creating the infrastructure to support hydrogen this won't be economically viable. E-Hybrid systems on the other hand, manage to skip a lot of these barriers, whilst being able to significantly reduce the emissions produced from a petrol engine. They avoid the biggest challenges facing EVs; they don't require the charging infrastructure needed to support EVs due to the braking system charging the battery. They don't need a long time to charge, as they can do it whilst driving. (Romm, 2005)

Discussion

I feel that there is a very strong argument for the hybrid system to be a key player in reducing carbon emissions. Future advancements in lithium-ion batteries will allow for a faster and safer charge, as well as an increasing infrastructure, to support hybrids, such as plugin hybrids and effectively reducing CO₂ emissions. However, as hybrids are increasing in popularity more batteries will need to be produced and recycled. Hybrids are often more expensive for consumers compared to regular petrol-powered cars.

Conclusion

In conclusion, hybrid system cars will be around for many years to come. The many modes of transport and constant development of existing technologies mean they are a good balance between efficiency, reliability and practicality whilst keeping cost to a minimum. Rule changes to F1 and the new interest by big manufacturers should help accelerate the progress of Research and Development, allowing the hybrids to maximise its potential. In terms of alternative fuels, hydrogen as a potential fuel for commercial still requires further research and development. The trouble handling high-pressure fuel and the cost of developing the technology and implementing them is not a viable idea.

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