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Review Article

Investigation of Hybrid Electrical Vehicle using Dual Mode Transmission System

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Abstract: Due to the increased demand of high efficiency vehicle to reduce the carbon content in atmosphere, Electric hybrid vehicle are more likely preferred by the automobile industry. In hybrid vehicles the transmission system plays an important role for better performance of the vehicle. The dual mode hybrid transmission investigated contains three planetary gear units, four electrically controlled clutches and two electric machines. That allows six different operation modes in which two electrically variable transmission modes and four fixed gear modes.

Keywords: Hybrid Electric Vehicle, Dual mode transmission, Planetary Gear.

1. INTRODUCTION

The hybrid vehicle is the attractive sector for the automobile industry and the first hybrid vehicle was called the Lohner Porsche Mixte. At the time, however, the electric components' technological progression could not keep pace with that of the ICE, and both hybrid vehicles and electric vehicles essentially vanished from the automotive scene. The latter dual vehicle types have been revived periodically since, but have always been seen as technologies that struggle to compete with hugely successful (ICEV) ICE vehicle. A recent confluence of circumstances has provided an opportunity for the renaissance of the hybrid vehicle, most notably rising oil prices, oil supply concerns, and concerns with ICEV emissions. The internal combustion engine-battery hybrid vehicle has been popularized with the introduction of the Honda Insight in 1999 and especially the Toyota Prius [2]. Both vehicles offer gas mileages more than twice those mandated by the corporate automobile fuel economy standard of the United States of 25 mpg. Both vehicles have also been designated as partial zero emission vehicles. It is defined as a vehicle that is 90% cleaner than the average new model year vehicle, while a zero emission vehicle is 98% cleaner than the average new model year vehicle [2]. The ICE-BHEV technology have been seen by many as a bridge technology that will improve the performance and cost structure of electric powertrains while also providing better gas mileage than the incumbent ICEV, therefore a fuel cell hybrid vehicle will provide the objective remains high performance ZEV. The popularity and availability of hybrid vehicles is certainly on the rise hybrid vehicles registered in the United States in 2005 approximately an increase of 139% from the previous year [3]. Honda Motor and Toyota Motor Corporation both have projected that hybrid vehicle s will comprise some 10 to 15% of the United States market by 2010. Toyota has confirmed to produce 1 million hybrid vehicle sa year by 2012-13 [4]. The future indeed looks bright for this technology. With different ways in distinguishing the different types of hybrid vehicles currently in various stages of development.

1.1 Types of Hybrid Vehicle

Hybrids have been placed in one of three categories (a) series hybrid vehicle (b) parallel hybrid vehicle (c) series-parallel hybrid vehicle. There have also been attempts to introduce further subsections of the main hybrid types. As an example the hybridization could be introduced and it refers to a continuum f designs in which the power production responsibilities are partitioned between the power sources. This partitioning could be expressed by an industry measure that is called the (DOH) degree of hybridization through the following equation [5].

$$DOH = \frac{P_{elec}}{P_{elec} + P_{eng}} \quad (1)$$

Where *Pelec* is the power capabilities of the electric motor and *Peng* is the power capability of the engine. The degree of hybridization is then a measure of the relative amount of total vehicle power train power that is delivered by the electric motor. Therefore a degree of hybridization of zero, the vehicle is a conventional ICE vehicle, whereas at a degree of hybridization of one the vehicle is an electric vehicle. Hybrid vehicle will lie between the dual extremes with larger values signifying the usage of a smaller ICE and larger electric motor role. The important thing in equation (1) that applies to the cases where the hybridization takes the form of an ESS and ICE such as a battery. When the vehicle is a (FC-ESSHV) fuel cell energy storage system hybrid vehicle, which is always a series design, equation (1) becomes

$$DOH_{FC-ESSHV} = \frac{P_{ESS}}{P_{ESS} + P_{FC}} \qquad (2)$$

Where P_{ESS} and P_{FC} represents the power provided by the ESS and fuel cell respectively. A degree of hybridization of zero is in this case a FCV while a DOH of one will be an electric vehicle powered entirely by an ESS. Moreover the parallel and series designs are more mature in development the series parallel design is making significant progress and has come to dominate the (LDV) light duty vehicle available in market. The series parallel and split powertrains could be considered to be a special case of (CVT) continuously variable transmissions: the (IVT) infinitely variable transmission. The split nomenclature refers to the fact that the design uses a (PSD) power split device, usually a planetary gear to allow the engine power input to be split between the electrical and electrical path. The Conventional CVTs could provide continuously variable speed ratios over the velocity range of the vehicle but require launch clutches or engine is connect devices for vehicle start up because the i/o to i/o speed ratio should be finite. Moreover the most CVT designs are friction based belt and traction types that are unsuitable for high torque and high power applications [6]. On the other hand the IVT could provide an infinite number of input to output speed ratios, including a geared neutral. That allows the output velocity of the vehicle to vary from reverse through zero to forward. There is no launch device such as a torque converter in an automatic transmission and a clutch in a manual transmission is necessary, and the engine can remain directly connected to the transmission for all speeds. It is provided in split powertrains by the power of the engine having mechanical and electrical paths in addition to the electrical path of the battery for the case of a hybrid vehicle.

2. HYBRID VEHICLE ARCHITECTURE

The basic block diagram of Allison 1 is presented in Figure 1. In the block diagram the power electronics devices such as inverters are not included. The basic architecture of Allison 1contains one planetary gear and three clutches. The mechanical engine is connected to the carrier via a (CL3) clutch to motor or generator first is connected via a gear train to the ring gear and via the gear train and (CL2) clutch to the driveshaft motor or generator two is connected via a gear train to the sun gear and to the driveshaft via a (CL1) clutch and to the another gear train [1]. This presented model may be operated in several different regimes i.e. either in all electric that is which can be considered to be series or parallel, series and parallel regimes through manipulation of the clutches.

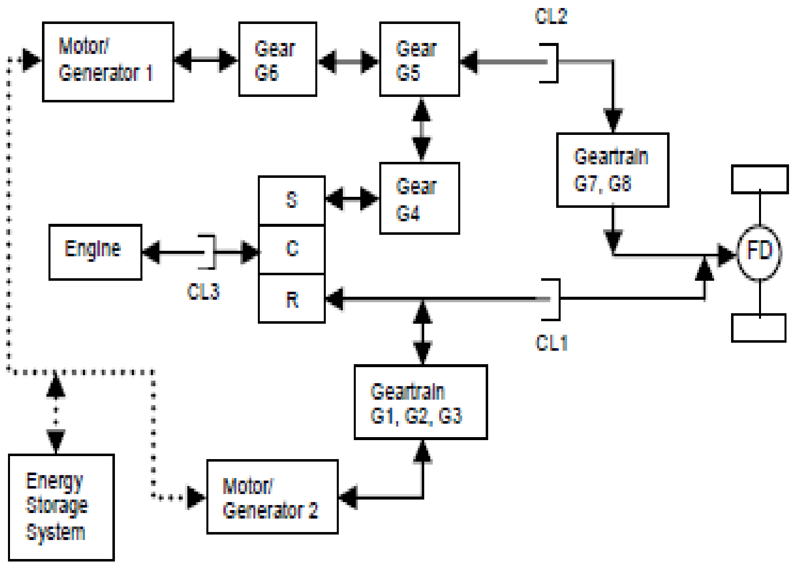

Figure 1: Block Diagram for Hybrid Electric Vehicle

All electric regime is limited only by the capacity and power density of the ESS and the power curves of the electric machine and not by the maximum rotation speed. The difference is because of the presence of (CL3) clutch that allows for the sun and ring gears to rotate at whatever speeds are desired and not at a predefined speed that prevents the carrier from rotating [3]. The scheme that is used in operation of the Allison 1 design is presented in Table 3.1 [7]. It is interesting to note that for the parallel techniques the power of the input from the engine and one of the electric machines are combined in parallel at the planetary gear and further on this overall power is then combined with the power of the remaining electric machine.

3. SYSTEM FOR HYBRID TRANSMISSION

A dual mode hybrid transmission has been developed with the help of Simulink toolbox of Matlab. In the presented model three planetary gear sets and four clutches has been implemented.

Table 3.1: Operating schemes of the Allison1 design

Scheme	Clutch 1	Clutch 2	Clutch 3
All Electric	×	1	×
All Electric	1	×	×
All Electric	1	1	×
Parallel	1	×	1
Parallel	×	1	1
Series & Parallel	1	1	1

As this combination permits four fixed gear ratios plus dual power split modes. The power split modes are used to transition between fixed gear ratios and for heavy acceleration or deceleration and the fixed ratios.

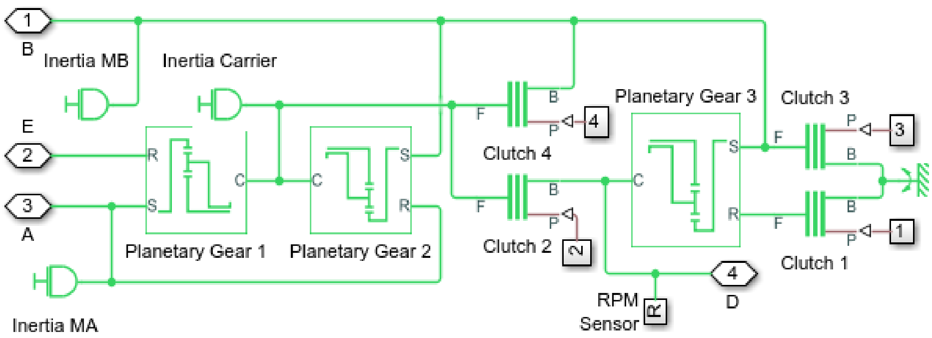

Figure 2: Hybrid Transmission System

In the developed model, the strategy subsystem defines a set of rules that determine when to change between transmission modes during a steady acceleration profile. A full vehicle control strategy would also need to include control of electrical power as a function of driver demand, speed and battery state.

Table 2: Clutch schedule Hybrid Transmission of vehicle

Mode	Clutch 1	Clutch 2	Clutch 3	Clutch 4
Input Split	1	×	×	×
Compound Split	×	1	×	×
1	1	×	×	1
2	1	1	×	×
3	×	1	×	1
4	×	1	1	×

4. SIMULATION RESULTS

In figure 3 the graph is presented to elaborate the battery power consumption in (Ah) ampere hours. The maximum power is 150 Ah that goes for minimum up to 144 Ah. The drop is of 6 Ah is observed. This shows that battery is utilized form the initial point. The maximum drop in battery charge is observed in the after half time of the process.

In figure 4 the graph is presented to elaborate the battery losses in (kW) Kilowatts. The maximum battery losses are observed up to 65 kW approximately. Maximum losses are observed after half execution time. There are some spikes observed in the battery losses accordingly the maximum losses are observed up to 110 kW. These spikes show that spikes in losses plot are observed in change of mode. In figure 5 the graph is presented to elaborate consumption of fuel in (g) grams by engine for the whole process of simulation. The maximum fuel consumption is observed approximately up to 71 g.

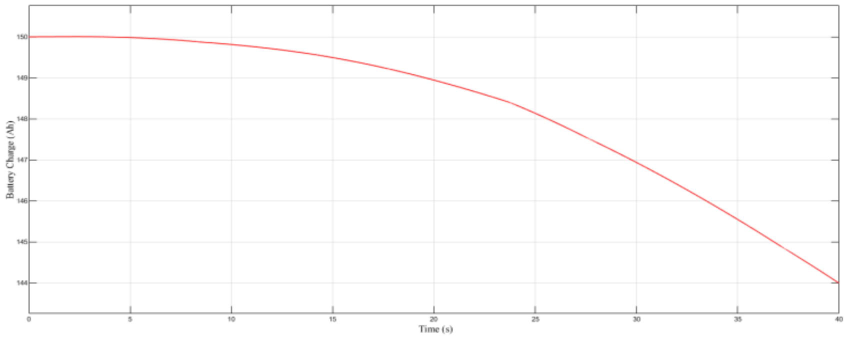

Figure 3: Shows variation in battery charge

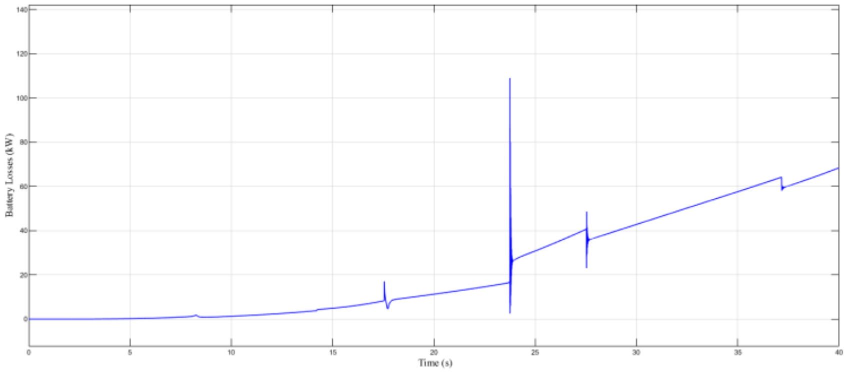

Figure 4: Shows variation in battery losses

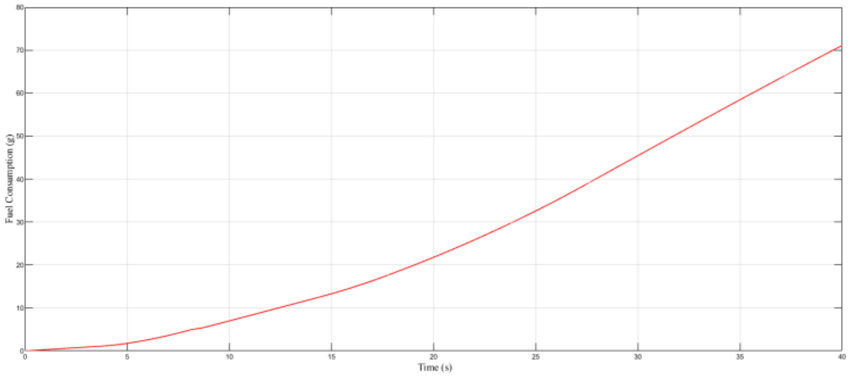

Figure 5: Figure Shows fuel consumption

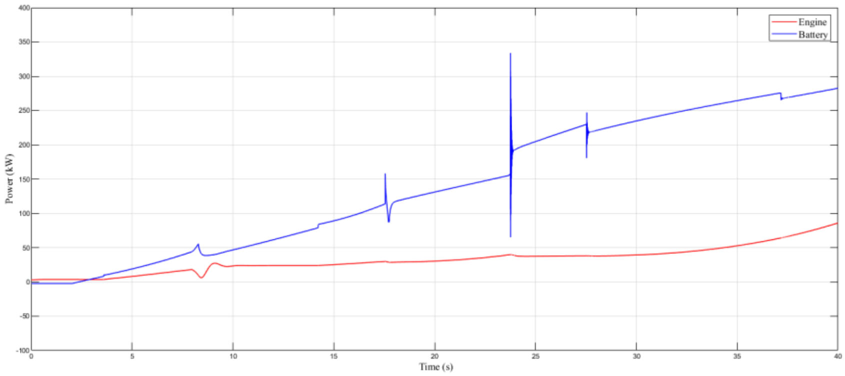

Figure 6: Comparison of power for engine and battery

In figure 6 the graph is presented to compare the battery power and engine power utilization in (kW) kilowatts for the full simulation time. The maximum engine power utilization is approximately up to 45 kW, whereas, the maximum power utilization through battery is up to 25 kW. This comparison shows that the engine power utilization is much lower as compared to battery power utilization, moreover it could be concluded that lower engine power utilization results less fuel consumption and that is exactly for what electric hybrid vehicle is designed.

5. CONCLUSION

A dual mode hybrid transmission for hybrid electric vehicle is simulated and investigated. Combination of two continuously variable operating modes with four fixed gear ratios modes for parallel hybrid operation is presented. Simulation results for the developed model have been presented in graphical representation. The plot below presents the battery charge, battery losses, fuel consumption and utilization of battery and battery power dual mode hybrid electric vehicle. In future more design strategies could be explored that lead to more fuel efficient design.

REFERENCES

1. Tim, M., Grewe, B., Conlon, M., & Alan, G. H. (2007). "Definig the General Motors 2-Mode Hybrid Transmission," presented at the SAE World Congr. Exh, Detroit, MI, Paper 2007-01-0273.
2. Benford, H., & Leising, M. (1981). "The lever analogy: A new tool intransmission analysis. SAE paper, 810102.
3. Wishart Jeffrey, D., Zhou, Y., & Dong, Z. (2007). Review, Modeling and Simulation of 2-Mode Hybrid Vehicle Architecture." ASME 2007 International Design Engineering Technical Conferences & Computers and Information in Engineering Conference.
4. Jeongmin, K., Talchol, K., Byungsoon, M., Sungho, H., & Hyunsoo, K. (2011). Mode control Strategy for a Two-ModeHybrid Electric Vehicle Using Electricaly Variable Transmission (EVT) and Fixed-Gear Mode. *IEEE transactions on vehicular technology*, 60(3).
5. Hendrickson, J., Holmes, A., & Freiman, D. (2009). General Motors front wheel drive two-mode hybrid transmission. SAE paper, 2009-01-0508.
6. Schmidt, M. R. (1996). Two-mode, input-split, parallel, hybrid transmission. United States Patent Office, assignee: General Motors Corporation, Patent No.:5,558,588.
7. Aimin, D., & Hongwei, C. (2011). An Analytic Foundation for the Two-Mode Hybrid Transmission with a Comparison to Other Hybrid Vehicle Power Split Transmissions. *International Conference on Transportation, Mechanical, and Electrical Engineering (TMEE*), Changchun, China, 16-18.
8. Vidyanandan, K. V. (2018). Overview of Electric and Hybrid Vehicles. Energy Scan (A House Journal of Corporate Planning, NTPC Ltd., India). III. 7-14.