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Effect of Different Fuels on Fuel Consumption of Hybrid Vehicles

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Hibrit Araçların Yakıt Tüketimine Farklı Yakıtların Etkisi

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Abstract

The use of energy resources is increasing day by day. Accordingly, the search for different energy sources continues by researchers all over the world. In particular, the search for alternative energy sources to fossil fuels has increased in recent years. As the production of hybrid vehicles increases, the availability of fuels that can be used in hybrid vehicles is being investigated. For the hybrid vehicles, which are the subject of our study, the effects of the availability of natural gas on internal combustion engines were examined. In the study, numerical analyses were carried out by using AVL Cruise program. In the analyses, the properties of natural gas were compared with the properties of gasoline. The hybrid vehicle subject to the study was selected from the library of the AVL program. A four-cylinder, four-stroke, 1.5 L spark ignition internal combustion engine was selected. An electric motor with 10 kW power, nominal voltage 144 V and maximum current 150 A was applied. According to results of the analyses, it has been observed that gasoline consumes 12.5% less fuel as mass than natural gas at the same driving distance.

Key Words: *Natural Gas; Gasoline; Hybrid Vehicle; AVL Cruise; Fuel Consumption*

Öz

Enerji kaynaklarının kullanımı her geçen gün artmaktadır. Buna bağlı olarak dünyanın dört bir yanındaki araştırmacılar tarafından farklı enerji kaynakları arayışı devam etmektedir. Özellikle son yıllarda fosil yakıtlara alternatif enerji kaynakları arayışı artmıştır. Hibrit araç üretimi arttıkça hibrit araçlarda kullanılabilecek yakıtların bulunabilirliği araştırılmaktadır. Çalışmamızın konusu olan hibrit araçlar için doğal gazın kullanılabilirliğinin içten yanmalı motorlar üzerindeki etkileri incelenmiştir. Çalışmada AVL Cruise programı kullanılarak sayısal analizler yapılmıştır. Analizlerde doğalgazın özellikleri benzinin özellikleri ile karşılaştırılmıştır. Çalışmaya konu olan hibrit araç AVL programının kütüphanesinden seçilmiştir. Dört silindirli, dört zamanlı, 1,5 L buji ateşlemeli içten yanmalı motor seçilmiştir. 10 kW gücünde, nominal voltajı 144 V ve maksimum akımı 150 A olan bir elektrik motoru uygulanmıştır. Analiz sonuçlarına göre, benzinin aynı sürüş mesafesinde doğalgaza göre kütle olarak %12,5 daha az yakıt tükettiği gözlemlenmiştir.

Anahtar Sözcükler: *Doğalgaz; Benzin; Hibrit Araç; AVL Cruise; Yakıt Tüketimi*

1. Introduction

Today, different means of transportation have begun to be produced to meet the rapidly increasing need for transportation. Chief among these are electric vehicles (EV) and hybrid electric vehicles (HEV). More electric vehicles are encountered in traffic day by day (Yavuz and Özek 2020). HEVs, which use electrical energy with fossil fuels, have become especially popular. The increase in environmental problems has increased the need for electric cars. In addition, manufacturers have started to prefer hybrid vehicles using gasoline engines due to the higher production costs of diesel engine systems (Climent *et al*. 2022). HEVs help reduce the emissions of internal combustion engines thus, they are environmentally friendly vehicles (Beatrice *et al*. 2024). Legal regulations regarding fuel economy also indicate the need for studies on fuel consumption (He *et al*. 2022). Planning on fossil fuels usage decrement in the next decades have brought about a search for new and sustainable energy.

Hybrid vehicles using internal combustion engines (ICE), especially in spark ignition internal combustion engines, fuel efficiency trials of LPG, CNG and LNG fuels, which are easily flammable along with gasoline. Fuel studies aimed at developing hybrid vehicles are also applied to HEVs with diesel fuel engines other than gasoline (Benajes *et al*. 2019). Studies are also being conducted on fuel cell hybrid electric vehicles (Bahattin Tanç 2024). Studies on obtaining biogas also direct the search for an alternative energy source to fossil fuels (Yönet and Uludamar 2024). Fuel sources such as hydrogen are also being tested in hybrid vehicles, without relying on a single fuel. In addition, the effects of different fuels on vehicle equipment are also being investigated (Borettti 2025). HEV vehicles appear as parallel hybrid vehicles and series

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hybrid vehicles. HEV operating principle, the energy flow difference with internal combustion engines is shown in Figure 1 (Arat *et al*. 2018). Their efficiency and usability vary depending on the connection types that make up hybrid vehicles. Accordingly, HEV availability and production vary. Generally, in today's HEV production, series connected HEVs are produced. The benefits of connection types are given in Table 1.

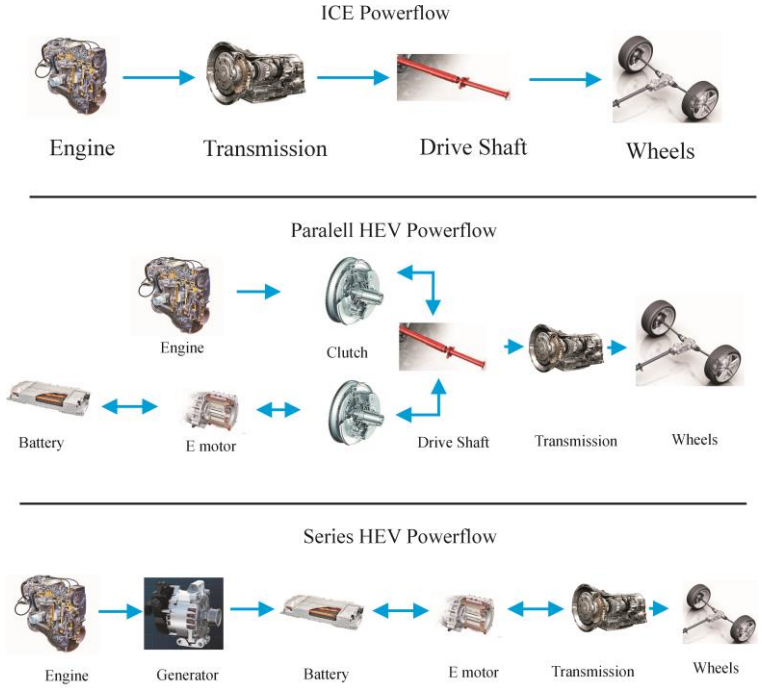


Figure 1. ICE, PHEV and SHEV power flow diagram (Yönet and Uludamar 2024)

Table 1. HEVs According to Connection Types (Shen *et al*. 2011, Yönet *et al*. 2017)

Series HEV
Series-connected Hybrid Electric Vehicles have an internal combustion engine, generator, converter, electric motor and battery. The connection between the internal combustion engine and the gearbox is not mechanical. The required power for the vehicle reaches maximum efficiency in this way.
Parallel HEV
HEV vehicle models where there is a mechanical connection between the internal combustion engine and the transmission, and the electric motor and the internal combustion engine work together.
Power-Split or Series-Parallel HEV
It is a hybrid vehicle model where series and parallel features are used together. There is a mechanical connection between the ICE and the transmission compared to series vehicles. There is an additional generator system compared to parallel vehicles.

Different simulation programs can be used to obtain rapid results regarding vehicle fuel performances (Rashid and Danial 2017, Ahmed *et al*. 2020). Techniques based on numerical analysis are mostly used in the MATLAB platform (Pandian and Palanivelu 2025). Thanks to the Advanced Vehicle Simulator (ADVISOR) program, which allows vehicle design, performance analysis of the produced vehicles can also be done with the Pheromone Based Approach (PBA) program (Shivappriya et al. 2025).

One of these is the AVL Cruise simulation program (Arat 2019). In the field of modelling, the AVL Cruise program provides convenience in evaluating parameters such as engine torque, fuel consumption, and driving distance, which can give results very close to reality (Yönet *et al*. 2017). Considering the search for alternative fuel, fuel consumption, and long driving distances are also important parameters in vehicle and fuel selection.

Working are being carried out on different systems suitable for different operating conditions of the engine (Öner et al. 2022). There are driving cycles that provide easy access to vehicle speed data and information about fuel and emission values. Driving cycles have long been used to predict vehicle fuel economy under laboratory conditions (Rios-Torres et al. 2019). These cycles have

been produced by different countries and organizations. In our study, the NEDC European cycle, which combines both urban and extra-urban cycles, was used. The NEDC cycle consists of urban (ECE) and extra-urban cycle (EUDC). Simulations are performed for 195 seconds for the ECE cycle and 400 seconds for the EUDC cycle. The ECE R15 cycle is a cycle that lasts for 195 seconds at a distance of 994.6 meters and is simulated by stopping and starting 4 times in total. EUDC is the cycle performed by stopping and going twice for 400 seconds at a distance of 6955.07 meters. If its technical features are listed; distance: 11,007 km, maximum speed: 120 km/h, total time: 1180s (ECE+EUDC), average speed: 33.6 km/h. A visual description of the cycle is shown in Figure 2.

By comparing parallel hybrid electric vehicle fuel consumption in various driving cycles, the most suitable driving cycle is tried to be determined (Paykani *et al*. 2011).

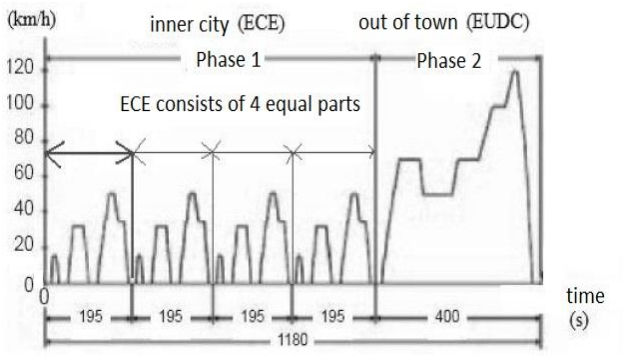


Figure 2. NEDC Conversion Chart (Gürsürer 2009)

The fact that hybrid vehicles have ICE also involves the use of different fossil fuels. The trial of different sustainable fuels, especially for emission reduction, is increasing (Prati and Costagliola 2022). It is seen in literature studies that the closest alternative fuel to gasoline is fuels containing methane gas (Yao and Wu 2024). Engine performance, torque and fuel consumption rates of LPG fuel, which is preferred as fuel for HEV with gasoline internal combustion engine, were compared. In the engine operating with LPG, a 12% improvement in fuel efficiency was observed. FTP-75 cycle stands out in the study (Jeong *et al*. 2025).

Official laboratory measurements show a gradual decrease in the average fuel consumption of the European passenger car fleet, which demonstrates the importance of the improvement work carried out (Fontaras *et al*. 2017).

When different fuel studies are examined for a hybrid electric vehicle with diesel fuel, hydrogen and methanol are used as additional fuel. It is observed that the fuel consumption of the engine with hydrogen is increased. On the contrary, the engine speed is also increased. In the engine with methanol, the engine power is calculated to be less than hydrogen (Hadi Taghavifar 2023).

In the study comparing the performance of liquefied petroleum gas (LPG) and gasoline fuel in internal combustion engines for an injection motorcycle, it was observed that fuel consumption decreased by 14.78% in LPG fuel compared to the average fuel (kg/100 km) (Duy *et al*. 2021). In the experiments conducted with similar fuels, it was found that similar rates were found in the literature research.

In the study, the effects of gasoline and natural gas fuels on driving distance on hybrid vehicles were investigated. A 4-cylinder, 4-stroke, 1.5 L spark-ignition internal combustion engine and a 10 kW electric motor with a nominal voltage of 144 V and a maximum current of 150 A were selected from the library of the AVL Cruise program.

2. Materials and Methods

In the study, a product tree was created by selecting a series connected HEV with internal combustion engine, electric motor, and battery features by using AVL Cruise software program. The visual of the created product tree is shown in Figure 3. The properties of gasoline and natural gas fuels selected as energy sources are given in Table 2. The characteristics of the ICE and electric motor used in the study are given in Table 3.

Table 2. Gasoline and Natural Gas Fuel Properties

Fuels	Gasoline	Natural Gas
Heating Value (kJ/kg)	42700	47700
Fuel Density (kg/l)	0.72	0.83
Specific Carbon Content	0.86	0.76

Table 3. ICE and Electric Machine Values

Components	**Features**
ICE	4-cylinder, 4-stroke, Idle 720 rev/min., Max. Speed: 5800 rpm, without charger
Electric Motor	PSM type, Nominal voltage: 144V, Max. Speed: 8000 rpm., Inertia moment: 0,15 kg*m^2, Initial temp.:55 ^{o}C, layout temp.:95 ^{o}C

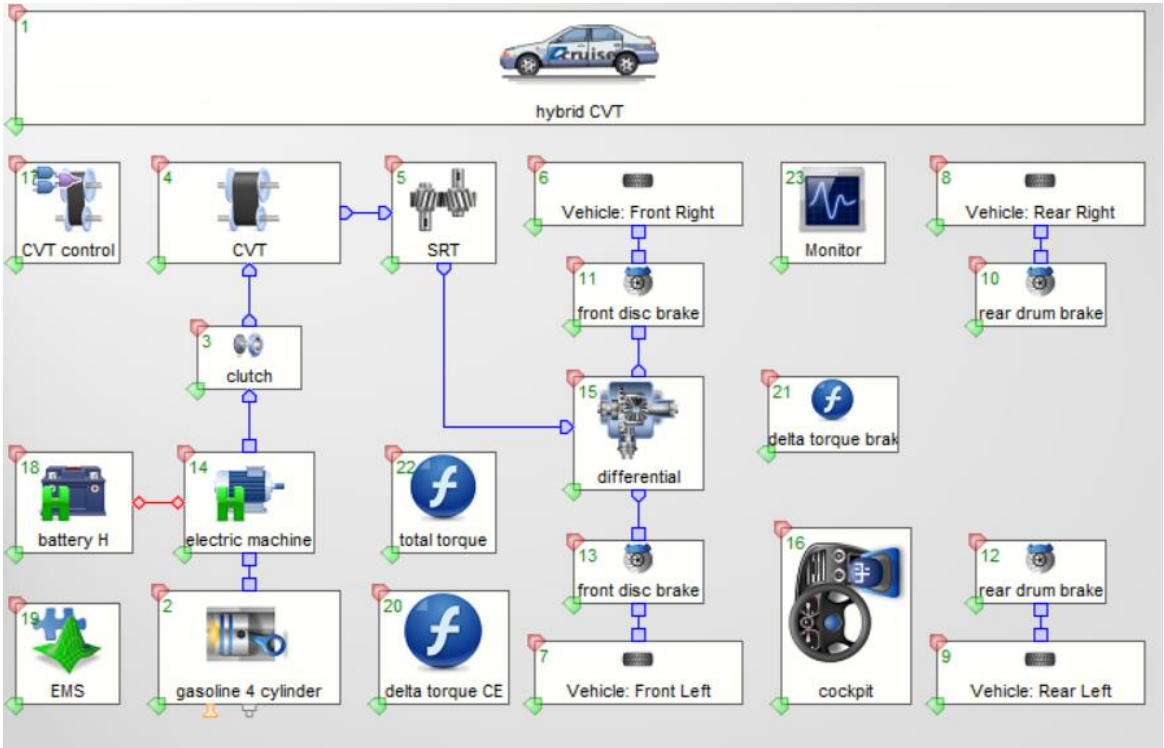


Figure 3. AVL Cruise Product Tree

In the internal combustion engine modelling for HEV, the parameters that can be used to analyse all functions of the vehicle can be selected from the program library or data can be entered by the user. The program also provides information about the fuel consumption of the engine when it is cold or hot. In the study, the analysis was done with a hot start engine at 55 °C. The fuel consumption results show the actual fuel consumption according to the average braking distance based on the engine speed at idle. The modelling uses this method for a perfect relationship between the parameters.

For fuel consumption calculation, engine speed $\phi_{E,out}$ and mean effective pressure $P_{eff,act}$ can be obtained from the fuel consumption map $b_{E,h}(\phi_{E,out}, P_E)$. Fuel consumption for ($\phi_{E,out} < \phi_{idle}$) and $\alpha_{th} < 0$ can be taken from the general map or selected as constant idle consumption. Specific fuel consumption is evaluated by dividing the fuel consumption (mass flow) for the engine power. When the engine power is in the range -0.5 kW ÷ 0.5 kW the specific fuel consumption is calculated using a threshold value equal to 0.5 kW as engine power (AVL 2015).

$$b_{E,act} = b_{E,idle} - \frac{b_{E,idle} - b_{E,SA}}{\varphi_{E,SA,low} - \varphi_{E,idle}} \cdot \left(\varphi_{E,act} - \varphi_{E,idle}\right) \quad (1)$$

Correction factors can be calculated with actual input conditions and conditions at the time of testing. The fuel consumption factor is evaluated. The relationship between actual consumption and map consumption is determined (AVL 2015).

$$q_c = \frac{p_{E,Mot}}{p_{E,inlet,act}} \cdot 1000 \cdot \pi \cdot \frac{N_{E,stroke} \cdot b_{E,h,act}}{V_{E,h} \cdot \varphi_{E,out}} \quad (2)$$

$$f_{fuel} = \frac{b_{E,act}}{b_{E,h}} \quad (3)$$

3. Results

In the simulation, constant driving distance was kept constant for each vehicle modelling. The amount of fuel consumed for the same distance was determined. In the study, in order to obtain fuel consumption results efficiently, results were obtained by selecting a single HEV and changing the fuel properties. Gasoline and natural gas fuelled HEV simulation results are shown in Figure 4 and Figure 5. The graph showing the distance, acceleration and speed values of HEV is shown in Figure 6. Gasoline HEV and Natural Gas HEV Fuel Consumption are shown together in Figure 7.

The fuel consumption value of a gasoline-fuelled HEV vehicle is calculated as 4.2 kg cumulatively, the maximum fuel consumption point is calculated as 1.8 kg/h. While the fuel consumption value of a natural gas-fuelled HEV vehicle is calculated as 4.8 kg cumulatively, the maximum fuel consumption point is calculated as 2.2 kg/h. Simulations are performed for 195 seconds for the ECE cycle and 400 seconds for the EUDC cycle. The ECE R15 cycle is a cycle that lasts for 195 seconds at a distance of 994.6 meters and is simulated by stopping and starting 4 times in total. The peaks and fluctuations in the graphs are caused by the cycle and show the fuel consumption during stopping and starting (Gürsürer 2009).

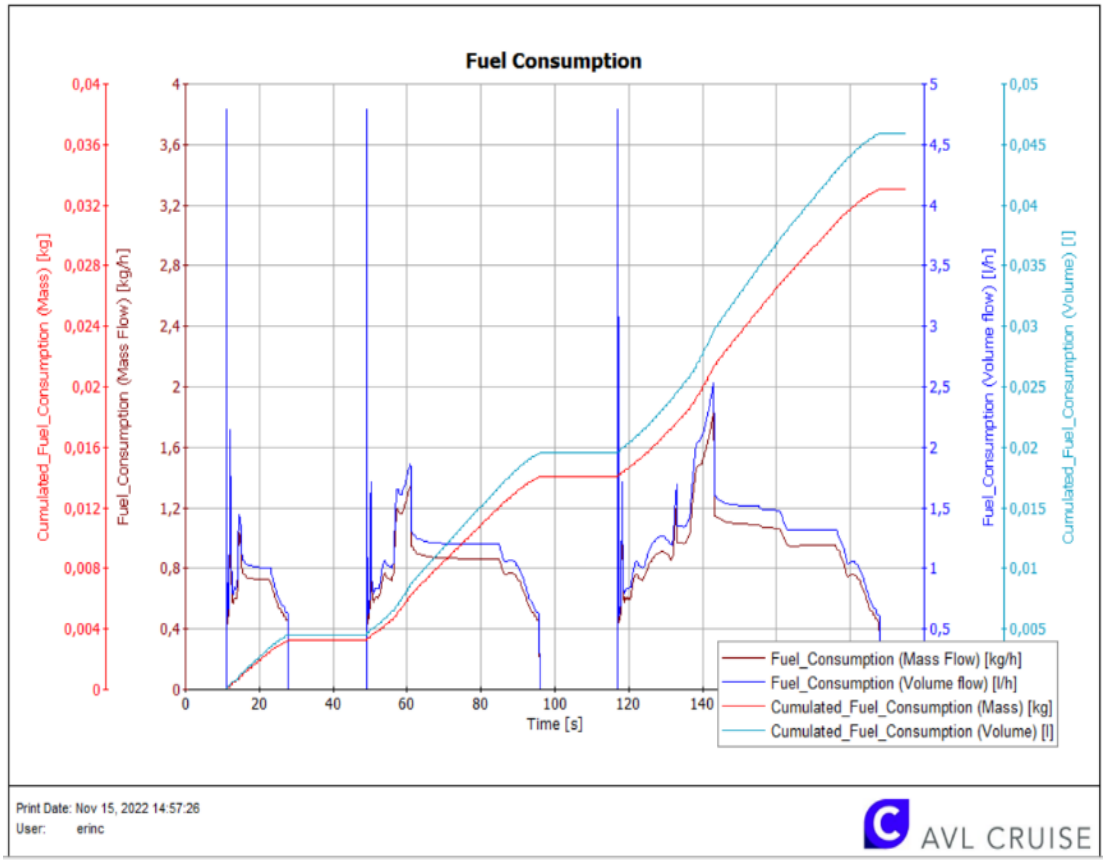


Figure 4. Gasoline HEV Fuel Consumption

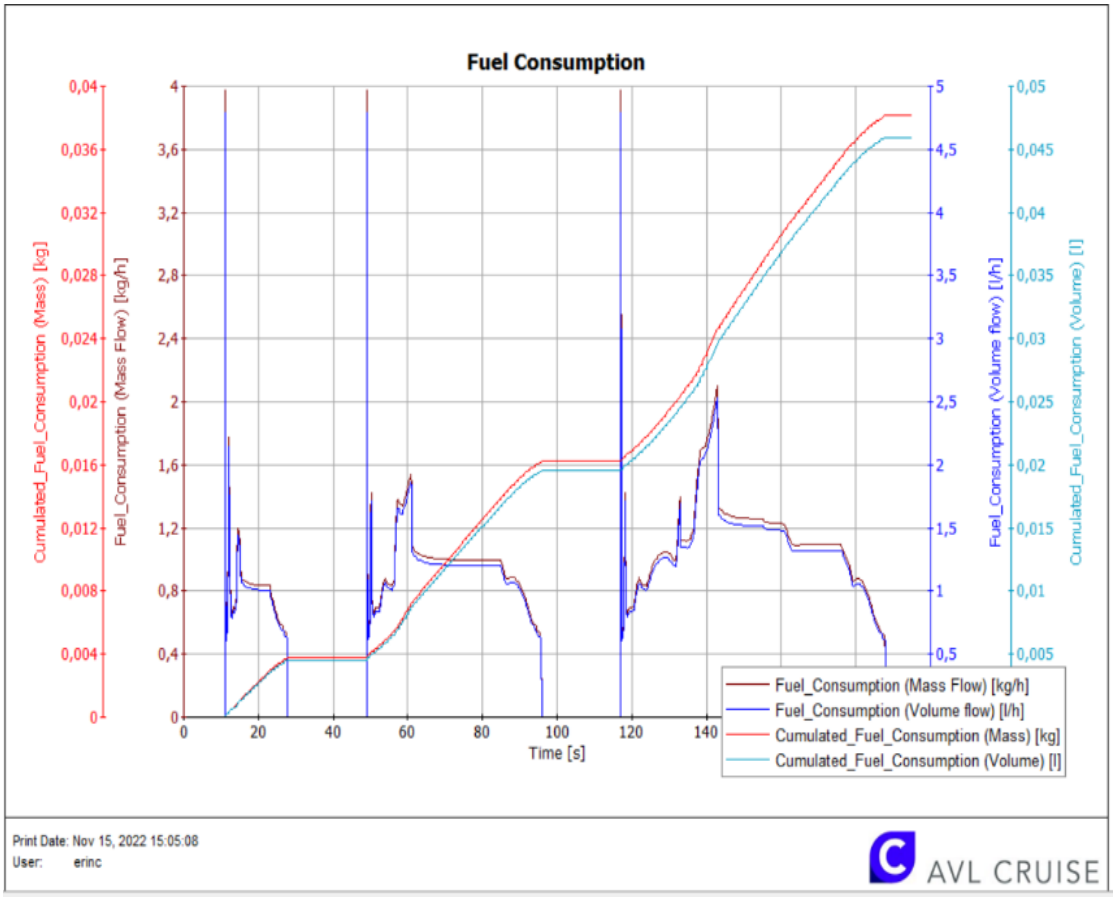


Figure 5. Natural Gas HEV Fuel Consumption

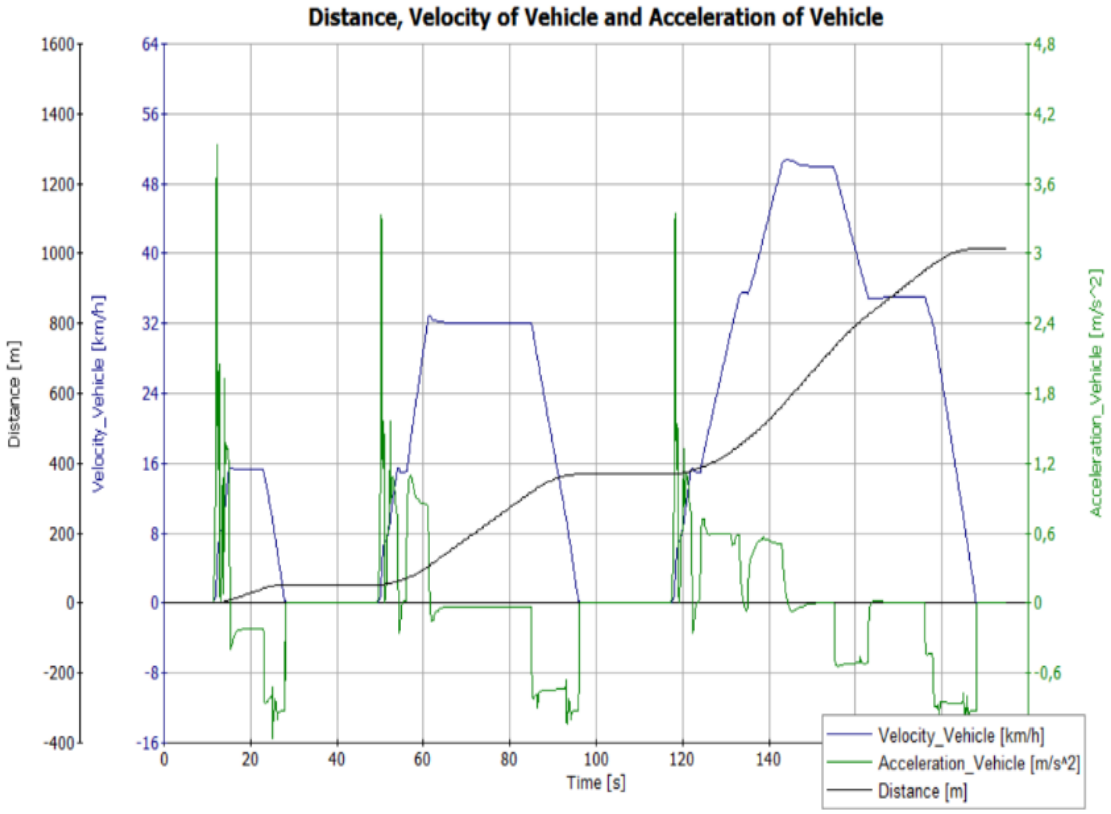


Figure 6. Distance, Velocity and Acceleration of HEV

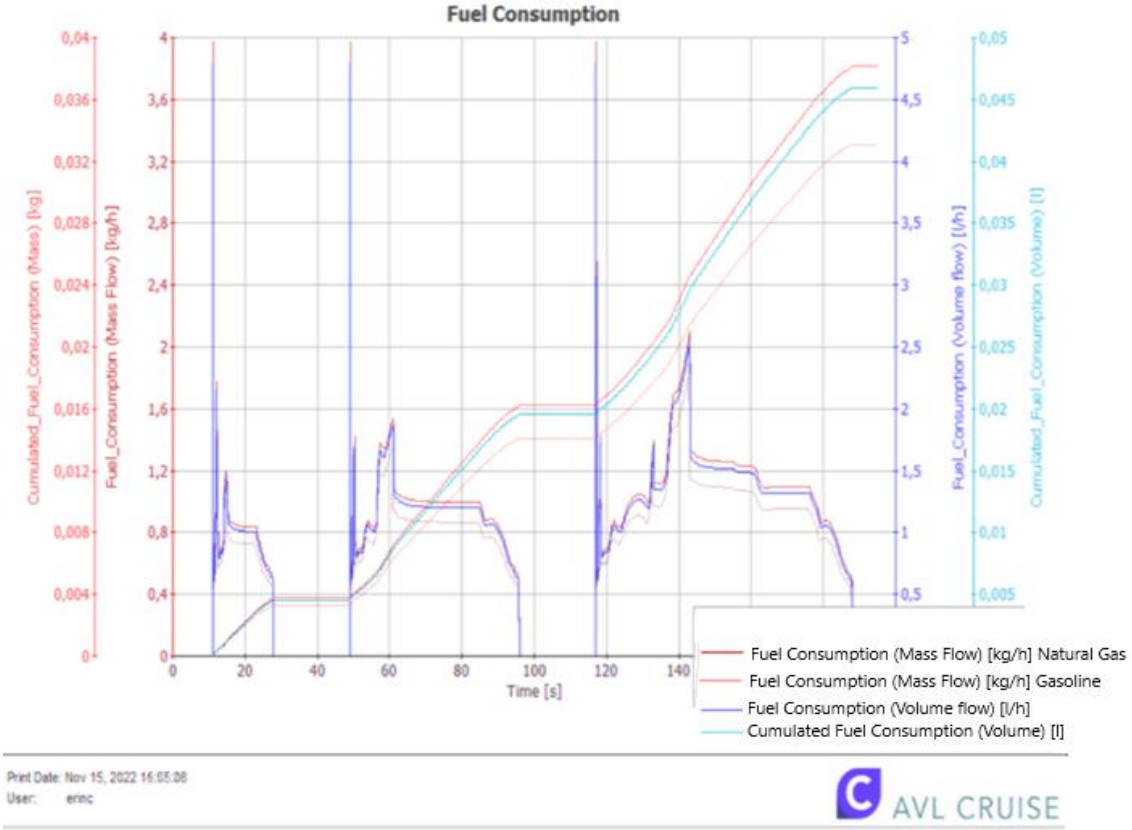


Figure 7. Gasoline HEV and Natural Gas HEV Fuel Consumption

While selecting HEV parameters, other parameters were kept constant based on observing fuel consumption. Driving was done based on a distance of 1600 meters. The simulation was completed with the cycle at a distance of just over 1000 meters. According to the NECD European driving cycle, driving took place in 3 phases. Maximum vehicle speed is calculated as 52 km/h. There are many benefits that can be an alternative to traditional fossil fuels in LPG, ethanol, biodiesel, and hybrid vehicles used as fuel. Fuel consumption, fuel consumption, emissions and vehicle performances include the evaluated effect. It is seen that especially gaseous energy sources can be an alternative (Markov 2019). In a similar study conducted with the MATLAB-based ADVISOR simulation program, the efficiency of hybrid vehicles provided a fuel efficiency of 10.03% with gasoline fuel (Shivappriya et al. 2025). In the study comparing the features of a gasoline-fuelled vehicle engine and a hybrid vehicle, fuel consumption varied from a maximum of 3.69 g/s to 4.98 g/s. MATLAB Simulink vehicle modelling was used in the study using the NECD cycle (Dogdu ve Reyhancan 2024). There are studies that different fuels reduce fuel consumption of gasoline engines. In the research, adding 12% Iso-butanol by volume for the NEDC cycle can reduce fuel consumption by 3.33% (Zhang et al. 2023). In the modelling done with the AVL Cruise program by adding Hydrogen fuel to the internal combustion engine, it was seen that the use of different fuels reduced fuel consumption by 8.43% in the same cycle (Ji et al.2016).

The simulation program used in the study gave results similar to the theoretical and real results of other studies. Studies in the literature indicate that the popularity of fossil fuels is decreasing. The effects of the internal combustion engine fuel, evaluated as a single parameter, on the hybrid vehicle were determined by the results of our study.

4. Conclusions

In the study, the fuel consumption of a hybrid vehicle with the same internal combustion engine and two different fuels was analysed in the same driving distance. Driving distance is based on the NEDC European driving cycle, which is accepted as the international analysis and performance test procedure. Fuel consumption analysis of gasoline and natural gas in internal combustion engines at a certain driving distance was made. When the study results were evaluated, it was seen that gasoline provided 12.5% less consumption by mass compared to natural gas in the gasoline HEV and natural gas HEV simulations at the same driving distance. The percentage similarity with the results of different studies is given in the results section. Based on fuel density and ignition temperature and time, it has been observed that natural gas is a gas that can ignite more quickly than gasoline. For new studies, the gaseous form of gasoline fuel, known as gasoline vapor, and the driving distance and fuel consumption of natural gas can be studied. Drive cycle availability according to NECD European norms has been observed. The fact that the gasoline consumption amount and the natural gas consumption amount are close to each other, the fact that natural gas is an environmentally friendly fuel and can be used as an alternative fuel to gasoline have been confirmed by the AVL Cruise program. The importance of using simulation programs that provide fast and practical results has gained importance again with our study. The parameters we obtained have shown similar results in studies conducted in the literature. In addition to theoretical studies, practical studies can be carried out to provide physical use in internal combustion engines.

Another important finding is that the comparison with the results of previous studies demonstrates the success of the AVL Cruise simulation program in producing accurate results for hybrid vehicle studies.

Declaration of Ethical Standards

The authors declare that they comply with all ethical standards.

Credit Authorship Contribution Statement

Author-1: Conceptualization, investigation, methodology and software, visualization and writing, original draft.

Author-2: Conceptualization, investigation, supervision and writing, review and editing.

Declaration of Competing Interest

The authors have no conflicts of interest to declare regarding the content of this article.

Data Availability Statement

All data generated or analyzed during this study are included in this published article.

5. References

Ahmed A., Yelamali P., Udayakumar R., 2020. Modelling and simulation of hybrid technology in vehicles. *Energy Reports*. Volume **6**, Supplement 2, Pages 589-594. https://doi.org/10.1016/j.egyr.2019.11.123

Arat H. T., 2019. Alternative fuelled hybrid electric vehicle (AF-HEV) with hydrogen enriched internal combustion engine. *International Journal of Hydrogen Energy*. Volume **44**, Issue 34, Pages 19005-19016. https://doi.org/10.1016/j.ijhydene.2018.12.219

Arat H. T., Tanç B., Yönet N., Baltacıoğlu E., 2018. Comparative Simulation Analyses On Energy Flow Characteristics of Different Hev Configurations. *16th International Conference On Clean Energy*.

AVL-CRUISE Users Guide, AVL, V2015.

Beatrice C., Capasso C., Doulgeris S., Samaras Z., Veneri O., 2024. Hybrid Storage System Management For Hybrid Electric Vehicles Under Real Operating Conditions. *Applied Energy*. Volume **354**, Part B, 122170. https://doi.org/10.1016/j.apenergy.2023.122170

Benajes J., Garcia A., Serrano J. M., Boggio S. M., 2019. Optimization of the parallel and mild hybrid vehicle platforms operating under conventional and advanced combustion modes. *Energy Conversion and Management.* Volume **190**, 73-90. https://doi.org/10.1016/j.enconman.2019.04.010

Boretti A., 2025. Electric turbochargers in hydrogen internal combustion engines powered hybrid electric vehicles: Advancing performance, efficiency, and sustainability. *International Journal of Hydrogen Energy.* Volume **103**, 690-700. https://doi.org/10.1016/j.ijhydene.2025.01.225

Climent H., Dolz V., Pla B., Dominguez D. G., 2022. Analysis on the potential of EGR strategy to reduce fuel consumption in hybrid powertrains based on advanced gasoline engines under simulated driving cycle conditions. *Energy Conversion and Management.* Volume **266**, 115830. https://doi.org/10.1016/j.enconman.2022.115830

Dogdu M. F., Reyhancan I. A., 2024. The comparison of gasoline powered vehicle and serial hybrid vehicle on emissions. *Heliyon.* Volume **10**, Issue 9. https://doi.org/10.1016/j.heliyon.2024.e28532

Duy V. N., Duc K. N., Van N. C., 2021. Real-time driving cycle measurements of fuel consumption and pollutant emissions of a bi-fuel LPG-gasoline motorcycle. *Energy Conversion and Management: X.* Volume **12**, 100135. https://doi.org/10.1016/j.ecmx.2021.100135

Fontaras G., Zacharof N. G., Ciuffo B., 2017. Fuel consumption and CO2 emissions from passenger cars in Europe – Laboratory versus real-world emissions. Volume **60**, 97-131. https://doi.org/10.1016/j.pecs.2016.12.004

Gürsürer K. M., 2009. Avrupa Şehir Çevrimiile Amerika Şehir Çevriminin Arasındaki Farkların Deneysel Olarak İncelenmesi. Yüksek Lisans Tezi, *İstanbul Technical University, Institute of Science and Technology*, 87.

Taghavifar H., 2023. The influence of different fuels and injection methods of RCCI and DCI in hybrid ICE-Battery vehicle performance. *Fuel.* Volume **340**, 127467. https://doi.org/10.1016/j.fuel.2023.127467

He L., You Y., Zheng X., Zhang S., Li Z., Zhang Z., Wu Y., Hao J., 2022. The impacts from cold start and road grade on real-world emissions and fuel consumption of gasoline, diesel and hybrid-electric light-duty passenger vehicles. *Science of The Total Environment*. Volume **851**, Part 1, 158045. https://doi.org/10.1016/j.scitotenv.2022.158045

Jeong J. W., Woo S., Koo B., Lee K., 2025. Analysis of hybrid electric vehicle performance and emission applied to LPG fuel system. *Fuel*. Volume **380**, 133225. https://doi.org/10.1016/j.fuel.2024.133225

Ji C., Yu M., Wang S., Zhang B., Cong x., Feng Y., Lin S., 2016. The optimization of on-board H2 generator control strategy and fuel consumption of an engine under the NEDC condition with start-stop system and H2 start. *International Journal of Hydrogen Energy*. Volume **41**, Issue 42, 19256-19264. https://doi.org/10.1016/j.ijhydene.2016.08.127

Markov K., 2019. A Review of The Possibility for Using of Alternative Fuels and Biofuels in Hybrid Vehicles. *Proceedings Of University of Ruse*, Volume **58**, Book 4, FRI-2.203-1-TMS-12X.

Öner C., Öztürk G., Tanyeri B., 2022. Investigation of the Effect of Using Ultrasonic Fuel System on Exhaust Emissions in a Spark Ignition Engine. *Afyon Kocatepe University Journal of Science and Engineering*. Volume **22**, 055902 ,1214-1224. https://doi.org/10.35414/akufemubid.1024495

Pandian S., Palanivelu A., 2025. An efficient energy management of a hybrid electric vehicle using hybrid QNN-GOA technique. *Journal of Energy Storage*. Volume **106**, 114827. https://doi.org/10.1016/j.est.2024.114827

Paykani A., Tabar M., T., S., 2011. A comparative study of hybrid electric vehicle fuel consumption over diverse driving cycles. *Theoretical and Applied Mechanics Letters*. Volume **1**, Issue 5, 052005. https://doi.org/10.1063/2.1105205

Prati M. V., Costagliola M. A., 2022. Real driving emissions of Euro 6 electric/gasoline hybrid and natural gas vehicles. *Transportation Research Part D: Transport and Environment*. Volume **113**, December 2022, 103509. https://doi.org/10.1016/j.trd.2022.103509

Rashid M. I. M., Danial H., 2017. ADVISOR Simulation and Performance Test of Split Plug-in Hybrid Electric Vehicle Conversion. *Energy Procedia*. Volume **105**, May 2017, Pages 1408-1413. https://doi.org/10.1016/j.egypro.2017.03.524

Shen C., Shan P., Gao T., 2011. A Comprehensive Overview of Hybrid Electric Vehicles. *International Journal of Vehicular Technology.* Volume **2011**, Article ID 571683, 7 pages. https://doi.org/10.1155/2011/571683

Shivappriya S.N., Gowrishankar T., Stoian G., Anitha J., Hemanth D., J., 2025. Enhancing performance of Parallel Hybrid Electric Vehicles using Powell's Artificial Bee Colony method. *Heliyon*. Volume 11, Issue 3, e42325. https://doi.org/10.1016/j.heliyon.2025.e42325

Tanç B., 2024. Simulational energy analyses of different transmission (automated manuel transmission vs continuously variable transmission) selection effects on fuel cell hybrid electric vehicles' energetic performance. *International Journal of Hydrogen Energy*. Volume **75**, 506-514. https://doi.org/10.1016/j.ijhydene.2024.02.360

Torres J., R., Liu J., Khattak A., 2019. Fuel consumption for various driving styles in conventional and hybrid electric vehicles: Integrating driving cycle predictions with fuel consumption optimization. *International Journal of Sustainable Transportation.* Volume 13, Issue 2, Pages 123-137. https://doi.org/10.1080/15568318.2018.1445321

Yao A., Wu J., 2024. Sustaining power distribution network submerged in plug-in hybrid CNG-electric vehicles for future green transportation: A risk-constrained analysis. *Sustainable Cities and Society.* Volume **111**, 105416. https://doi.org/10.1016/j.scs.2024.105416

Yavuz İ., Özek A., 2020. Effect Of Friction Coefficient Of Different Curve Diameters On Wheel Speeds For Electronic Differential. *Afyon Kocatepe University Journal of Science and Engineering*. Volume **20**, 065904, 1138-1146. https://doi.org/10.35414/akufemubid.684869

Yönet N., Uludamar E., 2024. Effect Of Recycled Polyethylene Catalyst for Mediterranean Pine Seed Shell Biomass Pyrolysis On Hydrogen And Methane Production. *Energy Sources, Part A: Recovery, Utilization, and Environmental Effects*, Volume **46**, 6555-6565. https://doi.org/10.1080/15567036.2024.2349710

Yönet N., Tanç B., Arat H. T., 2017. Effects of using different electric motors on hybrid engine's performance. *6 th International Conference on Renewable Fuels Combustion and Fire*.

Zhang X., Zhang S., Zhao Y., Liu J., Kong X., Zhang S., Wen M., Liu H., 2023. Effects of different additives on physicochemical properties of gasoline and vehicle performance. *Fuel Processing Technology*. Volume **242**, 107668. https://doi.org/10.1016/j.fuproc.2023.107668