Electric and Hybrid Vehicles

1st Mario Alberto Garza
Department of Mechanical and Industrial Engineering
Texas A&M University – Kingsville
Kingsville, TX 78363
mario.gonzalez_de_leon@students.tamuk.edu

2nd Maria Alvarado Ortega
Department of Mechanical and Industrial Engineering
Texas A&M University – Kingsville
Kingsville, TX 78363
maria_alvarado @students.tamuk.edu

3rd Claudia Miranda Perez Luz.
Department of Mechanical and Industrial Engineering
Texas A&M University – Kingsville
Kingsville, TX 78363
claudia_miranda_luz@students.tamuk.edu

***Abstract*—** This article seeks to investigate, through a narrative investigation, the relationship between electric cars and their needs so that they are more efficient. In this webinar, the Doctors explain clearly and concisely how technology can be used for its use in the evolution of electric cars, what advances have been made at present, as well as the demand for electric cars to be more efficient.

Keywords (IEEE, Electric Cars, Battery, Cells, Autonomy electric Car, Hybrids, Webinars, HEV, EV).

Resumen— Este artículo busca indagar, a través de una investigación narrativa, la relación entre los autos eléctricos y sus necesidades para que sean más eficientes. En este webinar, los Doctores explican de forma clara y concisa cómo se puede utilizar la tecnología para su uso en la evolución de los coches eléctricos, qué avances se han realizado en la actualidad, así como la demanda de que los coches eléctricos sean más eficientes.

Palabras clave (IEEE, Coches eléctricos, Batería, Celdas, Autonomía coche eléctrico, Híbridos, Webinars, HEV,

I. Introduction

The first pure electric vehicle was invented between 1832 and 1839 by Scottish businessman Robert Anderson. Even before the Diesel or Otto cycle engines of conventional vehicles were developed [1]. This type of vehicle continued to be developed throughout the 19th and early 20th centuries. Due to the technical limitations of energy storage systems and the great technological development of ICMs (internal combustion engines) of the time, electric vehicles definitively stagnated their progress in 1920.

Vehicles with internal combustion engines offered comfort, speed and great autonomy to travel long distances without having to refuel on many occasions.

The human being has achieved in the last centuries an immense technological development that has allowed a great improvement in the quality of life for millions of people. In countless sectors such as transportation, fossil fuels have brought countless possibilities: bringing people closer, traveling previously insurmountable distances, heating homes or providing electricity for all kinds of uses are some of these examples.

All these advantages have triggered a great increase in the burning of fossil fuels on the planet. This burning of fuels causes large CO2 emissions in the atmosphere and other varieties of so-called GHG (greenhouse gases), which are responsible for the increase in global temperature. In addition, these gases represent a risk to people's health, being the cause of respiratory diseases in cities with high pollution rates and reducing their life expectancy.

These circumstances make climate change one of the biggest and most complicated challenges that human beings must face. Despite this, pollution is not the only problem brought about by the large increase in the consumption of fossil fuels.

In this context of search for alternatives and since the transport sector is one of the most dependent on fossil fuels and the cause of approximately 60% of pollution, the electric vehicle emerges as an alternative in mobility to the increase in fuel prices. or other factors.

II. Autonomy

Autonomy has always been one of the great problems of the electric car, however it is increasingly common to see figures that exceed 400-500 km among the latest generation electric cars.

The electric car poses serious dilemmas when it comes to increasing autonomy, because although the improvement

in efficiency, aerodynamics and other sections allows kilometers to be scratched, the key to increasing autonomy lies in the use of larger batteries. However, this solution has two big problems: weight and price. Offering great autonomy can play against certain electric cars, since excess weight and cost can be unaffordable.

The ideal motor vehicle would be:

- Affordable-price similar or lower that gasoline/diesel-powered vehicles (cars and trucks)
- Safe
- Convenient: Charge time similar to fuel up gasoline; convenient to charge anytime anywhere.
- Low maintenance
- Long life
- Environment friendly

A. Hybrids

Also called parallel hybrids. (Figure 1) The motor stops running when stopped and provides additional power when accelerated. The electrical system also has auto-start and auto-stop functions. Gasoline consumption decreasing by approximately 10% [2]. Examples of light hybrid vehicles are the Honda Civic Hybrid and the BMW 7-series hybrid.

The latest version of the Honda model has a 20-kW lithium battery with a capacity of 100 kAh and a 17-kW electric motor. In these models you cannot talk about electric autonomy, because with the exception of some models that are capable of disconnecting the combustion engine at moderate speed, they cannot be driven by battery power.

Figure 1 Hybrid Car

B. HEV

Like light hybrid vehicles, its only source of energy is fuel and it does not allow charging of its battery through connection to the electrical network. The battery works intermittently in charge and discharge cycles and does not store a large amount of energy. It is recharged by means of excess energy produced by the gasoline engine and by means of regenerative braking.

The traction electric motor is reconnected as a generator during braking and the power terminals become energy suppliers which are conducted to an electrical load; it is this charge that provides the braking effect. Regenerative braking technology harnesses kinetic energy to charge the batteries each time the driver hits the brakes.

The reduction in gasoline consumption in these models ranges from 25% to 40%. Hybrid systems minimize idling and provide an integrated electric start, increasing the vehicle's ability to start and accelerate.

Its beginnings date back to the beginning of the 20th century. Porsche developed an electric vehicle relevant to their future operation. It used an internal combustion engine to drive an electric generator that powered coupled motors at each wheel.

This vehicle managed to travel close to 65 km in electric mode [3]. Examples of hybrid vehicles are the Ford Fusion Hybrid and the Toyota Prius. The difference with light hybrid vehicles is that they have the ability to activate the electrical system 9 voluntarily. [4]. The Ford Fusion Hybrid uses a 1.4kWh lithium-ion battery and is capable of traveling in electric mode up to 130 km/h. In electric mode it allows a minimum consumption of 19.9 km/L and a range of 3.2 km [5SP].

The strong point of hybrid vehicles is that through the electric motor they manage to increase the efficiency of the vehicle and therefore reduce fuel consumption. At the same time that they preserve the comforts of conventional vehicles. The disadvantages are that the initial price is usually higher than that of a conventional utility vehicle and that this class of vehicle does not definitively eliminate dependence on fossil fuels.

III. **BATTERY ELECTRIC VEHICLES (EVS)**

They are powered solely by an electric motor. The power source comes from the electricity stored in the battery that must be charged through the network. Although they also incorporate other charging technologies such as regenerative braking.

The operation and mechanics of the EV is much simpler than in conventional vehicles. Fundamentally it is based on one or more electric motors mechanically coupled to the vehicle's axles.

These electric motors are controlled with variable frequency drives and other methods of power electronics that execute the signals received by the driver when stepping on the accelerator. The volume of the engine is also considerably reduced compared to combustion engines.

A. Advantages and disadvantages of electric vehicles

- The great disadvantage of EVs for their market position is their price. Lithium batteries, despite their high energy density, are still very expensive and this affects the final price. This is expected to change in the short term with the mass production of the batteries. Although the electricity expenses per year are also considerably less than the fuel expenses of conventional vehicles and help to amortize the investment.

- The great advantage of electric vehicles compared to vehicles with MCI is that they do not produce any type of pollution in the place or at the time of use. Despite this, they can produce pollution indirectly, if the electricity 13 used to charge their batteries has not been produced by clean energy sources. With all this, it allows greater independence from fossil fuels, and if it happens that its generation source is renewable, its total cycle of emissions will be zero.

Currently, the bottleneck for EVs is the battery. Its autonomy and the time required for recharging are the main disadvantage compared to conventional vehicles in prolonged use. As the batteries are still very heavy, the total weight is greater and gives less autonomy.

B. Battery

There are currently several relevant types of commercial batteries. These are some of them: acid-lead, nickel-cadmium, nickel-metal hydride and lithium ion. Figure 2

The main parameters measured when analyzing the viability of the materials used in batteries are the specific energy (Wh/kg), the energy density (Wh/l), the number of life cycles and the voltage per cell. The first two parameters are especially important, since they determine the mass and volume that the battery to be used will possess. The number of life cycles defines the useful life that the product will have and the voltage per cell is crucial in the performance required by electrical equipment.

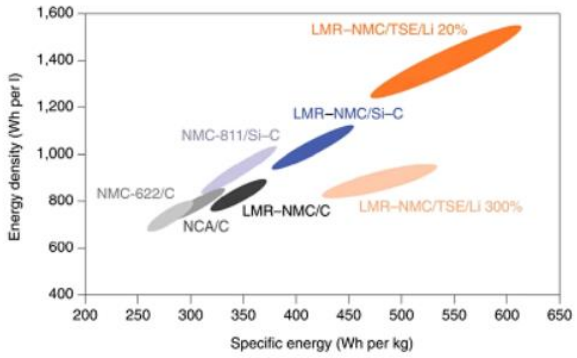

Figure 2 Types of Battery

Due to its characteristics and its relationship with those of its competitors, lithium batteries are currently the most attractive to automobile manufacturers among other industries. They have a greater storage capacity in smaller dimensions and less weight, which is more weighted by the electric car industry than its high price due to the scarcity of material and its environmental danger.

Despite the great progress that lithium batteries represent, this part of the electric vehicle is the one that entails the most obstacles to its development and expansion. Electric vehicles have great disadvantages compared to those with internal combustion engines due to the autonomy of their batteries and their subsequent charging time. For this reason, the field of batteries represents the sector with the greatest investment and research within the electric vehicle.

Through new production methods, it is expected to reduce the cost of batteries to 70% of their price, reduce the weight of their batteries by 60%, as well as increase their life cycles by the 2030s, compared to 2020 values. In this improvement of the characteristics, the search and application of new materials such as the example of graphene will have an important weight.

This material is achieving great results for batteries in its laboratory phase and could greatly increase the viability of the electric vehicle and therefore its expansion.

Meanwhile, the doctor exposes the following points that must be worked on at this time in order to improve in the area of opportunity

- Batterie is the most expensive components (More that car itself) and they need a second chance.
- The single most vulnerable piece in an EV- most concerned about safety, fire, explosion of EV batteries.
- Producing batteries induce environment pollution; use of heavy metal and rare-earth material, acids, etc.
- EVlife-cicle environment-friendliness needs tp be thoroughly studied
- Solid-state batteries may be the future but still have a long way to go.

IV. Conclusion and Discussion

This scenario is allowing the development of the electric vehicle in giant steps. Large companies such as Tesla Motors or BMW are achieving innovative and highly functional models, which even surpass conventional vehicles in many aspects.

In particular, it is worth noting the investment by Tesla Motors to minimize the costs of electric vehicle batteries and maximize their capacity. The innovation with the

greatest potential for a definitive boost to the electric vehicle may come from graphene batteries.

American researchers claim to have obtained batteries made from this material, which has ideal properties, such as an energy density much higher than that of lithium, great lightness and high conductivity. Also, when it comes to testing this carbon, it is a very abundant raw material. The researchers assured that their batteries would increase the autonomy of the EV up to 1000 km and its charge would be completed in 8 minutes, in addition to lowering the price with fatigue.

ACKNOWLEDGMENT

I thank the university in Kingsville Texas for allowing me to do my master's degree in Mechatronics and the professors who are committed to the students, giving their best to create great engineers, masters and doctors.

REFERENCES

[1] G. Eas Wikipedia. Wikipedia.com. [Online]. http://es.wikipedia.org/wiki/Veh%C3%ADculo_el%C3%A9ctrico

[2] IDAE, "Mapa Tecnológico de Movilidad Eléctrica," Observatorio Tecnológico de la Energía, Ministerio de Industria, Energía y Fomento, Informe 2018.

[3] U.S. Department of Energy. (2022) Fuel Economy Web site. [Online]. https://afdc.energy.gov/files/u/publication/hpev_spanish.pdf

[4] University Houston https://uh.edu [Online] https://uh.edu/uh-energy/ev-webinar-series/content/electric-hybrid-vehicles-raja-presentation.pdf

[5] Christ, J. (2021, julio 30). *Webinar on electric and hybrid vehicles*. Proceedings of the IEEE. https://proceedingsoftheieee.ieee.org/webinar-on-electric-and-hybrid-vehicles/

[6] Hybrid electric vehicles. (s/f). Energy.gov. Recuperado el 8 de diciembre de 2022, de https://afdc.energy.gov/vehicles/electric_basics_he