

3.1. Electrical vehicles and hybrids:- classification and how it works:-

Different types of hybrid electric vehicle can need different type of batteries and in order to understand it and to attribute a certain kind of batteries to an appropriate kind of vehicle. For this we first have to mention all possible type of hybrid electric vehicles. We know that there is a great advantage of electric motor over internal combustion engine. The electric motor allows reversible energy transfer.

When we talk about internal combustion engines, it burns the fuel, transfers it into the heat and further into the movement, but it cannot convert kinetic energy of movement back to the chemical energy of fuel.

But when we talk about electric motor, the situation is much more sustainable, because the electric motor can transfer electric energy, ~~and~~ stored in the battery into kinetic energy of rotating wheel and back, kinetic energy of a rotating wheel transforms into the electrical energy.

In an electric motor a coil or a circuit placed in an external magnetic field. In driving mode, if we will apply a voltage to such coil, we will start a current flow in the wire and a current flow, placed in magnetic field, result in some force, acting on the wire, and this acting force result in coil rotation. It is a kind of driving mode when we apply voltage and motor start to rotate the wheel. In generation mode, we use the same motor

the same coil, which is placed in the same external magnetic field, but, when we rotate the coil, the magnetic flux through the coil is changing. For example, when coil is perpendicular to the direction of an external magnetic field, the flux through the coil is maximum. But when we start to rotate the wheel, the flux is decreasing i.e. when it is perpendicular, we have the maximum force. When we ~~to~~ turn the coil a little bit, the force will decrease. ~~to~~

According to electromagnetic law, the change of flux through the coil results in current flow.

So the same device, the same electric motor can be used as for transforming electrical energy into the movement, and from the movement back to the electrical energy. It is the great advantage of any electric vehicle and hybrid electric vehicle and this features with regenerative braking is use in all hybrid electric vehicles.

The regenerative braking is ~~usually~~ used for decades at railways for locomotive and so on. The regenerative braking can slow down the car to some low-speed and after that we have to additionally use conventional friction brakes. As friction brakes are used at low speeds only, it increases the lifespan of friction brakes very much and decreases the cost of brakes and the technical work for changing the brakes but also it results in increased safety, because during the (brakes) wearing the braking distance is increasing.

The hybrid vehicle is that, this vehicle utilizes

two types of propulsion i.e. by conventional internal combustion engine and by electric motor. But the question is that what fraction of these two propulsion are used in this every car. In one car the dominant proportion is internal combustion engine, in another one electric motor is dominant.

So, let's start from the bottom, i.e. pure gasoline car. It use only one propulsion i.e. internal combustion engine. mild hybrid cars do use electric propulsion, but uses in rather negligible. It is adding a little bit of more torque i.e. it helps to utilize kinetic energy into the electric one and store it in the battery.

In full hybrid cars, two propulsion systems can be use independently, i.e. we can drive as using internal combustion engine and also using electric motor only.

The plug-in hybrid electric vehicles are just the same as full hybrid or conventional hybrid electric vehicle but with the ability to charge your battery from the wall, from the grid.

Another car i.e. parallel hybrid means that both propulsion systems are equal, we can use them separately or together. For example, we can use internal combustion engine for rotating the wheels on the front axle and use electric motor for rotating the wheels on the rear axle.

In Series hybrid vehicle, we are dominating the electric propulsion or more correctly to say that we have only electric propulsion but we can use internal combustion engine as a source of generated electrical energy for on board electric energy generation.

This kind of a series hybrids are called range-extended electric vehicles or extended-range electrical vehicles. But the key features of the series or range extended vehicles use the electric propulsion with some additional help of the internal combustion engine.

Another type of car is fuel cell car. It is just the same car as a series hybrid, but we use no internal combustion engine for on board electric energy generation. In this case we use electrochemical reactions just to get electricity.

The final destination is a pure electric car, or a battery electric vehicle or zero-emission vehicle.

If we will place all two types of vehicles in the row or column and from the bottom part is the internal combustion engine and the top part is an electric vehicle.

The difference of these hybrids is as follows.

In internal combustion engine car or conventional gasoline car, it utilize only one type of propulsion and so called micro hybrids. This micro hybrids are called hybrids just because they have a little bit bigger battery and this bigger battery allow us to start engine not only on the beginning of our trip, but many times during the trip because one of the ways to improve the fuel efficiency is to utilize so called start/stop system.

The next type is mild hybrid with bigger battery. Full hybrid with even more bigger battery and the difference between mild hybrid and full

hybrid usually in the size of the battery. Even more bit bigger battery is for parallel plug-in electric vehicle. The important thing is that different type of hybrids can utilize the different types of batteries.