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Electricity Regeneration Redefined

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Abstract: ***This paper provides an insight to the regeneration of energy in electric vehicles and additionally in the later part we have talked about how regeneration can be done from industries, looking forward towards smart grid systems.***

Keywords: alternators, less reliability on grid,power efficiency, car batteries, smart grid

1. Introduction

These days climate change is the main issue all the countries are facing carbon emission has gone up by an unprecedented rate many organisations are coming up in protection of the environment many are designing their own concepts on how to move towards a renewable carbon free and less harmful ways tocarry forward the world at the same pace.

Electrical vehicles are one of the major processes by which we are trying to control the major part of carbon emissions which occurs through day to day commute. though electric vehicles are not yet so popular in the market because of their high cost and comparably low efficiency the highest model of Tesla provides only 480kms of millage in one average charge cycleand as the weight of the vehicle increases the efficiency exponentially decreases and as we know with this efficiency and the price to be paid for this we cannot target the masses in the market there is a significant percentage of buyers In the market who cannot afford this cost margins besides if we somehow achieve the targeted market then with this efficiency we will be needing numerous number of charging stations to power those units. Powering these units is the main challenge we will be facing in this mission towards a carbon free environment. If we still rely on the conventional methods of power generation then there is no point of designing these expensive electrical vehicles this will act opposite because the power plants also doesn't work in more then 50-60% efficiency. That means it will be a total disaster if we design electric vehicles and still rely on the conventional ways to power these vehicles, the direct will be indirect just nothing more. Solar power is also an option in powering these but the situation gets much worse here too,most solar panels are between 15% and 20% efficient, with outliers on either side of the range. High-quality solar panels can exceed 22% efficiency in some cases (and almost reach 23%), but the majority of photovoltaic panels available are not above 20% efficient. That means we will need to put up a large investment to fulfil our energy need in both our homes and for our transportation systems which will be too heavy and time consuming for us after all.

Besides when we will put the vehicles on charge we will be increasing the load on the electric grid. Imagine in a country like India how many cars will be charging at a time throughout the country the surplus power needs to be fulfilled by some means.

One more thing is the time wasted in charging stations the time required to charge one unit and the long queue waiting behind waiting for their turn it will be pretty hectic. Every time it's not feasible to charge vehicles at our home outlets besides if we use our home outlets more often at a time the peak demand may go uncontrollably high at times. Our grids are not that upgraded to hold the power requirements. Talking about electricity usage, there are two different parameters that are important. Energy and power.

Energy: This is energy put into the battery to later drive the car. It's usually expressed in kWh. A kWh is 1,000 watts, used for 1 hour. So, 10 light bulbs, each 100 watts, on for 1 hour, would use 1 kWh.

The important thing about the energy needed for an electric car is that it has almost nothing to do with the size of the battery. The energy needed to charge an electric car depends on the miles driven and heating or cooling needs. Most electric cars get between 3 and 4 miles per kWh. Drive 60 miles, and your electric car will probably require between 15–20 kWh to recharge.

Power. Power measures how fast the energy is delivered. If you need 20 kWh, that can be 20 kW for 1 hour, 10 kW for 2 hours, or 1 kW for 20 hours.

A standard 120V/15A outlet in the U.S. will provide about 1.4 kW, so it would take about 14 hours to recharge 20 kWh. A 240V/30A circuit is 5.7 kW, so it would only take 3.5 hours.

Most people only drive about 30 miles per day, so would only need about 10 kWh, making all the times about half what I calculated above. You can calculate for your situation.
Either way, whether using high power for a shorter time, or lower power for a longer time, the energy is the same and determined by the miles you drove.

But the time consumed in charging still remains higher than the time consumed in gas filling.

Note: *(Some might know that Watts = Volts * Amps and wonder why my power calculation for 120V and 15A was 1400 watts instead of 1800 watts. Sustained current draw on a circuit isn't supposed to be more than 80% of its rated load. Since electric cars are a sustained load, they make sure to follow that restriction. All the calculations have that taken into account.)*

2. Methodology Section

The existing problems have been enumerated andall of us are equally trying to find solutions to all these problems. Our desires to overcome these challenges have helped us to come up with reasonably good number of solutions some of them include using energy under braking, using waste heat energy, additional supply by solar cells,improved mechanical energy transmission system, improved cars shell design, new generation of power convertors,special design of electric engines etc. but all these options have their own limitations, somewhere in terms of efficiency and somewhere in terms of cost. Increasing the efficiency demands for increase in cost so both are inter related.

But what we are trying to discuss here is a little bit different than all these.This is an existing technology clubbed together with the electrical vehicle concept which can not only increase the efficiency of the vehicle but also can eradicate the dependence on power grid for charging system, it is comparatively cost effective and is as reliable as any other existing super-efficient technology available in the market.
In this method the vehicle can use its own battery power to run and recharge itself and can store its generated power for further use and can repeat the cycle. This system can be used for solo electrically operated vehicles or can be used for the hybrid gas and electrically operated vehicles. There will be no (or comparatively less) load on the power grid for recharging of the vehicles and there will be no extra carbon emission for electrical vehicles so the carbon footprint remains unaltered besides we also can have option for recharging with the grid power in worst case scenarios. So all the options goes hand in hand. Besides by using this method we don't have to think about the time of operation of the vehicle under one charge, as long as the batteries remain intact the unit will operate smoothly. It can be used for vehicles starting from an E-scooter to a cargo carrying E-truck. All we have to worry about will be the battery life and the number of charge cycles a battery can hold. Though this problem is also not a major one for now, as many such researchers have come up with different options to design a more reliable efficient battery. This paper doesn't concern about the battery& charge storing part,and other devices used to increase the efficiency of charging either. But this paper mostly focuses on the charging method part and no dependence or relatively less dependence on the grid for power input. It discusses on the advantages of self-power generation and how it can reduce the carbon footprints globally when each nation starts using this method for manufacturing E-vehicles.

3. Findings

To start with, now a days we are familiar with the term caller regenerative braking used for recharging purpose when the vehicle is in braking mode. This results in charging for a very limited amount of time, only when the brakes are applied. While driving on an open road we drive free and brakes are applied rarely and while driving in a busy road we don't speed enough to apply brakes for a longer amount of time for stopping the vehicle, for which our regenerative braking process is not enough to recharge the battery for longer durations. So we face problems like lack of charge in the battery and we have to run for charging stations. What we can otherwise do is to reverse the regenerative process and do it while the vehicle is in running mode.

We are quite familiar with dynamos and alternators. The dynamo and alternator are two very similar devices that have the same function; to produce electric power via a rotating mechanical input. Both dynamos and alternators use the same concept of electromagnetic fields to produce power. The main difference between dynamos and alternator is the type of current they produce. Dynamos produce a direct current (DC) that flows in the same direction. In comparison, alternators produce an alternating current (AC), which constantly changes directions.The part that allows the dynamo to produce direct current is the commutator; at its simplest, it is basically a fixed switch which connects and disconnects as the shaft rotates due to mechanical input. The commutator constantly changes the polarity of the output current so that the output is always of the same polarity. Without a commutator, a dynamo would simply produce alternating current (AC) just like an alternator. The commutator here adds a point of possible failure, which lowers the reliability of the device. Even more so since the commutator contacts are constantly moving they may ware down quite quickly due to friction.But Direct current (DC) is desirable because most of the equipment's used inside an electrical vehicleuses directcurrent (DC) to function. Anything with semiconductors, which includes pretty much all appliances and gadgets inside an EV, require direct current (DC). Existing systems use the alternating current (AC)which is taken from the grid to the charging portswhich is then easily converted to DC by rectification using solid state devices. As the alternators are better than dynamos because of wear and tear due to friction, simple alternators can be clubbed to the shafts rotating the wheels. The shaft attached to the wheelcan rotate the alternator to produce alternating current (AC) the produced AC can be later rectified using solid state devices present along the charging system; quite similarly as it does after taking the power from the charging ports in charging stations.

What we have to do is we have to use two batteries instead of one with same power output same efficiency and everything; one will be used as a main battery and another will be used as an auxiliary one which will be kept on standby and will be continuously charging as the vehicle moves. With the help of the main battery the EV will do its ongoing operations like commuting lighting and cooling; the auxiliary battery on the other hand will be kept for charging with help of the various options available to us, like charging form the wheels through alternator, applying solar PV's over the roof and body etc.; but as the solar PVs are less efficient we can rely on the alternators only it will be cost effective, for higher price ranges we can add the solar PVs also. The four wheels can be connected with four alternators irrespective of four wheel or two wheel drive options, because we just need the rotating mechanical input from each one of the wheels.The alternators that are used for extracting current from the moving wheels will be producing an alternating current (AC) that can be later converted to direct current (DC) by using solid state drives. The operating systems will also keep an eye on the level of charge in both

the batteries; and save them from overcharging or undercharging as it does presently for a single battery. This system can not only save our time wasted in charging stations but also can help in extracting greater efficiency from the vehicle itself as we are taking care of the wasted energy from the wheels; the moving wheels are a great source of rotating mechanical input required for the rotation of the alternator. We could have used a dynamo also in place of an alternator but due to energy lost in commutation this will not be that efficient. Besides commutation produces sparking also which is highly undesirable if we are driving a hybrid option. Instead solid state drives are used to convert the energy from AC to DC with greater efficiency approx. 80 to 85%. Solid state drives have greater life expectancy then dynamos for obvious reasons. When our main battery is out of charge we can switch over to the auxiliary battery for operation and vice versa.

4. Discussion/Results

The process of extracting electric power from the wheels using alternators can produce electricity for longer durations. It is a reliable source of energy. But the question comes that with varying speed of the vehicle, at a time the generated electricity won't be same all throughout. For faster speeds the current produced will be higher and for slower speed the current produced will be lower. This can affect the battery life because the battery needs a constant supply of power for recharging. This problem can be solved by using various kinds of gears stabilizers and various solid state devices.

There are many types of gears such as spur gears, helical gears, bevel gears, worm gears, gear rack, etc. through which we can link the shaft of the front and back wheels with the alternator shaft. For the speed managing technique we can simply use the gear system used in an automatic transmission system. In an auto car, the gears automatically shift from 'park' or 'idle' to first and then gradually up to the fifth depending on the speed of the vehicle. Shifting to low gear in an automatic transmission means the car will stay in the first gear despite the engine being shifted to a higher gear. It is necessary to accurately understand the differences among gear types to accomplish necessary force transmission in mechanical designs of such systems (for which a link of the automatic transmission system is attached in the reference part). We can use the automatic transmission system for balancing the speed of alternator shaft rotation in different speed situations. The driver sitting inside the vehicle will have to shift gears not for speeding up or down, but for balanced charging purpose. Speed indicators are to be installed with respect to the number of gears used, indicating the fact that at what speed which gear is to be used.

Coming to the facts, fora vehicle moving at 70 miles per hour we use the formula: revolutions per minute = speed in meters per minute / circumference in meters. Following the example, the number of revolutions per minute is equal to: 1,877 / 1.89 = 993 revolutions per minute. 1000 RPM (approx.) as the speed varies the RPM also varies resulting in different output current and voltages at a time for which we can use a stabilizer circuit which can control the charging output current and voltages. These days we have large range voltage stabilizers which can stabilize voltages ranging from 50 to 300 volts. Thus varying speed of the car won't be a factor on the charging of the car. Also by now we will be having various sources of power like the solar panels and the alternators by clubbing these two sources we can generate the desired output required to charge our auxiliary battery. We don't need to invest on things like fast charging because we can charge our vehicles all the time as long as it is in running condition when in stand still we can use our home outlets for longer duration charging, thus decreasing the load on the charging stations and grids, because fast charging demands a higher rate of power. This alternators can solve number of problems at a time.

5. Conclusion

It's a high time for our generation to take active part in saving the mother earth and make a suitable room for our future generations. This can only be done by decreasing the amount of destruction and garbage that we are putting into our life saving elements. The one among the all aspects by which we can accomplish our goal is through the use of renewable energy. Renewable energy not only helps us in extracting energy from the already given sources but also makes us learn the process of waste management. Waste management is a greater lesson we need to learn in order to survive peacefully in the coming decades. We produce an ample amount of waste daily in matter of energy litter and other aspects. This wastes are hampering our given sources of energy and prosperity in a very negative way. These days pollution levels are much higher than what is expected controllable.

This paper mainly focuses on the redesigning ofelectrical vehicles and using the wasted energy in a more productive way. This way we can reproduce energy from the very basic things which we are missing out till now. This model of new generation electrical vehicles gives us power for longer durations of operations with a higher efficiency. Vehicles which require higher amount of power to run can also use this technique to reproduce their unused energy and rely on the sustainable sources. This paper suggest the use of alternators with the shaft of the wheels driving the car. We can design the process using four alternators for each wheels or we can just use two alternators for just the front and the back shaft of the car. If it feels like that the alternators are making the system bulky we can also use a single alternator with the main motor driving the car. Single alternator with the car main motor will also not require a gear system for operation.These days questions comes up like alternators will take much energy out of the car to rotate itself, but an alternator which can provide with energy without disturbing the torque required to move the vehicle is much more desired in this case, because a small amount of energy can also bring much helpful results. In this case we can use four or five alternators without hesitating (four for the wheels and one for the main motor), we can club the energy collected from the different alternators and use it for the single purpose. Besides we can use alternators with transformers, alternators will do the job of extracting the power and the transformer will step-up the power extracted from the alternator and then it can be converted to desired DC output. When we have a reliable source of extraction we can use

bigger motors to drive the vehicles. The number of kilometres that can be driven on one charge may fall alittle, but the auxiliary battery system can make the car self-reliable thus it has to remain less dependent on the grid and more dependent on itself only.

Alternators not only can solve the energy demands in electrical vehicles but alternators can also solve various other problems, for instance if the industrial heavy duty motors are connected with alternators then they can reduce the electricity cost to the industry required for lighting purposes. The alternators clubbed with farm machineries can not only save power but also can send back power to the grid making every one of us a contributor to the grid power bringing us more closer to our aim towards smart grid systems. There are free operating motors everywhere, YES the alternators can take up a little power but the advantage here is we can extract power which is otherwise wasted anyway. In worst cases we can use a heavier motor for the general operation and club an alternator to it, For example if earlier we were using a 50hp motor for a certain operation and the whole energy gets wasted with the operation, in that place we can use a 55hp motor and run an alternator clubbed along with it to extract some amount of energy from it. Or else the 50hp motor can also be clubbed with a comparatively smaller alternator which nowhere changes the operating speed of the motor but produces a certain amount of energy which can be sent back to the grid which makes everyone a contributor in the grid supply. A small contribution from each one of us can also make a large impact.

References

[1] https://www.quora.com/How-much-electricity-does-it-take-to-charge-an-electric-car
[2] http://www.differencebetween.net/business/structure-systems/difference-between-dynamo-and-alternator/
[3] https://khkgears.net/new/gear_knowledge/introduction_to_gears/types_of_gears.html
[4] https://www.youtube.com/watch?v=u_y1S8C0Hmc
[5] https://bestengineeringprojects.com/automatic-voltage-stabiliser-circuit/
[6] https://cleantechnica.com/2012/07/05/how-to-charge-your-electric-car-electric-vehicle-charging/
[7] https://sciencing.com/calculate-wheel-speed-7448165.html
[8] https://www.engineeringtoolbox.com/ev-electrical-vehicle--charging-power-voltage-amps-ac-dc-d_2110.html