DESIGN PROPOSAL OF THE ENERGY INSTALLATION SYSTEM FOR VEHICLE’S WIND TURBINE

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Abstract. New inventions is relating to the idea of mounting a wind turbine for power generating system in vehicles. This study will investigate on the existing energy conversion and storage systems used in standard vehicle’s power system. This study involves with a proposed design of a vehicle’s wind turbine system. The energy that has been generated by wind turbine will be stored in the 12 volt battery and will then, be distributed to the entire vehicle for the use of the vehicle components. The optimal design for energy conversion system is created based on the review of the existing energy conversion and storage systems which are used in vehicle’s power system. A simulation study using NI Multisim (National Instrument Software) is conducted on the energy conversion and storage system that. The objectives of this study are to convert a mechanical energy from the blade to electrical energy to generate 12V voltage and to store it in a 12 volt battery. The 12V battery voltage will then be supplied to a high voltage system, up to 200V voltage capacity. From the analysis that has been done, the energy from a turbine has the potential to generate power to car system. The wind energy is possible to integrate with other existing and renewable energy. At this stage, the energy gained does not replace the existing one but it can be considered as a new energy source in the future energy development

1. Introduction
A wind turbine is a device that converts kinetic energy from the wind, also called wind energy, into mechanical energy; a process known as wind power. [1]. A wind turbine is used to produce electrical power. The device may be called a wind turbine or wind power plant. If the mechanical energy is used to drive machinery, such as for grinding grain or pumping water, the
device is called a windmill or wind pump. Similarly, it may refer to as a wind charger when used for charging batteries [2].

Many research and studies have been done in order to invent more applicable wind turbine to obtain power generating system. Most of the studies focus on harvesting natural energy such as wind to be supplied to the living hood. New inventions and researches have been done lately relating to the idea of mounting a wind turbine for power generating system in vehicles [3-7].

The main concept will remain but some modifications will be made to suit the usages in vehicle. Thus, an optimized storage system for the power generating will be proposed. This study investigates the existing energy conversion and storage systems used in standard vehicle’s power system. Then, a design proposal of a new energy conversion and storage system with turbine system will be fabricate so that a performance test of the proposed conversion and installation systems can be conducted. The new design of energy conversion system for vehicles will be enhanced by adding wind turbine as the alternative source of electrical power. The wind turbine which has been developed and fabricated will be attached to the vehicle at the appropriate location. The location to place the turbine is based on the Sofian et al. studies[1].

An invention title “Wind-powered Battery Charging System” by Pena [2] relates generally to an electrically powered vehicle and more particularly to a system for charging batteries which utilizes a wind-operated turbine and generator for charging the batteries while the vehicle is in motion and a flywheel for charging the batteries when the vehicle slows down or is stopped. Kousoulis [8] then come out with his invention title “Motor Vehicle with Wind Generator Device”. The general idea of the invention is to incorporate the wind turbine for production of electricity using the wind speed created by vehicles. The electricity generated can be connected to vehicle power accessories and to batteries so to charge them and eliminate the drainage on a main vehicle battery.

Jamal A. Baroudi [9] provides a comprehensive review on detailed electrical component used for the generators. All his control methods described, attempt to obtain maximum energy transfer from the wind turbine to the grid. There is a continuing effort to make converter and control schemes more efficient and cost effective in hopes of an economically viable solution to increasing environmental issues.

2. Methodology

To perform this study, an investigation on the existing energy conversion and electrical storage systems used in vehicle’s power system has been done. The new electrical circuit design of energy conversion with the storage system will then be proposed. The analysis on the electrical design system is carried out using electrical software analysis, NI Multisim (National Instrument Software) in order to obtain the optimum design of energy conversion and storage systems for vehicle’s wind turbine.

Figure 1 shows the system flow block diagram for the energy installation system proposed to be installed to the vehicle’s wind turbine.
The important part in this study is to obtain the correct wiring circuit of the design conversion and storage system on vehicle. The system is enhanced by connecting it to the wind turbine as its source of power. Some adjustments were done to the electrical circuit to optimize the energy conversion and storage system on vehicle. Few cases of study were done to study the effect of different electrical circuit.

(1) The first optimization done was the system with turbine is attached to a converter which functions to boost up the power generated by the generator. This is important if the power generates from wind turbine is less than expected compared to the system.

(2) The second optimization done to the system was adding the electrical circuit with a series of battery. The series of battery is important in order to maintain the power after flow out from the battery.

(3) The next optimization implemented was to use three generators attached to wind turbine without converter as a booster. This is to obtain more power generated by the turbine to be supplied to the system.

Figure 1. System flow block diagram
(4) Then the electrical circuit was attached to wind turbine with 3 generators and a series of battery.

(5) The final optimization made was to enhance the electrical circuit on a vehicle attached to wind turbine with 3 generators and a series of battery together with the converter. The design for electrical circuit on a vehicle attached to wind turbine with turbo boost, 3 generators and a series of battery.

To assemble the rectifier circuit, the components involved are capacitor, diode and resistor. Capacitor acts to stores the waste energy from the voltage while diode protects the circuit from voltage surges and the resistor acts as the resistance. Table 1 shows the components in rectifier circuit.

| No. | Component | Type       | Quantity |
|-----|-----------|------------|----------|
| 1   | Capacitor | 470μF/25   | 1        |
|     |           | 0.1μF      | 2        |
| 2   | Diode     | 1N4007     | 4        |
| 3   | Resistor  | 4.7k       | 1        |

To assemble the regulator circuit, the components involved are capacitor, diode and semiconductor in plus transformer which act as conductor. Table 2 shows the components in regulator circuit.

| No. | Component | Type       | Quantity |
|-----|-----------|------------|----------|
| 1   | Capacitor | 4M7/35v    | 1        |
|     |           | 100n       | 3        |
|     |           | 100μ/35v   | 1        |
| 2   | Diode     | 1N4007     | 4        |
| 3   | Semiconductor | 2N3005  | 1        |
|     |           | 7812       | 1        |

To assemble the inverter circuit, the components involved are capacitor, resistor, potentiometer, miscellaneous and semiconductor. The potentiometer acts as measurement ammeter and miscellaneous (loads). Table 3 shows the components in inverter.

Assembling electronic circuit needs to be done cautiously as the entire electronic component is highly sensitive especially when it involves heat. One of the processes involved in assembling electronic circuit is soldering. The process must be done cautiously to make sure that the solder does not leak to the other side. If that happens, the circuit will not be working properly. Figure 2 shows the overall electronic system for this study.
Table 3. List of components in inverter circuit

| No. | Component  | Type         | Quantity |
|-----|------------|--------------|----------|
| 1   | Capacitor  | 330nF        | 1        |
|     |            | 1000μF/25V   | 1        |
| 2   | Semiconductor | MJ3001     | 2        |
|     |            | 555          | 1        |
|     |            | 4013         | 1        |
| 3   | Resistor   | 18k          | 1        |
|     |            | 3.3k         | 1        |
|     |            | 1k           | 3        |
| 4   | Potentiometer | 100k      | 1        |
| 5   | Miscellaneous | Fuse 5A    | 1        |
|     |            | Neon light   | 1        |

Figure 2. Electronic system of the vehicle’s wind turbine energy conversion

The proposed design is simulated in the analysis software, NI Multisim (National Instrument Software) to obtain the output result. Based on the input generated from turbine for the actual value and the data will be used to generate the output based on the design that has been made.

3. Analysis, Results And Discussion

The battery voltage capacity for a hybrid vehicle varies depends on the use of that vehicle itself. Most battery capacity range for battery pack for Honda vehicle is about 140V to 160V as mentioned in IMA system and up to 650 V for Toyota vehicle [6]. And yet, they are still using the standard 12 volt battery as the ignition and the use of the loads.

The objectives of this study are to convert a mechanical energy from the blade to electrical energy to generate 12V voltage and to store it in a 12 volt battery. The 12V battery voltage will then be supplied to a high voltage system, up to 200V voltage capacity. The specification of power generator is set at 12 volt for the voltage and 55Amp for the current and 50Hz for the frequency. The speed rotation for this generator is 1320 rpm for the minimum
cut in and up to 2700 rpm for the maximum speed. The real energy obtained by generator will be determined by the speed of turbine. Once the speed of turbine remains constant and achieves minimum requirement of generator speed, full voltage for the output should be obtained. The other hypotheses made such as using a series generator to obtain higher voltage and adding the booster into the circuit design to obtain higher voltage are true based on the analysis but not practical for the usage.

**NI Multisim analysis result**
The result obtained for this section will be on electrical circuit analysis using NI Multisim (National Instrument Software) and the actual testing on the system. This analysis software is a simulation on input and output of the energy obtained. There are a few factors that must be considered while performing this analysis which are fixing the capacity of the battery pack that we want to use, making an assumption on the power generated by the generator and also the electrical load of a vehicle. In this analysis, the voltages to be gained are both 12 volt and 200 volt.

The rectifier circuit analysis is to simulate the output voltage from 12 volt AC alternator. The analysis shows that the output voltage is about 15.49 volt. Theoretically, the DC voltage at the output is 15.49 volt and needs to be amended so that the required voltage can be generated.

From the analysis on regulator it can be concluded that, the analysis achieves the hypothesis that the system will be regulated the voltage at 12 volt. The data from the analysis result, 12 volt supply voltage gives 11.24 volt output voltage while for 6 volt supply voltage gives 5.26 volt output voltage and 24 volt supply voltage gives 12.45 volt as the output. Based on the result, all the voltage exceeds 12 volt will be regulated to 12 volt so that it will not harm the device.

**Existing energy conversion and storage system on vehicle**
Using NI Multisim (National Instrument Software) the input voltage to be supplied for 12V battery generated by an alternator is 9.072V. The generated voltage obtained is the peak voltage supply on the system. The $V_{rms}$ value can be calculated using the formula $V = V_{rms} \times 2^{1/2}$. Here
from the calculation we get \( V_{rms} \) equals to 6.414 volt. Figure 4 shows the simulation circuit and the result obtained for standard vehicle.

Based on the analysis that was done it can be concluded that the battery charging for a standard vehicle is about 6 to 9 volts based on peak voltage and the simulation voltage. It is a little bit lower compared to the capacity of the battery. Even though the charging voltage is lower than battery capacity, it does not affect the system because the battery is used for the starting and some specified components and not for continuous usage.

**Basic electrical circuit on a vehicle attached to wind turbine**

A simulation on electrical circuit attached to wind turbine uses a 24V generator in order to obtain higher voltage for the battery pack been performed. This simulation assumes that turbine will meet the minimum requirement speed to generate enough power for storage. From the simulation the output voltage generated is about 18.062V compare to calculate value using the same formula in previous calculation, the value for \( V_{rms} \) is 12.77V. Figure 5 shows the simulation circuit and the result obtained for a circuit design attached to wind turbine.
Figure 5. Simulation circuit and the result obtained for a circuit design attached to wind turbine and one generator.

From the analysis, it shows that the voltage generated is 18.062V. This result is obtained based on the 24 volt alternator with fullest cycle rotation. Here it can be concluded that voltage will decrease when 12 volt alternator is used. The voltage of the battery pack for the charging is 12 volt as mentioned before. So, there must have been some modifications on the circuit to filter and obtain the required value.

**Electrical circuit on a vehicle attached to wind turbine, 3 generators and a battery.**

The next trial for the circuit analysis was another two alternators were added to the system in order to increase the voltage. From the simulation the output voltage produced by 3 alternators in series is 30.404. The calculation for $V_{rms}$ value gives 21.5 volt. Figure 6 shows the simulation circuit and the result obtained for a circuit design attached to 3 wind turbine. In order to directly supply for high voltage battery pack which was discuss is also does not achieve.

Figure 6. Simulation circuit and the result obtained for a circuit design attach to wind turbine and three generators.
From the analysis, it shows that the voltage generated is only 30.404V. The voltage value increases compared to previous simulation using one generator but still does not meet the requirement of high battery pack which is 200V as mentioned before. However, the voltage is enough to charge the 12DC battery. Somehow the use of three generators simultaneously is not practical. It needs a lot of space and has a complicated connection. So another modification must be made on the circuit to obtain the required voltage.

4. Conclusions

From the analysis that has been done, the energy from a turbine has the potential to generate power to car system. The wind energy is possible to integrate with other existing and renewable energy. At this stage, the energy gained does not replace the existing one but it can be considered as a new energy source in the future energy development. In a hybrid system, the wind turbine can be an alternative for electrical source but not to replace the petrol engine. Wind turbine can minimize the usage of power generation from the engine as a source of electricity in hybrid system. The combination of wind turbine and petrol engine becomes more efficient and provides continuous electricity to the vehicle all the time.

The electrical circuit for the energy installation system will influence the output power for the vehicle’s wind turbine. For the electronic circuit there is classified into three sections which are inverter circuit to step-up the voltage from Dc to Ac, rectifier circuit is to convert Ac to Dc and regulator stabilizer is to stabilize the flow of voltage to 12vdc. The regulator will regulate the overload source to the required source. This study has achieved its objectives in proposing the electrical circuit design for storing the energy harnessed by vehicle’s wind turbine.

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