Alternative for Renewable Energy

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Abstract

The importance of renewable energy resources has increased since the discussion on climate change has evolved from a lesser-known fact to a global issue. Heavy traffic across the globe has increased abruptly. Utilization of the energy generated by the interference of wheels of a moving vehicle and a speed breaker. A roller conveyor would serve as a part of the road that is embedded as a speed breaker. Millions of cars pass through the national highways if we are to implement the system or the project which is under consideration by means of the “Power generation by using the speed breakers”. The apparatus would consist of a roller conveyor attached to a full-fledged mechanical gear operational on the rack and pinion mechanism. The product design is assembled to acquire less space and provide more useful energy. The product design is feasible and can be implemented across the globe anywhere on the highways. The whole concept is based upon the electromechanical principles of physics mainly.

Keywords:

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Introduction:

The maintenance cost of the product is far less than any other energy generating system as interaction of two bodies with respect to either or both are required to be in motion produces some energy (Chan & Gasparyan, 2003). This energy can be utilized, and this idea makes it even more significant for our project. The highways and other routes for transportation of the traffic on land have the speed breakers installed inside them at certain points interaction of the vehicle and the speed breaker produce some of the frictional energy (Bornstein, 2012). This energy is lost due to the absence of a proper system for the utilization of the energy which is produced inside the
process. Now, we have such an idea which is both feasible and efficient in nature. The static energy produced in the process of interaction between the vehicle and the speed breaker is utilized by the product. There are the implications of “Faraday's law of electromagnetism”, along with the principles of Physics which are important for guiding each part of the design to operate. Calculations relating the operation of the project with its implementation are also done in detail. (Denholm et al., 2010)

Objectives:

The objective is to have an alternative source of electric power source from the specified sector. These days the climate and requirement for having a much sustainable mechanism requires us to have a much-needed innovation across the globe (Stuart, 1946). There are many other mechanisms like that of photovoltaic techniques and the hydropower techniques for the generation of the electric power. But having an abundance of static energy inside the environment makes us think twice while we demand more energy. The product design is set to be assembled in such a way that it will generate the required level of energy much efficiently without having any losses. (Boyle, 2004)

Significance:

The product design is assembled to acquire less space and provide more useful energy. The energy generated can be used for the utilization inside the various aspects to fully fill the global energy demands. The whole concept is based upon the electromechanical principles of physics mainly. As there are the electromagnetic laws (Stuart, 1946). The generator use also has its relevance inside the product design as the suppression of spring utilizes the net static energy and produces a deflection inside the system which provides the design an alternating current (AC).
Figure 1: The resources used for the generation of power. This current has a direct effect and is converted into the DC voltage with the help of a capacitor. While the energy is stored inside the lead-acid battery. (Lund, 2007)

The project carries its significance in the optimum level of its electric power generation. The project is eco-friendly and has zero emission of the carbon dioxide (CO2).

The product design is feasible and can be implemented across the globe anywhere on Background

The blueprint for the implementation of the project consists of having a rotating shaft that is fixed inside the design. The rotating shaft is then directly associated with the prime mover. It is obvious for the prime mover to rotate with the rotational motion of the rotator, as they are linked to each other through a firm point (Shenoy & Bothra, 2000). The phenomenon of electromagnetism plays a vital point here as the rotator has a unique design for which there is the presence of a stator that is wrapped up in a winding of the coil. Now, it's very logical to think of the generation of electromotive force (E.M.F), if there is a presence of the electromagnetic force of lines across the windings of the coil which is termed to be present inside the stator. (Maxim, 2014)

Fig. 2: Power generation by using the speed breaker.
**Experiment:**

**The rack and pinion mechanism:**

The install of the gears having different dimensions allows us to reach the speed for the rotation of the motor’s propellers for achieving a high amount of electric power. Although the gears at initial stage receive less amount of energy for operation of the system as whole. The gears of varying dimensions are meshed up or we can say connected to each other for achieving much power while the energy flows across these mechanical components (Oldfield, 1901).

The rotator when moved in this given setup is able to produce the electromotive force by means of the E.M.F. As, the electromotive force (E.M.F) produced will be able to provide more energy to the system as whole as the power will be in the range of 0.98-kilowatt power for each vehicle weighing around 1,000 Kg across the speed bump inside which the system is being installed. As, there is a bridge rectifier which operates for the regulation of the electric power being produced by the system as whole. The function of the bridge rectifier is mainly to convert the generated alternative current (A.C) to the direct current (D.C). (Denholm et al., 2010)

**The use of Spur gear:**

As the type of gear being used inside the product design is the simplest of all gears which is also known as the Spur gear. Spur gears are composed of different parts but the significance of a cylinder or disk with teeth’s projecting radially, as the structure of the teeth are not that straight rather the edge of each tooth is very straight in nature. While the spur gear’s teeth are aligned parallel to the rotational motion of the axis. These types of gears are much significant in their own domain by having relevance in terms of being assembled to the parallel shafts.
Components inside the product design:

We have the following sequence for our product design, which are as follows:

- The rack and pinion.
- Having a pair of bearings.
- Installation of the spur gear.
- The D.C Generator.
- We have the Shaft.
- The spring system.

Conclusion:

The rack and pinion:

we have the rack and pinion which enhances the system’s capabilities to convert the translatory motion of the components into the rotatory motion.

Parameters for the module = Pitch Circle’s Diameter/ No. of teeth’s = 36/18 = 2 mm

Radius of the Pitch Circle (r) = 36/2 = 18 mm.

The Addendum(a) = 2 mm.

Circle Radius’s Addendum (ra) = r + A (addendum) = 18 + 2 = 20mm.

Angle of pinion in regards to pressure (Φ) = 14.5° involute.

Contact path’s length = (a/sin Φ) + {[ra^2 – (r sin Φ) ^2]} ^0.5 - r sin Φ = 13.29 mm.

Length of arc of contact = Length of path of contact / sin Φ = 13.75 mm.

Minimum number of teeth in contact = Length of arc of contact / πm = 2.

Target angle for pinion turning effect= Length of arc of contact x 360 / 2πra = 39.39°.

Rack’s minimum length= 2πra = 125.66 mm.

Having a pair of bearings:

As there is the presence of frictional forces, F(friction) inside the system’s design along with the different energy losses due to heat.

The inner Diameter = 15 mm.

Outer Diameter the bearing = 35 mm.

The width, W of the bearing = 8 mm.
Installation of the spur gear:

By having a perfect design for the installation and overall design of the spur gear we can omit a large amount of energy losses.

The outside diameter of the spur gear \( (D_o) = 155 \text{ mm} \).

Total number of teeth \( (N) = 76 \) in total.

For the Pitch Circle Diameter \( (D) = D_o / (1+2/N) = 155/ (1+2/76) = 151 \text{ mm} \).

The modules \( = D/N = 151/ 76 = 2 \text{ mm} \).

Gear target angle for applying the pressure \( (\Phi) = 14.5^\circ \).

The diametral Pitch \( (P) = N/D = 76/151 = 0.5 \text{ mm} \).

The addendum \( (a) = 1/P = 1/0.5 = 2 \text{ mm} \).

The dedendum \( (b) = 1.157/P = 1.157/0.5 = 2.31 \text{ mm} \).

The parameter for the tooth Thickness \( = 1.5708/ P = 1.5708 / 0.5 = 3.14 \text{ mm} \).

The total whole Depth \( = 2.157/P = 2.157/0.5 = 4.314 \text{ mm} \).

For the clearance \( = 0.157/ P = 0.157/0.5 = 0.314 \text{ mm} \).

The parameter center Distance \( = (N1 + N2)/ (2*P) = (76 + 18)/ (2* 0.5) = 94 \text{ mm} \).

Calculation for the design of the pinions

The outside Diameter \( (D_o) = 40 \text{ mm} \).

The No. of Teeth \( (N) = 18 \) total number.

Diameter \( (D) \) pitch Circle \( = D_o / (1+2/N) = 40/ (1+2/18) = 36 \text{ mm} \).

The module \( = D/N = 36/ 18 = 2 \text{ mm} \).

Angle for the pinion \( (\Phi) \) to apply the pressure \( = 14.5^\circ \).

Pitch’s diametral \( (P) = N/D = 18/36 = 0.5 \text{ mm} \).

The parameters addendum \( (a) = 1/P = 1/0.5 = 2 \text{ mm} \).

The parameters dedendum \( (b) = 1.157/P = 1.157/0.5 = 2.31 \text{ mm} \).

The tooth Thickness \( = 1.5708/ P = 1.5708 / 0.5 = 3.14 \text{ mm} \).

The whole Depth \( = 2.157/P = 2.157/0.5 = 4.314 \text{ mm} \).

For clearance of the system \( = 0.157/ P = 0.157/0.5 = 0.314 \text{ mm} \).

The center Distance \( = (N1 + N2)/ (2*P) = (76 + 18)/ (2* 0.5) = 94 \text{ mm} \).
Working Depth = 2/P = 2/0.5 = 4 mm.

Circle Diameter of the Addendum = D + 2m = 36 + 2(2) = 40 mm.

Circle Diameter of the Dedendum = D – 2.5m = 36 -2.5(2) = 31 mm.

**The operations of the shaft inside the system:**

For the product’s design we have to maintain a certain level of torsion and lateral rigidity for driving the system on its optimum level. The transmission of energy has to be made efficient by a proper alignment of the components inside the designs.

We will be using the torsion equation - \( T/J = \tau/ r \).

Where we have the following quantities, which are as follows:

- \( T \) – Torque Transmitted (N-mm)
- \( J \) – Polar Moment of Inertia (mm\(^4\))
- \( \tau \) - Shear stress (N/mm\(^2\))
- \( r \) – Radius of the shaft (mm)

\[
T/ (\pi d^4/32) = \tau/(d/2)
\]

Torque Transmitted (T) = (Force) x (Radius of shaft) = 150 x 9.81 x 19 = 27958.5N-mm.

\[
27958.5/ [\pi (19^4)/32] = \tau / (38/2)
\]

Shear stress (\( \tau \)) = 41.51 N/mm\(^2\)

**The Spring system inside the system’s design:**

The spring has to be compatible with the magnitude of force being applied on it due to the contact of the vehicle that drives through the specified point.

**The designs calculation for the spring system:**

The total length = 22.5 cm.

Parameter for the pitch = 11.3 mm

The length for the outer Diameter = 27.1 mm

The length for the Inner Diameter = 19.7 mm

The coil’s Diameter = 4 mm

Total number of Turns = 22 total.
The DC Generator:
The DC generator is implemented inside the system for having the conversion of the generated alternate current (AC) into direct current (DC) form. The D.C generator is characterized by having the lightweight aluminums construction and the type of magnets used – Rare earth magnet (Iron-Neodymium-Boron).

The D.C Generator Design calculations:
Magnets installed inside the design = 16 pairs.
The length of shaft = 240 mm
Total slots = 31 in number.
Number of coils – 2

Benefits:
There are a number of components, or the devices installed inside the system’s design for providing us with the optimum level of electric power. We will be using the rack and pinion mechanism for the operations of our product’s design. Along with the concept of the gear which has its own significance for avoiding the slipping of the component’s slippage during the different operations. The presence of the gears makes it able to provide an advantage for the mechanical operations, as there is just a minute difference between the turning effect (Torque) of the gears and its rotational motion of the gears of the system’s design. For the operations of the system we have selected the lead-actic battery as the power storage component which is able to save and provide the required output upon the standard requirements. As the power generated can be used for the powering up of the lights. Or it can also be used for providing some fraction of the electric power to the electronic devices being installed on the highway. (Min et al, 2005).

There are however some of the pros and cons of our product design which have been specified for making it more understood. These characteristics are as follows:

Future Scope and Implementation:
Cities and towns are improving across the globe. There are now smart cities which operate their various departments ice waste management systems, lighting system, water supply etc by implementation of the modern and comprehensive form of computerized system. There is the implementation of the IOT (internet of things), wireless communication and other technologies for operations in these modern towns. And having this product as an alternative to the power generation other than the presence of solar panels (PV modules) inside the smart cities will...
increase the overall efficiency of the region (Chan & Gasparyan, 2003). There are some smart cities and towns which face a high number of traffic each day, so having such a system which can generate 60 volts of electric power by interacting with a single vehicle can be able to produce thousands of watts of energy in just one day or so. As we have the following solutions for the high energy demands of the future, which are as follows:

- There can be a redesign of the product to make it compatible to deal with the heavy loaded vehicles on the road.
- Along, with which the alternative for having renewable energy is also presented as the solution for the future energy demands.

**The Mechanism of operation:**

The blueprint for the implementation of the project consists of having a rotating shaft that is fixed inside the design. The rotating shaft is then directly associated with the prime mover. It is obvious for the prime mover to rotate with the rotational motion of the rotator, as they are linked to each other through a firm point (James, 2007). The phenomenon of electromagnetism plays a vital point here as the rotator has a unique design for which there is the presence of a stator which is wrapped up in a winding of coil. Now, it's very logical to think of the generation of electromotive force (E.M.F), if there is a presence of the electromagnetic force of lines across the windings of the coil which is termed to be present inside the stator. (Maxim, 2014)

We know that by the law of electromagnetism, there will be a net generation of electromotive force (e.m.f) inside the subjected coil, so we get the power generated by the rotational motion of the rotator. As it will be there under the surface which is connected to the springs connected as support for the flexible operations (Oldfield, 1901). There is a proper circuitry system for regulating the electric power generation each time a vehicle passes the point of intersection by means of the speed breaker. (Min et al., 2005)

**Attachment A:** Risk Assessment Matrix

**Attachment B:** The product design sketches design of the power generation outline of the system.
References:


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