

Power Generation using Speed Surfs

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Abstract: *India's GDP is increasing day by day and in parallel the living standard of people have also increased which results in increase in power demand. People have been using various forms of energy to power up their daily requirements. Their insatiable thirst for power consumption has led to depletion of valuable natural resources. This extensive usage of energy has resulted in energy crisis, and there is a need to develop and utilize optimal methods which will not only ease the crisis but also preserve the environment. So we must head towards the unconventional methods to generate electricity.*

The idea of power generation using speed breakers were first seen in South Africa.[3] Here an elastic material is installed on the road in form of speed surfs. The weight of the vehicles when they cross it is converted into potential energy of the spring. This spring provides an oscillatory motion to the piston cylinder system. This oscillatory motion is converted into circular motion and energy is produced from this by using a generator. The main aim of this paper is design and development of a working model and the results are satisfied by fabricating the model. It uses a simple mechanism of energy conversion in day to day life. It reduces the stress on the conventional energy sources by providing alternative way to generate power. Also it would help to meet the growing demand for power.

Keywords: *Power Consumption, Unconventional Methods, Speed Surfs, Elastic material, Oscillatory motion*

1. Introduction: An innovative and useful concept of generating electricity from a speed surfs is our step to improve the situation of electricity demand.

The idea of generating electricity from speed breakers came to fruition with the problems that are being faced while generating electricity. Electricity has become the part and parcel of our lives. We depend on it for almost every task and in this digital age it is almost impossible to do any kind of work without it. Electricity is a secondary energy source that we get from the conversion of other sources of energy, like coal, natural gas, oil, nuclear power and other natural sources. Before electricity generation began over 100 years ago, houses were lit with kerosene lamps and rooms were warmed by wood-burning or coal-burning stoves[11]. Nikola Tesla pioneered the generation, transmission, and use of alternating current (AC) electricity, which helped to transmit power over greater distances. Tesla's inventions have helped us to light our homes and they helped in powering up industrial machines. [8]

Electricity generation was first developed in the 1800's using Faraday's dynamo generator. [4] Even after 200 years, we are still using the same basic principles to generate electricity, but only on a much larger scale. Producing electricity from a speed breaker is a new concept that is undergoing research [12]. India's total installed power capacity is nearly 20 per cent as that of China's total capacity though both countries have billion plus people. There is around 12 per cent power deficit in India in the peak hours. India has nearly 10 per cent of the coal reserves that are present in the world but without environmental clearances and other disputes production is hindered [13]. Fig no-1.1 shows the oil demand of the world. Coal fired power plants account for more than half of India's power generation. Oil and gas represent 38% of India's energy consumption.[3]

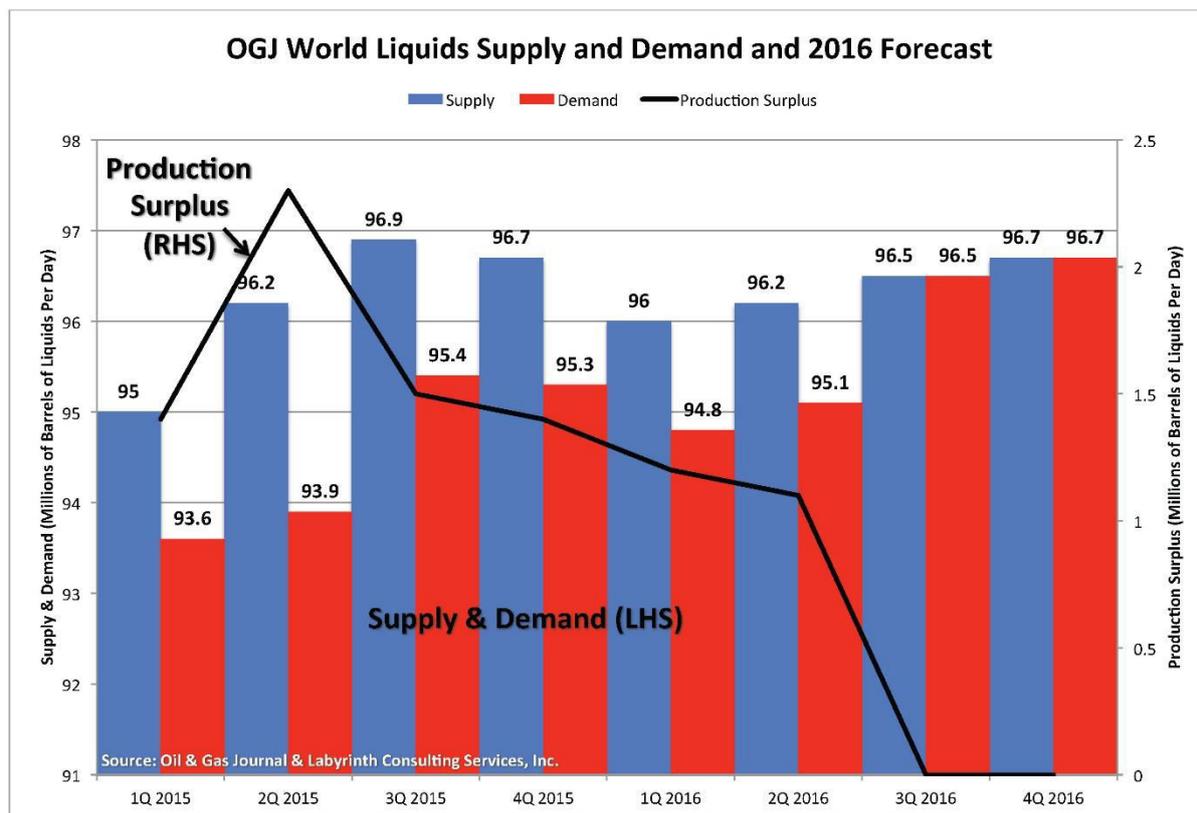


Fig. 1.1 Summary of Global Oil Demand

There are already existing systems using renewable energy such as solar, wind [2]. The latest technology which is used to generate the power by such renewable energy is the Speed Surf Mechanism. [14]

The number of vehicles on roads are increasing rapidly and if some of the potential energy of these vehicles is converted into the rotational motion of the generator, then a considerable amount of electricity can be produced and this is the main concept. [15] At present a shortage of electricity is being faced. Electricity can be generated using speed surfs. The idea is to generate electricity for the streetlights, hoardings and then for other uses [5]. Generally, when vehicle is in motion it produces various forms of energy. For example, due to friction between vehicle's wheel and road, heat energy is produced. [4] When vehicle is traveling at high speed, it strikes the wind and then heat energy is produced which is always lost in environment and which cannot be used. It can be concluded that all of this energy that can't be used and is being wasted and it is abundantly available around us [2]. Such energy can be used in order to generate electricity. The principle of "conversion of potential energy to electrical energy" is the main

idea here. [6] Potential energy can be thought of as energy stored within a physical system.

2. Theory: The speed breakers or humps apart from slowing down the vehicles can also be used for power generation [10]. The weight of the vehicles put on the speed surf can be used to our advantage for power production.

2.1 Principle: The basic principle behind the project is the conversion of energy from one form to another. The weight of the vehicle is converted to an oscillatory motion. This oscillatory motion is converted into rotatory motion and from this rotatory motion power is produced.

2.2 Principle of Operation: The mechanism of electricity generation using speed surfs is exhibited here. For applying this concept, an elastic speed surf is used instead of a rigid one. When a vehicle passes over a speed breaker the hump will compress because of its elasticity and it will elongate again because of the spring installed at the bottom. It will create a To-and-Fro motion. This To-and-Fro motion is converted to rotatory motion with the help of gears and levers. The gear is connected to a smaller gear so a single rotation of bigger gear will give multiple rotation of small

gear. The smaller gear is then connected to the generator.[Block Diagram 5.1]

3. Hardware Implementation: Many hardware elements have been used to generate power from the speed breakers. It consists of materials like shafts, generator, connecting rods, chain, spring and rechargeable battery. [3]

3.1 Gears: Two gears of different sizes are used in this project. Both the gears are used in the ratio of 3:1. The larger gear is connected to the smaller one using a chain drive.

3.2 Gear Shaft: The gear shaft is connected to the smaller gear to generate electricity using the generator.

3.3 Connecting Rod: The connecting rod is used to connect the piston to the larger gear. It helps in converting the translatory motion of the piston into rotatory motion.

3.4 Spring: The spring is used to convert the translatory motion of the piston into compressive force. The value of spring constant should be small

enough that it can be compressed easily but can withstand heavy loads. [8]

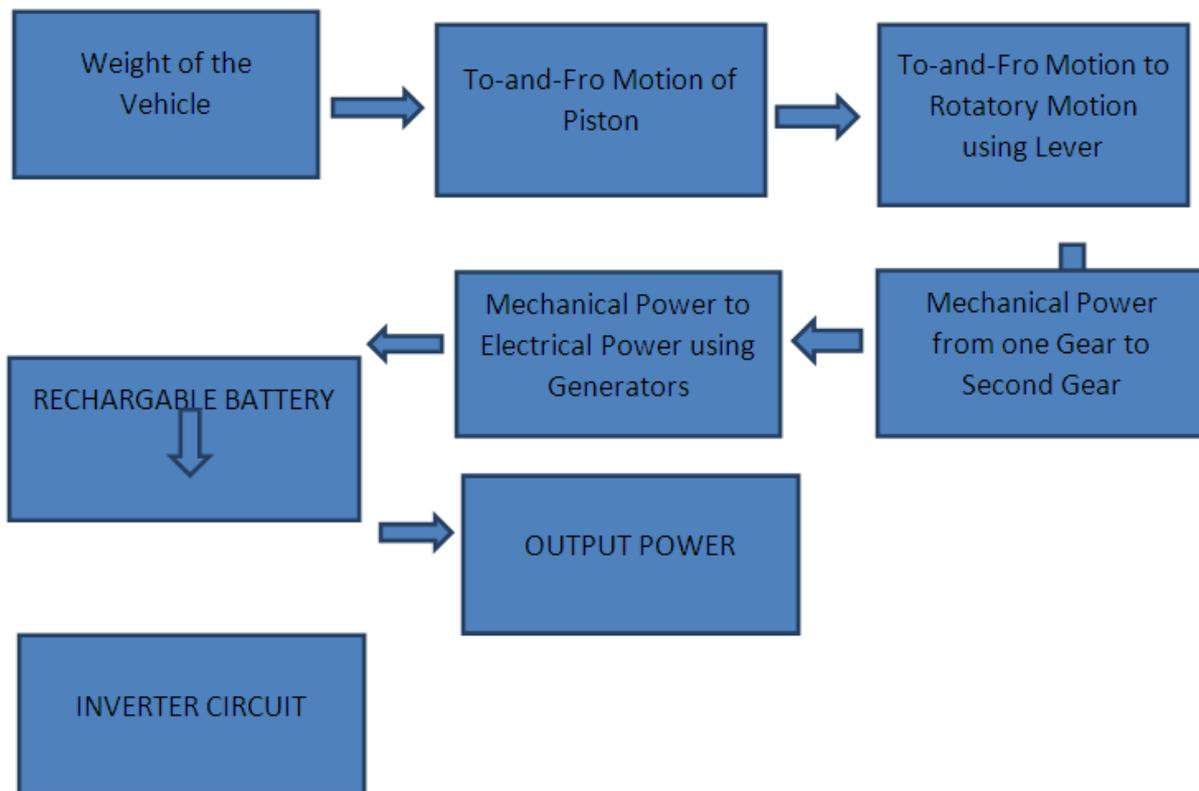
3.5 Chain: The chain is used to connect the two gears using a drive like mechanism. It has to be sturdy enough to resist instant changes in the direction of motion of the gears.

3.6 Generator: It is a device which converts mechanical energy into electrical energy. It uses rotating magnetic fields and rotating armature to produce current using Faraday's Law of Electromagnetic Induction. [4]

3.7 Rechargeable Battery: The battery used is a rechargeable one and hence it can be used to store power and it will also remove the impulses in the power supply.

4. Literature Review: The energy is a bottleneck in the way of supply of energy resource to an economy [10]. The studies to sort out energy crisis led to the idea of generating power using speed breakers. South African people were the first to make use of speed breakers as a source of power for lightning of small villages near highways. [17] The basic idea is to convert the kinetic energy into electrical energy which generally goes waste.

5. Block Diagram:



Block Diagram no 5.1 .The total Block Diagram is discussed in the principle of operation.

6. Mathematical Modelling:

Spur Gear:

It is a positive power transmission device with definite velocity ratio. In involute teeth profile is preferred for adjusting some linear misalignment. It should have high wear and tear, shock-absorbing capacity.

Gear Specifications

Design of Gears:

Power to be transmitted from 1st shaft to 2nd shaft (P) = 1.22 KW Number of teeth on gear (z2) = 48

Number of teeth on pinion (z1) = 18 Speed of gear (n2) = 280 rpm Speed of pinion (n1) = 840 rpm Velocity Ratio (i) = n1/n2 = Z2/Z1 = 3

- Outside Diameter (Do) = 150 mm
- Number of Teeth (N1,N2) = 48,16
- Pitch Circle Diameter (D) = Do / (1+2/N) = 150 / (1+2/48) = 144 mm
- Module = D/N = 144 / 48 = 3 mm
- Diametral Pitch (P) = N/D = 48 / 144 = 0.34 mm
- Working Depth = 2/P = 2 / 0.34 = 5.88 mm

Shaft:

It is a rotating element, which is used to transmit power from one place to another place. It supports the rotating elements like gears and flywheels[8]. It must have high torsional rigidity and lateral rigidity.

Shear Stress in the Shaft

It is calculated using the torsion equation-

$$T/J = \tau / r$$

Where, T – Torque Transmitted (N-mm)

J – Polar Moment of Inertia (mm⁴)

τ - Shear stress (N/mm²)

r – Radius of the shaft (mm)

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

$$\begin{aligned} \text{Torque Transmitted (T)} &= \text{Force} \times \text{Radius of shaft} \\ &= 30 \times 9.81 \times 15 \\ &= 4414.5 \text{ N-mm} \end{aligned}$$

Mass of vehicle = 30kg (approximately)

Height of speed breaker = 15cm = 0.15m

The height of the speed breaker is equivalent to the distance covered during calculation of work done.

Force developed by the vehicle

$$= \text{Mass of the vehicle} \times \text{acceleration due the gravity}$$

Work done by the vehicles

$$= \text{Force of the vehicle} \times \text{Distance covered} = (30 \text{kg} \times 9.81 \text{ms}^{-2}) \times 0.15 \text{m}$$

$$= 44.145 \text{ N-m}$$

$$\text{Power developed per second} = 441.45 / 60$$

$$= 0.73575 \text{ watts}$$

This power produced in the to-and-fro motion is to be delivered to the gears for rotation due to which some losses will be encountered [7].

Assuming the losses to be approximately 15%. [3]

So applying the law of conservation of energy

$$\begin{aligned} \text{Final output power} &= \text{work done by vehicles} - \text{losses} \\ &= P_1 - (15\% \text{ of } P_1) = [0.73575 - (0.15 \times 0.73575)] \text{ watts} \\ &= 0.6253875 \text{ watts} \end{aligned}$$

$$\begin{aligned} \text{EMF generated, } E &= P \dot{Z} N / 60 A \\ \text{By taking } P \dot{Z} / 60 A &= k \text{ (constant)} \end{aligned}$$

$$E = k \cdot N$$

Therefore, EMF produced is directly proportional to the speed of smaller gear (N).

7. Results:

Case 1:- for 15 kg mass,

$$\text{Work done} = \text{Force} \times \text{Displacement}$$

$$\text{Work done} = 15 \times 9.81 \times 0.15 = 22.07 \text{ J}$$

$$\text{Power} = \text{Work done} / \text{time}$$

$$\text{Power} = 22.07 / 60 = 0.3675 \text{ Watts}$$

$$\text{Power, } P = VI = 0.3675 \text{ Watts}$$

As the current is generated from a rechargeable battery, it is constant.

Assuming I = 0.25A,

$$\text{Voltage produced, } V = 1.43$$



Figure no 7.1

Case 2:- for 30 kg mass,

$$\text{Work done} = \text{Force} \times \text{Displacement}$$

$$\text{Work done} = 30 \times 9.81 \times 0.15 = 44.14 \text{ J}$$

$$\text{Power} = \text{Work done} / \text{time}$$

$$\text{Power} = 44.14 / 60 = 0.7356 \text{ Watts}$$

Power, $P = VI = 0.7356$ Watts
 Assuming $I = 0.25A$,
 Voltage produced, $V = 2.9332V$



Figure no 7.2

Case 3:- for 60 kg mass,
 Work done = Force*Displacement
 $Work\ done = 60 * 9.81 * 0.15 = 88.28J$
 Power = Work done / time
 $Power = 88.28 / 60 = 1.471$ Watts
 Power, $P = VI = 1.471$ Watts
 Assuming $I = 0.25A$,
 Voltage produced, $V = 5.8832V$



Figure no 7.3

Load = Weight of the vehicle
 Assuming the current to be 0.25A

Table no 7.1

Mass of the vehicle (kg)	Voltage generated (volts)
15	1.4316
30	2.9332
60	5.8832

8. Conclusions:

Energy is an important input to sustain industrial growth and standard of living of a country and can be directly related to the per-capita energy consumption.[5]This day, traffic is a major problem in big cities. This can be used as an advantage by installing these speed breakers in roads with heavy

traffic and certain other places. Electricity can be produced almost all the time by using the weight of the vehicles to produce mechanical power in the shafts by using the gears and springs for conversion of energy from one form to other.[6] This method does not require any external power and also the traffic never decreases. These speed surfs are more reliable and have a greater life span.

- It is economical.
- It is eco-friendly.
- Maintenance cost is low.
- Will solve some of the electricity problems of the world.
- This can be implemented on heavy traffic roads and toll booths and can be used to power the street lights.
- It can be a solution the electricity shortage in most villages.
- The mechanism has to be checked often.
- The gears might rust during the rainy season or in very humid environment.

In this paper 3 cases are studied as per the results the voltage developed from 1.47 volts to 5.88 volts (Table no 7.1) This shows the mathematical modelling satisfied with the result obtained. In future this can be extended through smart controllers etc there by the tariff rate also decreases.

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