UTILIZATION OF EXHAUST GAS OF VEHICLE FOR ELECTRICITY GENERATION

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ABSTRACT- Energy means capacity to do work. There are various types of energy available in the environment which is made by conventional and non conventional energy sources. The all forms of energies are required for doing various mechanical operations, But now there is large problem of electricity due to low availability energy resources. So in villages there is no maximum electric supply for doing simple operations such as mobile charging power for lamps etc.

By taking above factors we made the model which can produces electric power by using kinetic energy of exhaust gas of vehicle specially by two wheeler. When the model is in working condition, the runner rotates due kinetic energy of exhaust gas. This runner is attach to large gear by using shaft which further attach to small gear, placed on dynamo finally dynamo produces electric power. This is simple in construction due to it made by local available material.

Key Words : electricity Generation, Exhaust Gas, Kinetic Energy,

1. INTRODUCTION

Now-a-days technology is moving at a very faster rate. The conventional energy sources like Petrol, Diesel etc. are on a verge of extinction. So scientists are moving towards the use of non-conventional energy resources. But it also requires some kind of energy to convert it into another form. In this project we are utilizing the kinetic energy of exhaust gases of vehicle which is of no use.

Energy means capacity to do work. There are various types of energy available in the environment which is made by conventional and non conventional energy sources. The all forms of energies are required to doing various mechanical operations, which are related to the agricultural sector. There are mainly use of electric energy is done by cultivator for irrigations operation. But now there is large problem of electricity due to low availability energy resources. So in villages there is no maximum electric supply for doing simple operations such as mobile charging power for lamps etc.

By taking above factors we have made the model which produce electric power by using exhaust gas of vehicle specially two wheeler. In the model, by using kinetic energy of exhaust gas the runner rotates which attach to large gear by using shaft which further attach to small gear, placed on dynamo finally dynamo produces electric power. This is simple in construction due to it made by local available material. By using this waste gas of vehicle this model can work better for the electric power generation. This set up is mainly useful for villages. It can be use as power source at night when output power produced by set up is stored in battery. This set up is easy to handle and cheaper, in concern with everyone.

2. LITERATURE SURVEY

Generation of Electricity by Using Exhaust from Bike by **S.Vijaya Kumar, Amit Kumar Singh, Athul Sabu and Mohamed Farhan.P[1]:-** According to their study, it has been identified that there are large potentials of energy savings through the use of waste heat recovery technologies. Waste heat recovery entails capturing and reusing the waste heat from internal combustion engine and using it for heating or generating mechanical or electrical work

Study and performance analysis of charging vehicle battery using bike exhaust gas by **K. Kumaravel, P. Balashanmugam, and G. Balasubramanian[2],** They had done different studies according to their practical inputs. They had approached the problem with different engine RPM. Practically for different engine speeds for different turbine power output were observed.

Power Generation by Exhaust Gases On Diesel Engine by **Kranthi Kumar Guduru, Yakoob Kol ipak, Shanker. B and N. Suresh[3]:-**. Waste heat recovery entails capturing and reusing the waste heat from internal combustion engine and using it for heating or generating mechanical or electrical work. It would also help to recognize the improvement in performance and emissions of the engine if these technologies were adopted by the automotive manufacturers.

3. COMPONENTS

3.1 TURBINE:

A **turbine** is a rotary mechanical device that extracts energy from a steam and converts it into useful work. A turbine is a turbo machine with at least one moving part called a rotor assembly, which is a shaft or drum with blades attached. When the kinetic energy of exhaust gas acts on the blades so that they move and impart rotational energy to the rotor.

Design Calculation of Turbine wheel :-

1)Calculate the net head (H):-

H = Hg-hf

Hg = gross head (m)

hf = total head loss (m)

These losses are approximately Equal to 6% of gross head

We know that,

ρghg = ρwhw

Given,

hw = 3.2cm = 0.032m

ρg = 1.25 (density of gas)

ρw = 1000

hg = (100080.032)/1.25=25.6m

hg = 25.6m

Where hf 6% of hh

hf = 1.536m

H = 25.6-1.536

H = 24.064m

2)Calculation of flow rate (Q)

Q = velocity*area

$Vf = (2ghg)^{0.5}$

$=(2*9.81*25.6)^{0.5}$

Vf = 22.41 m/s

$Af = \pi/4d^2$

$= 3.14*10^{-4}\ m^2$

$Q = 22.4*3.14*10^{-4}$

$Qt = 7.040*10^{-3}\ kg/m^3$

3)Calculation of the input power

$Pi = \rho w*g*Cv^2*H*Qt$

$=1000*9.81*(0.98)^2*24.064*7.040*10^{-3}$

Pi= 1.596 kw

4)Speed

$Ns = 85.49*\frac{\sqrt{n}}{H\string^0.243}$

n = Qt/Qn

Qn = V1*A

Where,

$V1 = Cv*\sqrt{2gH}$

$=0.98*\sqrt{2*9.81*24.064}$

V1 = 6.733 m/s

$Qn = 6.733*3.14*10^2$

$Qn = 2.114*10^{-3}\ kg.m^3$

n = 1

$Ns = 85.49*\frac{\sqrt{n}}{H\string^0.243}$

$= 85.49*\frac{\sqrt{1}}{24.064\string^0.243}$

`Ns = 39.467 rpm

$N = Ns*\frac{H^{5/4}}{\sqrt{Pi}}$

$= 39.467*\frac{(24.064)^{5/4}}{\sqrt{1596}}$

N = 52.65 rpm

5)Calculation of runner diameter:-

$D = \frac{60*K}{\pi N}*V1$

$=\frac{60*0.46}{\pi*1665}*6.733$

D = 0.0355 m

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6)Bucket dimension:-

i) Axial width (Bw):-

Bw = 3.4*d = 3.4*0.02 = 0.068m = 6.8cm

ii) Length (Bl):-

Bl = 3*d = 3*0.02 = 0.06m = 6cm

iii) Depth of bucket (Bd):-

Bd =1.2*d = 1.2*0.02 = 0.024 = 2.4cm

7)Number of buckets:-

$$Z=15+\frac{D}{2d}$$

$$=15+\frac{0.0355}{2*0.02}$$

Z = 15.875 = 16

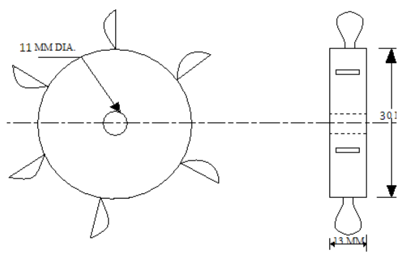

Fig.1. Turbine Wheel

3.2.SHAFT:

A Shaft is a cylindrical and a solid metal object which commonly goes through and holds other rotating items (e.g. pulleys, gears, bearings). The shaft is also used to transmit the rotational forces.

Calculation for shaft:

Speed of runner N = 400 mm

Weight of runner = 0.270 kg = 2.65 N

Runner diameter = 160 mm

Power received = 1.596 Kw

From table

Torque = $19.20*10^{-3}$

$$P = \frac{2\pi NT}{60} = \frac{2\pi*400*19.20*10-3}{60}$$

P = 0.8 Kw = 800Watt

Design torque, Td

$$Td = \frac{60*P*1000*KL}{2\pi N}$$

$$= \frac{60*800*2}{2\pi*400}$$

$= 38.2*10^3$ N.mm

Tangential force acting on turbine wheel

$$Ft = Ft = \frac{2T}{D}$$

$$= \frac{2*38.2*1000}{160}$$

= 477.5 N

Normal load acting on the runner

$$W = \frac{F}{\cos\alpha}$$

= 508.14 N

Since the turbine wheel is mounted at distance of 140mm from bearing so it simply supported beam with intermediate load therefore banding moment of gear

$$M = \frac{Wab}{L}$$

$$= \frac{508.14*140*140}{280}$$

= 35569.8 N.mm

Equivalent twisting moment

$$Te= \sqrt{(Km*m)+(Kt*T)}$$

$$= \sqrt{(3559.8)^2+(38200)^{\wedge}2}$$

= 38365.5 N.mm

$$Te = \frac{\pi}{16}*T*d^3$$

$$38365.5= \frac{\pi}{16}*42*d^3$$

d = 11 mm

Fig.2. Shaft

3.3 GEARS

Gears are the machine elements that transmit motion by means of successively engaging teeth. The gear teeth is act as a small lever. Gears are the toothed wheels which can be used for transmitting motion and power from one shaft to another shaft.

Spur gears and straight-cut gears are the two simple type of gear. They consist of a cylinder or disk with the teeth projecting radially, and although they are not straight-sided in form, the edge of each tooth is straight and aligned parallel to the axis of rotation. These gears can be meshed together correctly only if they are fitted to parallel shafts.

Design for spur gear:-

Ø= 20^0 (full depth involutes)

Z_p=14 (no. of tooth on pinion)

Z_g=98 (no. of teeth on gear)

P= $1.596*10^3$

N=1665 rpm

Material for gear and pinion nylon fiber

Sut=200mpa

Lewis form factor

$Y_p=0.484-\frac{2.87}{Zp}=0.279$

$Y_g=0.484-\frac{2.87}{Zg}=0.456$

Service factor Ka=1.25

Load factor Kw =1

Factor of safety =1.5

Deformation factor = 11400C

For grade 8

e = 16+1.25d, where Ø = $m+0.25(d)^{0.5}$

b = 10m

beam strength

$\sigma_{bg} = \sigma_{bp} = \frac{Sut}{3} = \frac{200}{3} = 66.67$ N/mm^2

As pinion and gear both are of same material, pinion is weaker than gear, hence necessary to design pinion for bending.

Fb = σbp.b.m.Yp

= 66.67*10m*m*0.279

Fb = $186m^2$ N

Effective load

$V=\frac{\pi*14*m*1665}{60*1000} = 1.22m$ m/s

$Ft = \frac{P}{V} = \frac{1.596*1000}{1.22m} = \frac{1278.68}{m}$ N

$Kv = \frac{6}{6+V} = \frac{6}{6+1.22m}$

$F_{eff} = \frac{Ka.Km.Ft}{Kv} = \frac{1.25*1*1278.68}{m}*\frac{(6+1.22m)}{6}$

$F_{eff} = \frac{266.43(6+1.22m)}{m}$ N

Estimation of module,

In order to avoid bending failure

$Fb = Nf. F_{eff}$

$186m^2 = 1.5*\frac{266.43(6+1.22m)}{m}$

$186m^2 = 2397.87+487.56m$

m = 2.13mm

Selected standard module is m = 2mm

Dimension of gear pair

M = 5mm

Zp = 14

Zg = 98

B =10m = 10*5 = 50mm

Dp = m.Zp = 2*14= 28mm = 2.8cm

Dg = m.Zg = 2*98 = 196mm = 19.6cm

Ha = 1m = 1*5 = 5mm

Hf = 1.25m = 1.25*5mm

$A = (\frac{dp+dg}{2}) = \frac{70+490}{2} = 280mm$

Precise estimation of dynamic load by Buckingham's equation

For grade 8

$e = 16+1.25[m+0.25\sqrt{28}]$

For pinion

$ep = 16+1.25[2+0.25\sqrt{28}] = 20.45\ \mu m$

$eg = 16+1.25[2+0.25\sqrt{196} = 22.875\ \mu m$

$e = ep+eg = 20.15+22.875 = 43.025*10^{-3}\mu m$

The Buckingham's equation for the dynamic load in the tangential direction is given by.

$Fd = \frac{21V(bC+Fmax)}{21V+\sqrt{bC+Fmax}}$

$Ft = \frac{1278.68}{2} = 639.34\ N$

V = 1.22m = 1.22*2 = 2.44 m/s

$Ft_{max} = Ka.Km.Ft = 1.25*4*639.34 = 799.175\ N$

$C = 11400e = 11400*43.025*10^{-3} = 490.485\ N/mm$

$Fd = \frac{21*2.44*(20*490.485+799.175)}{21*2.44+\sqrt{20*490.485*799.175}}$

Fd = 3523.57 N

Available factor of safety:

$F_{eff} = Ka.Km.Ft+Fd$

= 1.25*1*639.34+3523.57

$Fd = 186(m^2) = 186\ (2^2) = 7440$

Hence the available fos

$Nf = \frac{Fb}{Feff} = \frac{7440}{4322.75} = 1.717 > 1.5$

Hence design is also safe

Surface hardness

$Q = \frac{2Zg}{Zg+Zp} = \frac{2*98}{98+14} = 1.75$

$K = 0.16\ [\frac{BHN}{100}]^2$

Fw = dp.b.Q.K

$= 28*20*1.75*[\frac{BHN}{100}]^2$

$Fw = 980[\frac{BHN}{100}]^2$

$Fw = Nf.\ F_{eff},$

$980[\frac{BHN}{100}]^2 = 1.5*3523*57$

BHN = 232.23

BHN = 240

3.4 D.C GENERATOR

In electricity generation, an **electric generator** is a device that converts mechanical energy to electrical energy. A generator forces electric current to flow through an external circuit. The source of mechanical energy may be a reciprocating or turbine steam engine, water falling through a turbine or waterwheel, an internal combustion engine, a wind turbine, a hand crank, compressed air, or any other source of mechanical energy. Generators provide nearly all of the power for electric power grids

3.5 BEARINGS

A **bearing** is a machine element that constrains relative motion between moving parts to the desired motion. The design of the bearing may, for example, provide for free linear movement of the moving part or for free rotation around a fixed axis; or, it may prevent a motion by controlling the vectors of normal forces that bear on the moving parts.

Bearings can be classified broadly according to the motions they allow and according to their principle of operation as well as by the directions of applied loads they can handle.

Selection for Bearing

Diameter of Shaft- 11mm

For 11mm shaft diameter following type of bearing are suitable which have bore diameter of 12 mm

1)6001
2)6201
3)6301

We have selected 6001 series bearing because it sustain more static and dynamic load and it is very cheap and easily available in the market

Specification of 6001 bearing:-

Bore diameter	:-12mm
Outside Diameter	:-28mm
Width	:-8mm
Static Load	:-220kg
Dynamic Load	:-400kg

Fig.3. Bearings

4.RESULTS

We have done different studies according to our practical inputs. We have approached the problem with different engine RPM. Practically for different engine speeds for different turbine power output were observed.

Different readings at different RPM of the Turbine Wheel are noted as shown below in the table.

Fig. Assembly of the Set up

SR. NO	SPEED OF TURBINE WHEEL in rpm	OUTPUT OF GENERATOR in Volts	CURRENT in Ampere	POWER DEVELOPED (V *I) in W
1	200	2.7	0.05	0.135
2	220	2.9	0.07	0.203
3	240	3.2	0.09	0.288
4	260	3.4	0.09	0.306
5	280	3.7	0.10	0.370
6	300	4.0	0.12	0.480
7	320	4.2	0.13	0.546
8	340	4.3	0.15	0.645
9	360	4.4	0.16	0.704
10	380	4.8	0.19	0.912
11	400	5.1	0.21	1.071

Tab. Observation Table

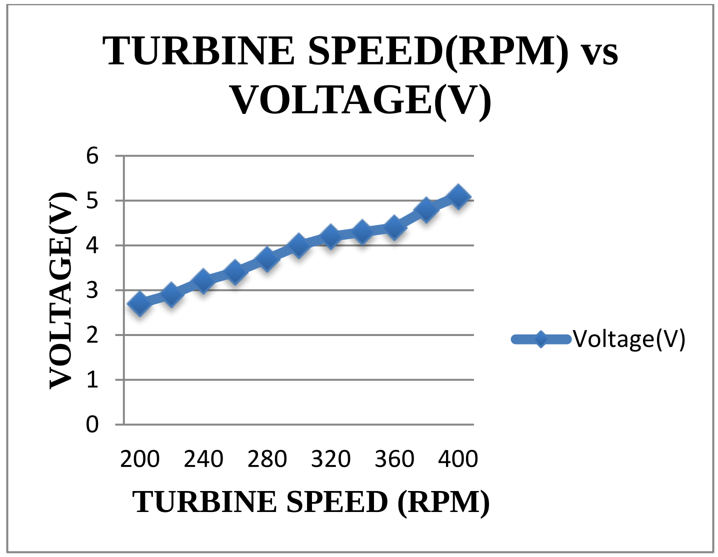

Fig. Turbine speed vs Voltage graph

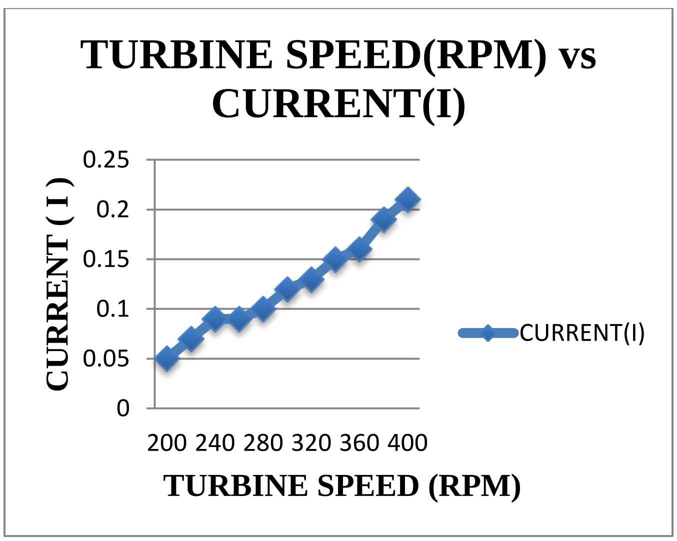

Fig. Turbine speed vs Current graph

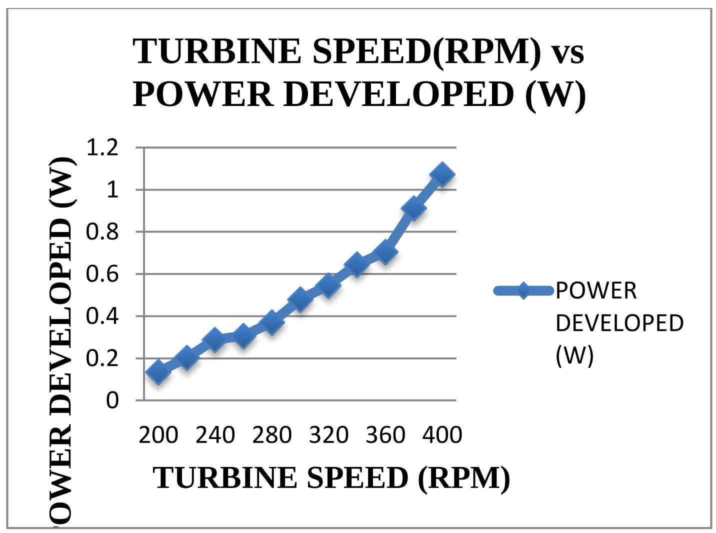

Fig. Turbine speed vs Power Developed graph

5.CONCLUSION

The efficiency of the turbine is less, but in optimum design best results can be achieved. Battery charging system from exhaust gas is better idea to save the power. In general the battery is charged through flywheel in which we lost some amount of power. From the experimental investigation, we have observed that the fuel economy can be saved up to a greater extent. The engine performance is almost same in with and without battery charger

The study also identified the potentials of the technologies when incorporated with other devices to maximize potential energy efficiency of the vehicles. The project carried out by us made an impressing task in the field of mechanical department. It is used for to produce the current in vehicle exhaust unit

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