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Roadside Dust Cleaning System

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Abstract - *The work deals with minimization of dust particles on Roadside by designing a portable highway wind turbine. The particulate matters which are present on roadside gets subtended in air by the motion of vehicles. This directly affect the riders or drivers vehicle handling capacity. So the idea is to take energy from the pressure column created by the automobiles while passing through the highways and expressways. The pressure column is due to high and low pressure energy band created by the motion of automobiles. Wind flows by the virtue of this pressure difference, this wind is sufficient to generate electricity which can run a vacuum pump. A pump starts suction periodically and removes the dust from the road.*

Wind works as a primary source of energy for the system consists of a Vertical axis wind turbine.

***Key Words*: Wind Energy, Vertical axis wind turbine, Vacuum pump, Dust cleaning**...

1.INTRODUCTION

As air pollution is becoming a major threat for the society thus we aim towards eradicating this threat with the help of a renewable source of energy. The dust particles present on the roads are danger to the road safety. The motivation of this project comes from the Swachha Bharat Abhiyan, a scheme of central govt. of India for pollution free environment. We can eradicate this problem by applying manual man power or any other non-renewable technology, which can be costly. Therefore, to suppress this problem we initiate a project which uses a renewable source of energy i.e. wind energy. The wind energy is a fastest growing, eco source of energy which is reliable and inexpensive energy source.

The problem arises due to the presence of the dust particles on roads are:

Visibility; the dust particles present on the road, when mixes with the fog and forms smog, this decreases the visibility on the road, which results in mishandling and fatal accidents.

Vehicle handling; the contact between the road surface and the surface of tyre reduces due to the presence of dust particle layer between them, during the braking and turning of the vehicle, it causes the problem like skidding.

Road safety; foreign dust particles when entering in the eyes of the driver or the rider causes discomfort and irritation which is a critical problem when driving or riding on a busy road.

As these problems are fatal and life threatening, we design an idea to solve this problem by employing the vacuum pumps on the roadside powered by vertical axis wind turbine. The VAWT is designed in such a way that it's blades are positioned vertically towards the axis of rotation so blades will always rotate in the same direction regardless of the direction of the wind flow. The wind is generated by the motion of the vehicles on the highways which is always destined to remain in one direction.

The concept of wind generation by the vehicle's motion is as shown in the figure

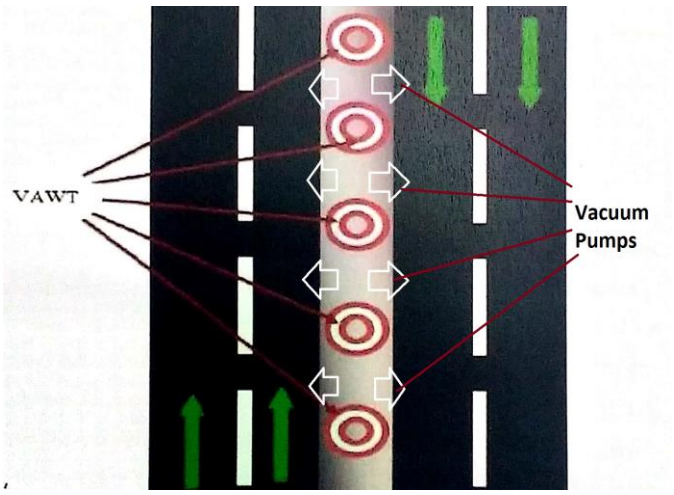

Fig 1.1: Position of VAWT and Vacuum pumps on Road

2. Experimental Setup

The overall project has been setup on dividers of highway. The generation of wind is due to pressure difference created by the motion of vehicles on highway. The operation of road cleaning system will be as follows;

2.1 Construction

The construction of the project contains following major components :-

Structure	Blades	Bearings	Centre Shaft
Pulley	Belt drive	Dynamo	Batteries
Electrical Arrangement	Controllers	Vacuum Pump	Filter

2.1.1 Turbine

We are implementing the vertical axis wind turbine whose blades will rotate about the axis of the turbine. To overcome from the stationary inertial force of the wind turbine is a major challenge hence to overcome this it is suggested that the pitch angle of the turbine should not be 90 degree, for self starting.

Fig 2.1: VAWT set-up

2.1.2 Dynamo

Dynamo is employed to convert the rotational energy of the turbine blades into the electrical energy. When the central shaft of the turbine rotates by the rotation of the blades, the central shaft of the turbine is connected with the driven shaft of the dynamo by the belt and pulley arrangement. The electrical energy generated by the dynamometer is supplied to the electrical storage unit.

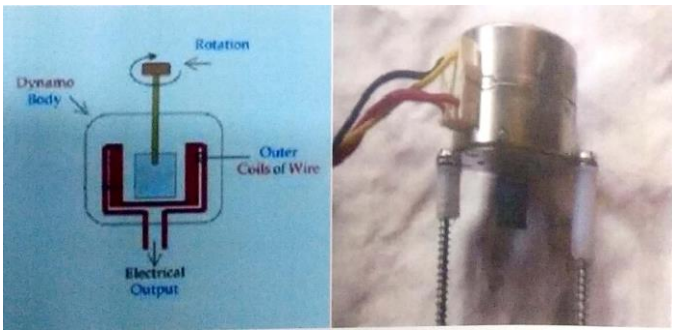

Fig 2.2 : Dynamometer used in project

2.1.2 Electrical Battery

The electrical energy generated by the dynamo is stored in the battery, the energy stored in the battery can be further used to run different components. There are different electrical components attached to the battery which act as a charge controller to prevent damage to the battery.

2.1.3 Vacuum pump

To accomplish the desired objective of our project we are using an electrically powered vacuum pump. The dust particles present on the roadside are sucked by the pressure difference created by the vacuum pump. This vacuum pump is driven periodically by using the electrical energy stored in the battery.

Fig 2.3: Vacuum Pump

2.2 Design Calculations

Power of wind is directly proportional to the density of air, area of segment and the cube of natural wind speed. the power equation of wind is given by;

$$P_w = 1/2\ \rho A v^3$$

P_w= power of wind
ρ= air density
A= area of blade
v= velocity of wind

At standard temperature and pressure (STP= 273K and 101.3KPa)

$$P_w = 0.647 A v^3$$

Mechanical power that can be obtained from wind with an ideal turbine

$$P_m = 1/2\ \rho(16/27\ v^3)$$

Energy which we have to produce 20hrs a day

E=17000 (Battery=16200J)

Let us assume to pass 100 vehicles with a speed of 60 to 70kmph wind generated by this is 4.5 m/s for at least 4 sec per vehicle.

We want to charge Battery for 20 hrs

Available energy = 20*100*4
= 8000sec

Power required= P_m
Energy Required

$$17000 = P_m * 8000$$
$$P_m = 2.125 \text{ W}$$

Area of blades

$$A = D * h$$

The battery used in this is 6V or 45A.

Overall efficiency of a dynamo

$$\eta_o = \eta_g * \eta_m$$

$$\text{Electrical energy generated} = \eta_o * E_m$$

3. Implementation on the Highways

The moving vehicles may be all types i.e. light or heavy running on road such as two, four wheelers and even bigger vehicles, when these vehicles move across the divider in opposite direction they will generate a pressure difference which results in the flow of wind at a high velocity. When these high velocity wind strikes on the designed blade, this will cause them to rotate which results in the rotation of the central shaft of the turbine, the central shaft of the turbine connects with the pulley which acts as a driving member. Thus, the rotational energy of this system runs the dynamo which generates the electrical energy.

Now the generated electrical energy is stored in the battery, the continuous supply of energy can cause a problem of overcharging so by using the electrical controllers, we prevent our battery from overcharging. If wind is properly directed towards the wind turbine blades, optimum electricity may be generated.

A vacuum pump is employed on the base of the divider, to remove the dust particles from the roads.

The pump is driven by the electrical energy supplied by the battery periodically. There are different filters provided on the pump which will prevent the pump from suction of larger and unwanted particles such as polythenes, stones and metal pieces etc. Since these particles may harm the pump and ultimately reduce the efficiency of the system.

Fig 3.1 : Implementation of Set-up on Roadside.

4. Result & Conclusions

4.1 Result

The results are taken, when implementing the project on highway so when vehicles pass on road this cause rotation in blades of turbines. The energy generated from system is sufficiently used to drive vacuum pump. The dust particles are easily cleaned from roads.

4.2 Conclusion

Conclusively, different data is collected by implementing the system on roads. Using the data it is clear that we have to use more than one system within some distances. When the number of system increased on highways it will able to drive vacuum pumps. Collective of turbines on a long strip of highways has a potential to generate large amount of energy that can be used to drive pumps, street lights and other applications. The generated power stored in battery is sufficient to drive more than one vacuum pumps. High capacity Vacuum pumps should be employed to get satisfactory results on roadside. The design of system is sustainable and environmental friendly.

Cleaning of road will be in periodical manner, when the traffic will be low, vacuum pumps will start cleaning and will continue till some minutes. The time duration of pumps will depend on their the suction capacity.

According to our practical observation on roads and traffic density, the time for cleaning dust should be four times in a day. This should be started on 6AM then 11AM, 4PM and 8PM respectively. This time also depends upon the pollution level of dust particles and surrounding atmospheric conditions such as velocity of wind etc.

Hence, the system is reliable and effective on highways where the problem of dust particles is a serious concern. This project needs onetime investment and proper designing. During the setup proper guidance and observation is needed which increases the efficiency of the system.

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