VAWT Which Makes Use of the Turbulent Winds Generated by the Highway Traffic

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***Abstract*—This paper presents the method of harnessing the turbulent winds generated by the high way traffic by use of Vertical Axis Wind Turbine (VAWT). By combining numerous VAWT, the turbulent winds created by the surplus flow of High Way traffic can be used to generate electricity which can be used for the highway lighting and the Toll gates in the High way. It also helps in providing efficient lighting to reduce the high way accidents. To design and Analysis of the model by using Pro/E and, CFD software. The Further developments of model by various methods.**

***Index Terms*—VAWT, Model_Pro/E, CFD, Helix blade, turbulent winds, surplus flow, Fibre glass**

I. Introduction

Wind energy generation is growing rapidly worldwide and will continue to do so for the foreseeable future. Researchers are going in ways of maximize convertible energy available from the winds available across the globe.

A very novel way of re-capturing some of the energy expended by vehicles moving at high speeds on our nation’s highways. We know how much air turbulence is generated by vehicles moving at speed particularly trucks. This would involve mounting vertical axis wind turbines at the centre of the roads that would be driven by the moving air generated by the passing traffic. The electricity generated by spinning these turbines could be used for lighting up the roads to avoid accidents and for the use of toll gates. The excess energy generated could be fed back into the grid or power up the villages nearby.

VAWT along the middle of the traffic lanes that can generate a significant amount of power from the turbulence created by cars and trucks passing by. While we'll never recover much of the energy wasted pushing air out of the way of a sixteen wheeler, even a fraction could be a significant source of power.

Average vehicle speeds on the valley highways are approximately 70 mph. This power production estimate will increase exponentially with an increase in wind turbulence speed. We believe that the wind stream created over the freeways by our primary mode of transportation will create an average annual wind speed well beyond the baseline of 10 mph.

The wind turbines shown in the proposal are of a quiet running type. Certainly in many built up areas there is enough constant traffic volume to maintain a steady airflow through much of the day.

"If these devices were situated along railway lines and in the underground rail network especially they'd harness the energy projected by passing trains -say, to supply buildings above, although it would by a rather variable power source."

Manuscript received January 3, 2012; revised March 22, 2012.

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II. Turbulence Model

The kinetic energy of the turbulence produced during the movement of the vehicle is represented by the widely used Operational Street Pollution Model (OSPM, Hertel and Berkowicz 1989), developed by the Danish National Environmental Research Institute, vehicles in a street canyon are treated as moving roughness elements.

Their mechanical effect on turbulence is parameterised by assuming that the roughness elements have an overall associated variance of the velocity fluctuation depending on the square of the velocity. It writes (Berkowicz 1989) as:

$$\sigma_{wmt} = b^2 U^2 \quad (1)$$

where

U is the average vehicle speed;

b is a constant factor related to the aerodynamic drag coefficient;

D is the density of the roughness elements in the canyon given by:

$$D = N\, v\, A\, UL \quad (2)$$

where

Nv is the number of vehicles passing in the street per time unit;

A is the plan area occupied by a single vehicle

L is the width of the street.

III. Alternate Model

Moving vehicles produce turbulent kinetic energy in the street canyon. From the analysis of the terms of the turbulent kinetic energy equation, in absence of strong insulation and in absence of industrial and domestic heating, two mechanisms are important: the turbulence production and dissipation.

The balance between turbulent kinetic energy per unit mass of air and dissipation reads as:

$$\frac{C_D\, 1/2 \rho_{air}\, U^3 A_{fr}}{\rho_{air}\, V_{canyon}} = cw'^3 L_c^{-1} \quad (3)$$

where

Lc is a length scale

c is an empirical constant to be determined.

C_D is the aerodynamic drag coefficient

Afr is the frontal area of the vehicle projected towards the flow direction

ρ_{air} air density

V_{canyon} is the volume of the canyon

W' is a velocity scale associated with the turbulence generated by the vehicles.

$$w'^2 = \left(N'\frac{1}{2}C_D A_{fr} U^3 \middle| cL\right)^{2/3} \quad (4)$$

From the above equation,

where

N' is the number of vehicles per unit length;

L is a length scale of the turbulent motion produced by the vehicles;

Afr is the frontal area of the car projected in the direction of the wind flow.

IV. Power Formula for VAWT

The power of the wind is proportional to air density, area of the segment of wind being considered, and the natural wind speed. The relationships between the above variables are provided in Eq. 5

$$P_w = ½ \rho A u^3 \quad (5)$$

where

P_w: power of the wind (W)

M: air density (kg/m^3)

A: area of a segment of the wind being considered (m^2)

u: undisturbed wind speed (m/s)

At standard temperature (273K) and pressure (101.3 KPa) STP, the Eq.5 reduces to:

$$P_w = 0.647Au^3 \quad (6)$$

A turbine cannot extract 100% of the winds energy because some of the winds energy is used in pressure changes occurring across the turbine blades.

This pressure change causes a decrease in velocity and therefore usable energy. The mechanical power that can be obtained from the wind with an ideal turbine is given as:

$$P_m = ½ \rho\ (16/27)\ Au^3 \quad (7)$$

where

P_m: mechanical power (*W*)

In Eq.7, the area, A, is referred to as the swept area of a turbine. For a VAWT, this area depends on both the turbine diameter and turbine blade length. For an H-type VAWT the equation for swept area is

$$A_s = D_t\ l_b \quad (8)$$

where

A_s: swept area (m^2)

D_t: diameter of the turbine (m)

l_b: length of the turbine Blades (m)

The constant 16/27 = 0.593 from Eq.7 is referred to as the Betz coefficient. The Betz coefficient tells us that 59.3% of the power in the wind can be extracted in the case of an ideal turbine. However, an ideal turbine is a theoretical case. Turbine efficiencies in the range of 35-40% are very good, and this is the case for most large-scale turbines. It should also be noted that the pressure drop across the turbine blades is very small, around 0.02% of the ambient air pressure.

Eq. 5 can be re-written as

$$P_m = C_p\ P \quad (9)$$

where,

C_p: coefficient of performance.

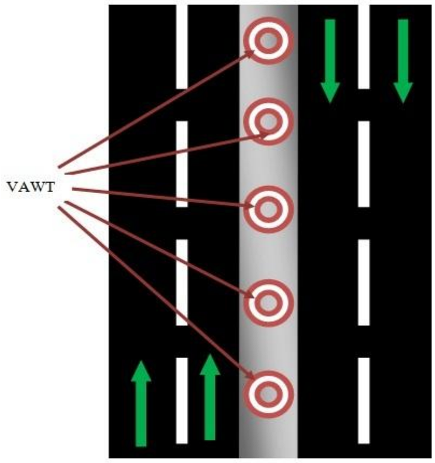

Fig. 1. Layout and VAWT positioning in the high way roads.

V. New VAWT Model

Fig. 2. Helix Type VAWT .

VI. Work in Progress

CFD analysis of Turbulence driven VAWT.

ACKNOWLEDGEMENTS

I thanks to Mr. N. Senthilnathan B.E., Project Assistant, Centre for Wind Energy Technology, Chennai. For supporting and helping to do this paper.

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