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A novel approach for energy generation from wind power

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Abstract

The objective of this work is to obtain energy from gust produced near the ground surface of a moving object based on the `Boundary layer theory'. According to Boundary layer theory, from the point of contact of the body, there will be a decreasing velocity profile. By placing an Omni-directional wind mill (helix windmill) at an optimum point in this velocity profile, maximum output (electrical energy) is obtained. This highly feasible method is applicable to energy generation using the movement of train or any fast moving objects. This method is highly advantageous because it provides high rotational or mechanical power to the wind blades, which in turn can be converted to electrical power. At places where normal wind mills are installed, the minimum wind speed required is 15km/hr. However, at the places where the gusts are produced by fast moving objects, the minimum wind speed is 25 to 35 km/hr. The proposed method is a better and efficient way to support the government's plans in the promotion of wind energy sector.

Key Words: Boundary Layer; Gust; Omni-directional; Helix.

Introduction

Due to the increasing congestion of road traffic, the introduction of high-speed trains has made train travel for business purposes compatible in comparison to travel by road (Al Shaera *et al*., 2008). Fluid dynamics, structural mechanics and automatic control engineering have made large contributions to the present aerospace technologies. Of them, fluid dynamics mainly dealing with aerodynamic drag has played the most important role in the development of airplanes, trains and flight vehicles (Lee *et al*., 2001). Aerodynamic and aero acoustic problems accompanied by the speed-up of train system are, at present, receiving a considerable attention as practical engineering issues that should be urgently resolved (Bakera *et al*., 2004). With the speed-up of train, many engineering problems that were neglected at low speeds are being considered with regard to aerodynamic noise and vibrations (Gerhardt *et al*., 1998).

Materials and Methods

The system considered in this study is the impingement of heavy wind or gust on the surface of helix wind mill (Fig.1). Fundamental equations

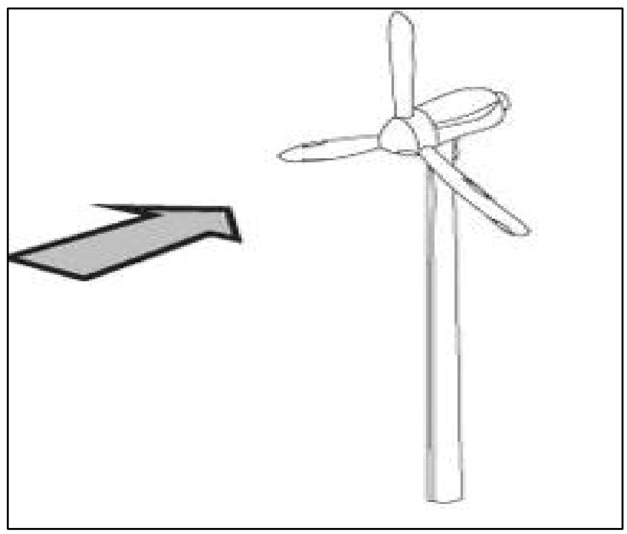

Fig.1. Traditional wind mill

from boundary layer theory were used for modeling and simulating our systems with special boundary conditions. The surplus amount of wind energy present is converted into electrical energy by placing an Omni directional wind mill ex:-helix or helical wind mill. The helix or helical wind mill is an Omni directional wind mill with high momentum, efficiency and cost effective than other wind mill. Helix wind mill captures the wind energy from all directions feasibly and converts it

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into electrical energy and a simple picture depicting highly momentous nature of helix or helical wind mill is shown in Fig.2. On comparison with efficiency and cost, the helical wind mill is far better than conventional wind mills. The Helix windmill's small scale version starts at $8,500 and the larger capacity (5kW) model starts at $16,500 thereby making them economically feasible and profitable compared to conventional windmills that are costlier for the same capacity.

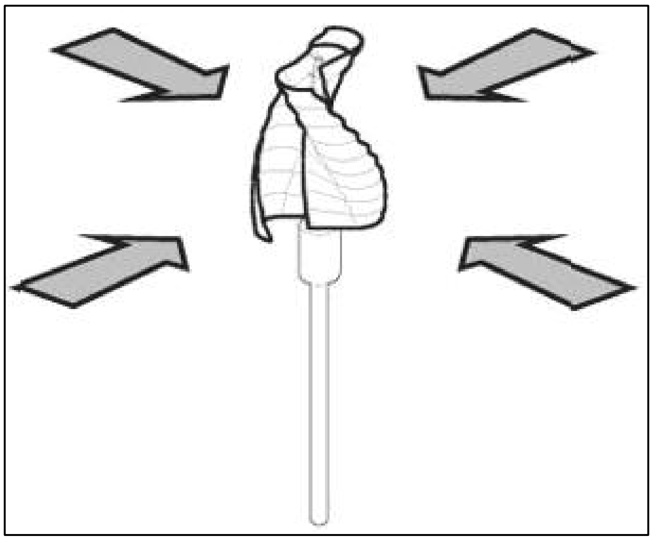

Fig.2. Working of a Helix wind mill

Results and Discussion

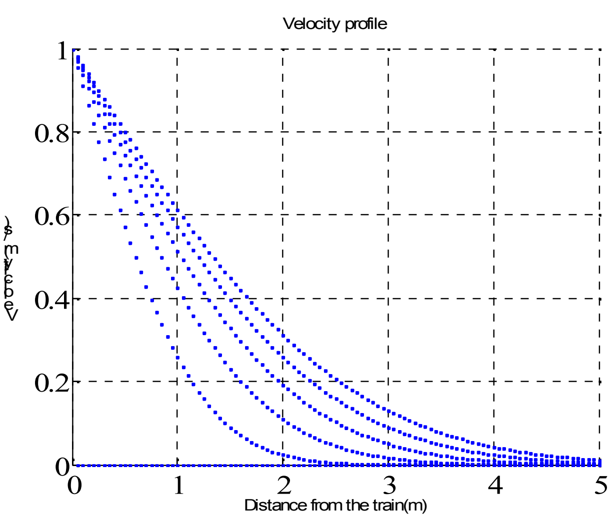

Fig.3. Velocity Profile for our model

The velocity profile depicting the variation of velocity with respect to distance from the point of contact of the body to certain region is shown in the Fig.3. The transient pressure changes due to trains passing a will induce transient forces. A typical non-dimensional time history is shown in

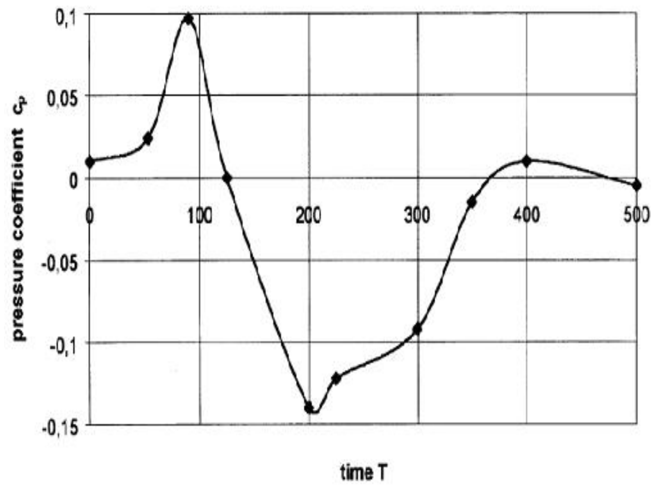

Fig.4. Non-Dimensional pressure/time trace, (Source: Gerhardt *et al*., 1998)

Fig.4. The pressure was normalized using the stagnation pressure based on the train velocity; the time was normalized with the train velocity and the influence length of the pressure wave. The boundary layer equations are

$$\frac{\partial u}{\partial t}+\frac{u\partial u}{\partial x}+\frac{v\partial u}{\partial y}=\frac{-\partial P}{p\partial x}+\Lambda\frac{\partial^2 u}{\partial y^2}$$

Where

The equation of continuity is given by

$$\frac{\partial u}{\partial x}+\frac{\partial u}{\partial y}=0$$

In steady flow, the general equation of boundary layer becomes as follows,

$$\frac{u\partial u}{\partial x}+\frac{v\partial u}{\partial y}=\frac{-\partial P}{p\partial x}+\Lambda\frac{\partial^2 u}{\partial y^2}$$

If the velocity of the potential flow is constant then

$$\frac{dP}{dx} = 0$$

Then the above boundary layer equation becomes as follows

$$\frac{u\partial u}{\partial x} + \frac{v\partial u}{\partial y} = \Lambda \frac{\partial^2 u}{\partial y^2}$$

Thus the equation of the moving body is given by, V =Y/ $(2(2nt)^{0.5})$, where 'V' is the velocity of the body (m/s), 'Y' is the horizontal distance from the moving body (m) and 't' is the time (s), 'n' is the kinematic viscosity of the air. This is the basic modeling equation of our concept. The analysis from our model gave the result as shown in Fig.5. It is compared with the distribution pattern obtained by Gerhardt *et al*. (1998) which is shown in Fig.4.

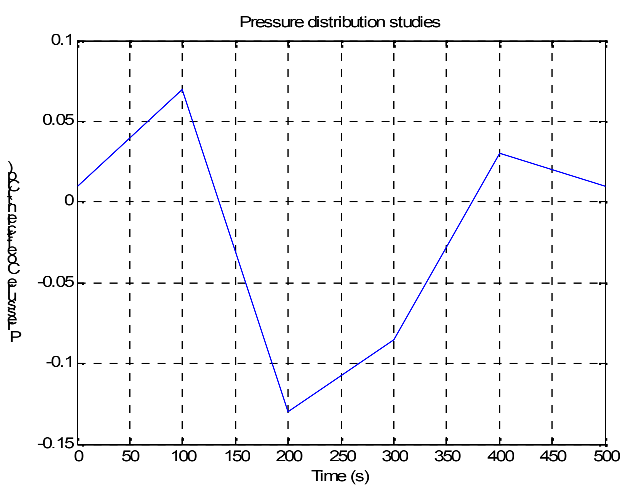

Fig.5. Non-dimensional pressure/time trace (Predicted from our analysis)

Conclusion

Velocity profiles and the analysis on the pressure fluctuations help us in optimizing the location for the installation of the helix wind mill. For maximized energy production, the wind mills have to be placed at the location where the turbulent layer starts to develop. In pressure gradient analysis, a non-dimensional pressure gradient was obtained. However, the pressure gradient decays rapidly with increasing distance to the tracks. From the energy production analysis, it is concluded that installing wind mills near the fast moving trains can be a potential and environmentally friendly way for the power generation in order to meet the energy demands of the future generation.

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