AIR DUCT TURBINE

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Abstract

A AIR DUCT power generator. The apparatus comprises a vortex housing with a large frontal opening at one end and a smaller exhaust opening at another end. The housing further has a concave internal surface leading rearward to the exhaust opening and an exhaust channel. A propeller-driven electrical generator is mounted inside the exhaust channel for generating electrical power from the wind. The apparatus is mounted atop a vertical-axis base for free pivotal movement, and a plurality of air-foil fins are mounted toward the rear of the housing to continuously maintain the frontal opening of the apparatus facing the wind. Based upon Bernoulli's principle, wind entering the frontal opening increases in velocity as it is constricted towards the exhaust opening and channel. Thus, a high velocity wind is created for passing over and turning the generator's propellers and thereby increasing the rotation speed of the propellers.

1. Introduction

This chapter introduce ducted turbines for the use of wind power generation. The interest for this grew from the ever increasing demand for energy. After investigating the nature of the three bladed wind turbines, it became apparent that the machines were not very efficient, expensive and have a limited fatigue life. The ducted twin turbine wind power generator is proposed in this chapter and a comparison in performance has been carried out between the ducted turbine and the conventional turbine. The ducted turbine has the ability to accelerate the air flow through a converging intake thereby increasing the power that can be extracted from the air flow. As the wind passes through a converging duct the velocity increases while the pressure decreases. The power extracted has a cubic relationship to wind velocity where as the relation to pressure is linear. Hydro power dams release carbon that was locked up in the trees and plants that were drowned during the filling of the dam. Any sort of fossil fuel powered plant releases carbon into the environment during the combustion process. Nuclear plants are generally unpopular and will not be accepted in many country's for a very long time. Renewable, environmentally friendly, clean, safe, even wholesome, are the types of adjectives we should be using to describe power production. Wind energy is the closest we may have at present that may be considered to fit into those criteria. Certain aspects such as noise and blade flash are a concern. The ducted twin turbine is proposed in this report as an environmentally friendly, safe alternative method of power production from renewable sources. The ducted turbine has the ability to accelerate the air flow through a converging intake thereby increasing the power that can be extracted from the air flow. As the wind passes through a converging duct the velocity increases while the pressure decreases. The power extracted has a cubic relationship to wind velocity where as the Wind Turbines relation to pressure is linear. The ducted turbine uses Variable Inlet Guide Vanes (VIGVs) mounted in the air stream prior to the first stage turbine; this controls angle of attack maintaining optimum performance, while the mechanisms do not have to be mounted in confines of a hub. An annular arrangement is proposed that houses the pitch change mechanism in the nacelle or inner ducting reducing inertia on the rotating mechanism.

2. Method

Another prospect of this turbine will be the ability to site this item close to built-up areas. As noise and blade flash is reduced these items will be mounted directly onto buildings and in urban areas where the power is used, and any surplus sold to the power distribution company. This will; also have the effect of reducing transmission losses as power production will occur on site. The ducted turbine has not been a popular choice with wind turbine designers. The cheaper option has been the three bladed, low rotational speed turbines commonly seen in the large commercial wind farms. With micro generation, a smaller more efficient system of a ducted turbine is proposed.

Field of the Invention:

The present invention relates to electricity generation and, more particularly, to a device that employs the Bernoulli principle for converting fluid flow to power.The traditional approach for electrical generation using wind energy is to connect the wind turbine axis to the axis of an electrical generator. Modem electrical generators have an efficiency value around 85%. Thus, existing blade configurations and/or wind collection vanes could be far more efficient.

SUMMARY OF THE INVENTION

It is, therefore, an object of the present invention to provide an efficient power generation system that produces supplemental electricity at no operating cost, with minimal capital outlay, to reduce consumption of scarce, irreplaceable, fossil fuels. It is another object to provide an efficient power generation system which relies on the Bernoulli principle to improve efficiency by increasing the wind velocity past a generator. According to the present invention, the above-described and other objects are accomplished by providing an electricity-generating device using wind power, based on Bernoulli's principle. The power generating apparatus comprises a vortex housing with a large frontal opening at one end and a smaller opening leading to an exhaust channel at another end. The vortex housing has a concave internal surface leading rearward to the exhaust channel. Wind enters the vortex housing at the frontal end and passes through the exhaust channel. A propeller-drive electrical generator is mounted inside the exhaust opening for generating electrical power from the wind passing there through. The apparatus is mounted atop a vertical-axis base for free pivotally movement, and a plurality of air-foil fins are mounted toward the rear of the housing to maintain it facing the wind. The concave shape of the vortex housing of the wind power generating apparatus employs Bernoulli's principle to induce a decrease in pressure and thus an increase in the velocity of the wind as it passes from the front of the vortex housing into the exhaust channel and over the propeller of the generator. Thus, when the wind enters the exhaust opening it will have obtained maximum velocity, faster wind increases the rate of rotation of the propeller and thereby increases electricity production of the generator.

Acceleration of airflow velocity

Giovanni Battista Venturi (1746 – 1822), accredited with the effect named after him, is an

example of Bernoulli's principle of incompressible gasses where an acceleration of airflow

must occur through a constriction to satisfy the equation of continuity.

Pa + ½ ρ V2+ ρ g h = constant (2) From this we can derive,

Pa1– Pa2= ½ ρ(V^2)– V^2--------- (3)

And, A1* V1= A2* V2-------------- (4)

Where:

A = area,

V = velocity,

ρ = density of fluid,

TSA = turbine swept area,

g = acceleration constant,

h = height,

Pa = fluid pressure.

The acceleration of the airflow was achieved with the use of a converging duct.

3. Results

The specifications were set as a goal for us to achieve with our design. From the specification a rough design was envisaged and the first of the basic principles were A Ducted Horizontal Wind Turbine for Efficient Generation 105 mathematically modelled, this provided evidence that the design was feasible. Further expansion to the design was carried out and more of the fundamental mathematics was discovered that would describe the Air flow through the duct. Power calculations were provided for the ducted turbine and the conventional turbine. These provided a direct comparison that was referred to as condition 1 and condition 2. This showed a theoretical power rating difference of a factor of 17, it must be shown here that the theoretical power shows the amount of power that is available in the wind flow. The Betz limit describes that maximum amount of power that is able to be extracted from the wind flow his is 16/27 (59.3%). A more conservative approach was taken and a coefficient of 0.41 was chosen. This provided evidence of a 3 kW out put. The Reynolds number shows turbulent flow through the ducting as the number was in the order of 106(anything above 2000 can be considered turbulent flow). Therefore VIGVs and stators were added to reduce the possibility of vortex generation. The VIGVs also provide control of the wind flow over the turbine blades; this allows the optimum power to be extracted while reducing the boundary layer over the blade and minimising the possibility of turbulent boundary layer flow interacting with the blade trailing edge.