Journal of Energy Technologies and Policy
ISSN 2224-3232 (Paper) ISSN 2225-0573 (Online)
Vol.2, No.4, 2012

Windmill Power Generation Using Mult-Generator and Single Rotor (Horizontal and Vertical Blade)

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Abstract

Wind energy is the environmental pollution free, hazardless and one of the best renewable energy for generation of electric power. The main aim of the paper is "to produce current using multi generator and single rotor". This paper proposes multi-generator to address potential challenges: dimension, cost and reliability. The two electromagnetic induction generators are desired to share the single shaft through straight bevel gears. These poles of the two generators will be changed as alternate to parallel. This paper discussed about the design procedure of gears, gear life and wind turbine rotors. The output current is stored in series of battery to appliances through converter and step up transformer. The Construction, working, parts of windmill, materials are discussed detailed in this paper.

Keywords: Electromagnetic Induction Generator, Wind Turbine, Straight Bevel Gear, Poles of Generator.

1. Introduction

The wind energy is an environment-friendly and efficient source of renewable energy. The kinetic energy of the wind can be used to do work. This energy is harnessed by windmill in the past to do mechanical work. This is used for water lifting pump and generating electricity. To generate the electricity, the rotary motion of, the windmill is used to turn the turbine of the electric generator. The output of single windmill is quite small and cannot be used for commercial purposes. Therefore, a number of windmills are erected over a large area, which is known as wind energy farm. The each and every windmill is coupled together to get a electricity for commercial purposes. The wind speed should be higher than 15 Km/hr.

2. Literature review

Wind farms are created when multiple wind turbines are placed in the same location for the purpose of generating large amounts of electric power. Due to rising energy prices and the resultant search for alternatives, there are now thousands of wind farms in many countries around the world. There is still a lot of controversy surrounding the pros and cons of wind power and its local impact. The articles listed on this page explore news and information about wind farms.

The three-bladed rotor proliferates and typically has a separate front bearing, with low speed shaft connected to a gearbox that provides an output speed suitable for the most popular four-pole (or two -pole) generators. This general architecture commonly, with the largest wind turbines, the blade pitch will be varied continuously under active control to regulate power in higher operational wind speeds. Support structures are most commonly tubular steel towers tapering in some way, both in metal wall thickness and in diameter from tower base to tower top. Concrete towers, concrete bases with steel upper sections and lattice towers, are also used but are much less prevalent. Tower height is rather site specific and turbines are commonly available with three or more tower height options.

The author Fujin Deng used a variable speed wind turbine, where multiple permanent magnet synchronous generators (MPMSGs) drive-train configuration is employed in the wind turbine. A cascaded multilevel converter interface based on the MPMSGs is developed to synthesize a desired high ac sinusoidal output voltage, which could be directly connected to the grids. What is more, such arrangement has been made so that the output ac voltage having a selected phase angle difference among the stator windings of multiple generators. The multiple pole Permanent magnet synchronous generators are cost effective duo to multiple pole it induces eddy current and Hysteresis losses so it is reduced by proposed method.

3. Materials and methods

3.1 Windmill using multi generator

The two electromagnetic induction generator are connected in both end of the shaft through coupling. The windmill rotor transmit the power to the two generator through straight bevel gear. The power output of multi- generator used windmill will be two times of single generator used windmill.

3.2 Principle of the methods

The windmill is works on the principle of generating power through the force of the nature (air). The blades of windmill are rotated due to the force of wind strikes them. The rotating blades are transmitting the power to the generator through the shaft and gear box and generate the electricity.

3.3 Construction of the methods

For Horizontal blade wind turbine, the main parts are follows below:

- Blades and rotor,
- Electromagnetic Induction Generator (2Qty),
- Gears (straight bevel gear mechanism),
- Shaft.

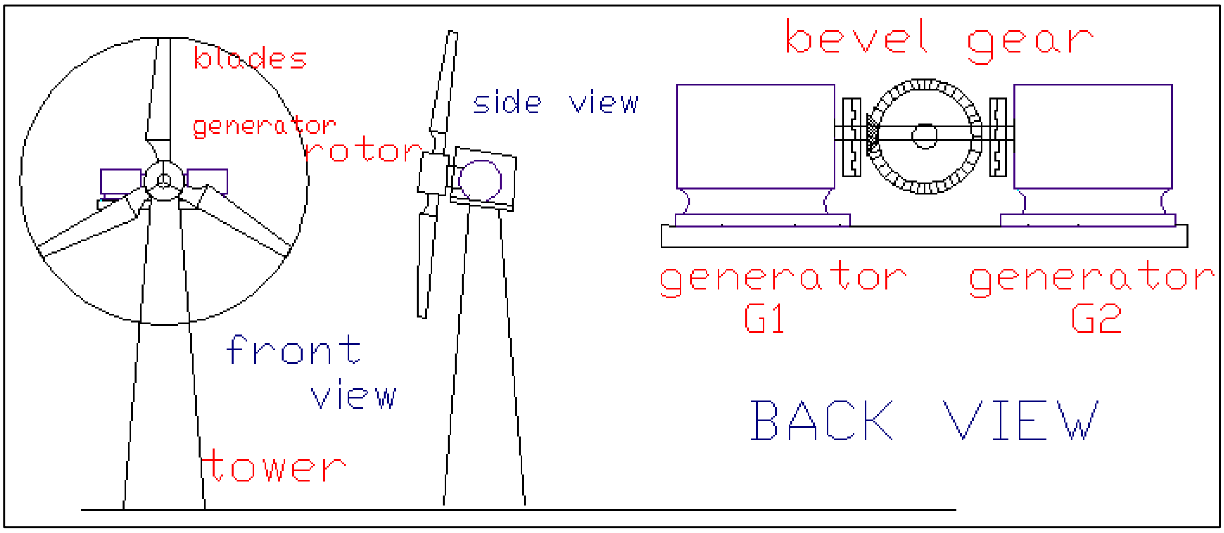

Figure 1. Experimental setup for horizontal wind turbine

The blades are attached with rotor by using bolt and nut. The rotor connected with gear through shaft and balance by bearing. The gear box consists of driver and driven gear. The driven gear teeth are mesh with driver gear. The one end of the low speed shaft is connected with driver gear and other end is connected with rotor turbine of the windmill. The long high speed shaft is connected at the center of the driven gear. The both end of the shaft is connected with two same or different generator through coupling.

For vertical blade wind turbine, the main parts are follows below:

- Blades and rotor,
- Electromagnetic Induction Generator (2Qty),
- Gears (straight bevel gear mechanism),
- Shaft.

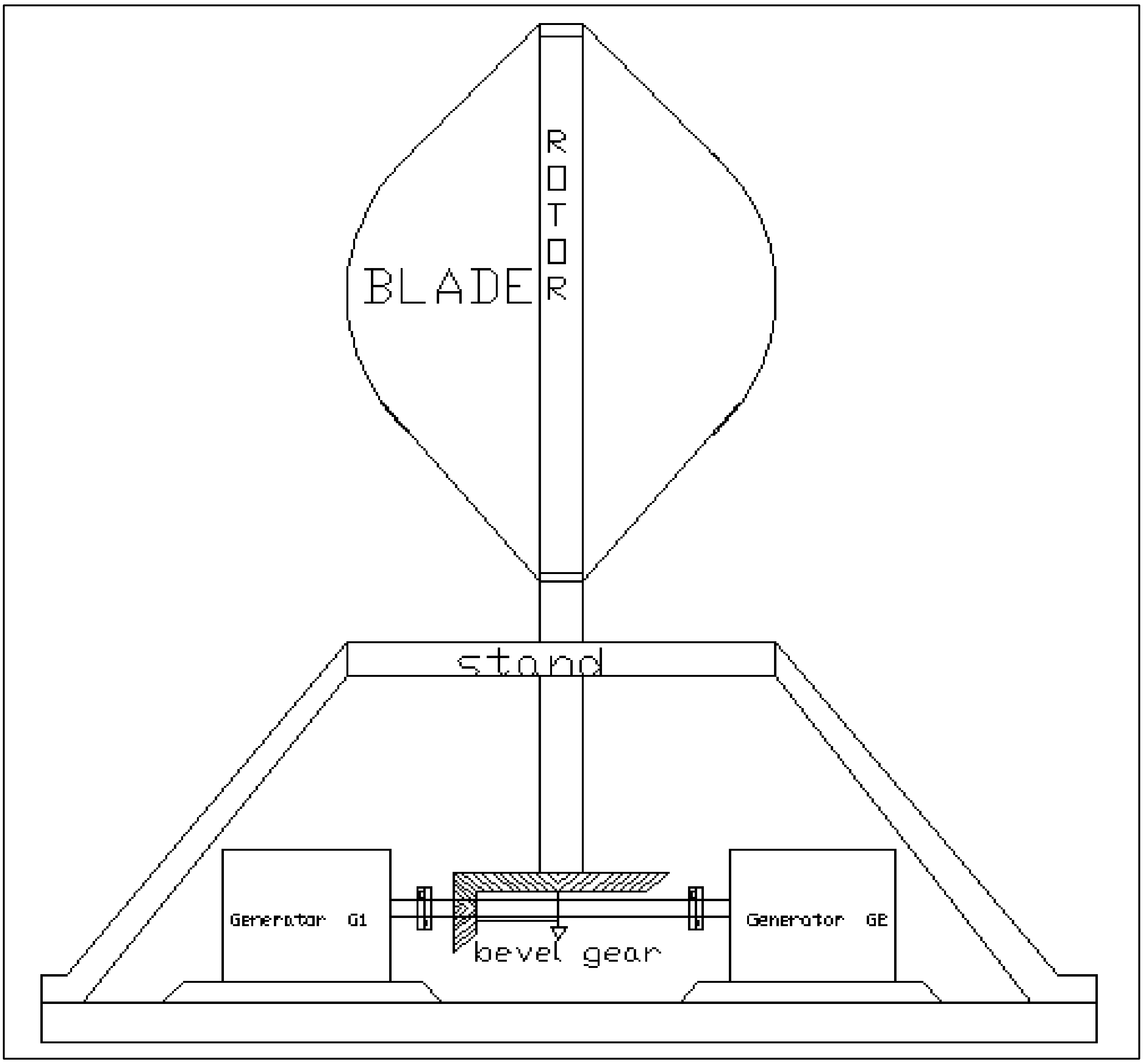

Figure 2. Experimental setup for vertical wind turbine

The blade is attached with rotor. The rotor connected with straight bevel gear through shaft. The gear box consists of driver and driven gear. The one end of the low speed shaft is connected with driver gear and other end is connected with rotor turbine of the windmill. The long high speed shaft is connected at the center of the driven gear. The both end of the shaft is connected with two same or different generator through coupling.

3.4 Poles of generator

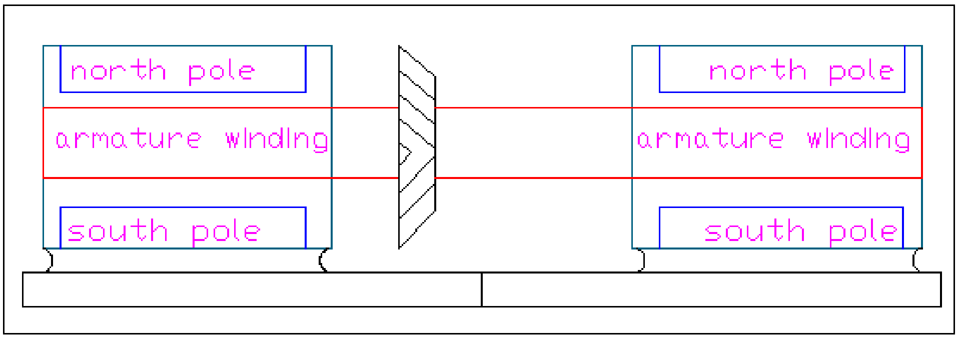

Figure 3. poles of generator

The one of the Generator is rotated at clockwise and other one is rotated at anticlockwise. The anticlockwise rotating Generator is not giving the current. So, we change the poles inside the motor. The poles of two motor is parallel and connected with driven gear through long shaft.

3.5 Working of the Method

The rotor is rotated due to the force of wind strikes the blades of windmill. The rotating blades are transmitting the power to the gear box (driver gear) through rotor from the shaft. In gear box, the straight bevel gear mechanism is used which consist of driver and driven gears. The driver gear is transmitting power to the driven gear. Finally, the gear box is transmitting power to the two Generator through shaft in driven gear. The Generator shaft is rotated and same torque is produced. Because, torque is product of force and area so we balance the force and area the torque will be same. The Generator generates current.

3.6 Power and Torque transmission in bevel and spur gear

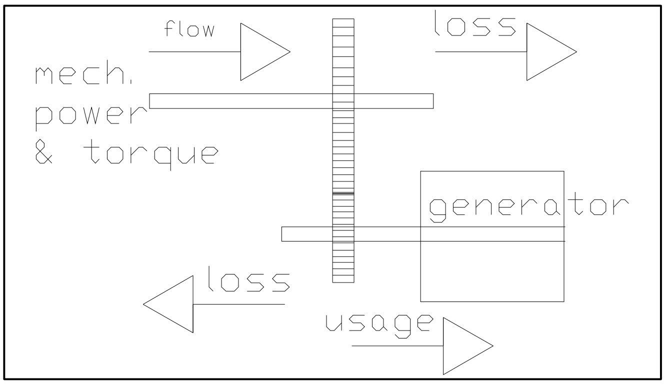

Figure 4. Power and Torque flow of transmission in spur gear

In spur gear, when the power and torque produced from the wind turbine rotors flows to the driver spur gear and divided into two ways: one is part goes straight and become a loss of power and torque another side goes to driven spur gear then again divided into two ways one is right side which is used by generator and opposite side is loss of power and torque. so, the windmill carries maximum efficiency is 50%.

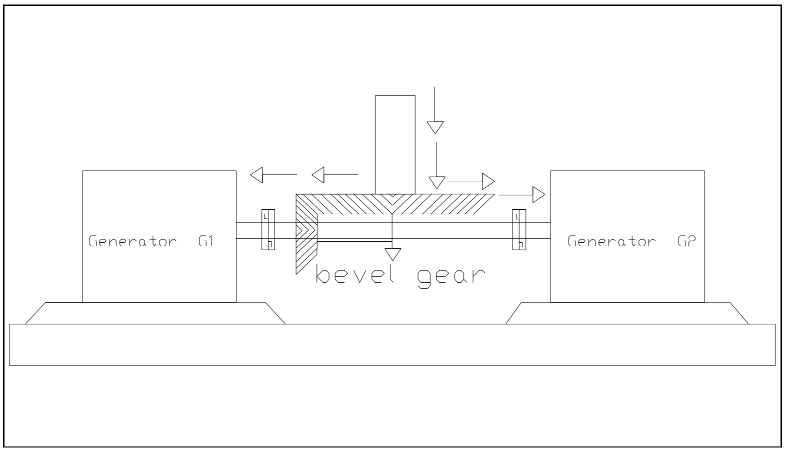

Figure 5. Power and Torque flow of transmission in bevel gear

In bevel gear, when the power and torque produced from the wind turbine rotors flows to the driver bevel gear and again goes to driven bevel gear then again divided into two ways one is right side which is used by Generator G2 and opposite side is also used by Generator G1. so, the windmill carries efficiency is increased when compare to using spur gear.

4. Parts of windmill

the main parts of windmill are follows below:

- Blades and rotor,
- Shaft.
- Gears (straight bevel gear mechanism),
- Generator (2Qty),
- Tower

4.1 Blades and Rotor

The blades are basically the sails of the system; in their simplest form, they act as barriers to the wind (more modern blade designs go beyond the barrier method). When the wind forces the blades to move, it has transferred some of its energy to the rotor. They are two types of blades as follows: Horizontal and Vertical blades. Then rotor which converts the energy in the wind to rotational shaft energy.

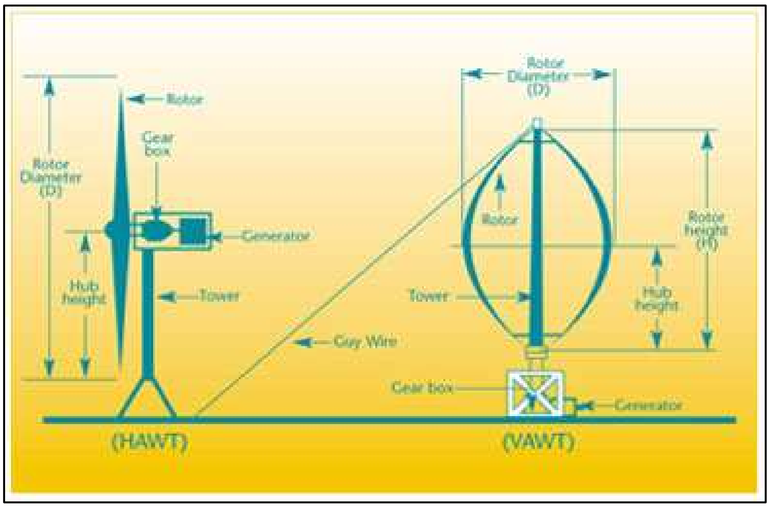

Figure 6. Horizontal and Vertical Blade and Rotor of wind turbine

4.2 Shaft

The wind-turbine shaft is connected to the center of the rotor. When the rotor spins, the shaft spins as well. In this way, the rotor transfers its mechanical, rotational energy to the shaft, which enters an electrical generator on the other end.

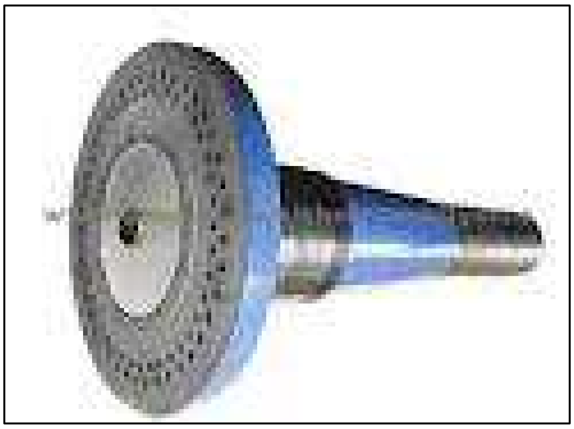
Figure 7. Shaft of wind turbine

4.3 Gear (bevel gear)

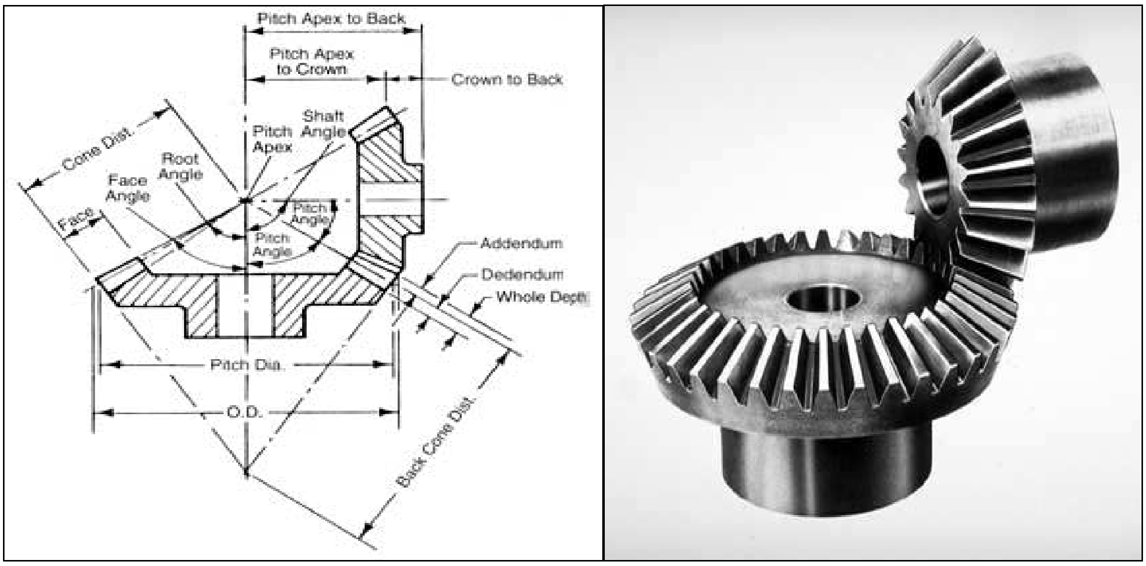

Figure 8. Specification of straight bevel gear

Bevel gears are useful when the direction of a shaft's rotation needs to be changed. They are usually mounted on shafts that are 90 degrees apart, but can be designed to work at other angles as well

4.4 Generator

At its most basic, a generator is a pretty simple device. It uses the properties of electromagnetic induction to produce electrical voltage - a difference in electrical charge. Voltage is essentially electrical pressure - it is the force that moves electricity, or electrical current, from one point to another. So generating voltage is in effect generating current. A simple generator consists of magnets and a conductor. The conductor is typically a coiled wire. Inside the generator, the shaft connects to an assembly of permanent magnets that surrounds the coil of wire. In electromagnetic induction, if you have a conductor surrounded by magnets, and one of those parts is rotating relative to the other, it induces voltage in the conductor. When the rotor spins the shaft, the shaft spins the assembly of magnets, generating voltage in the coil of wire. That voltage drives electrical current (typically alternating current, or AC power) out through power lines for distribution


Figure 9. Induction generator

4.5 Tower

The Tower that supports the rotor and drive train and other equipment, including controls, electrical cables, ground support equipment, and interconnection equipment.

Figure 10. Tower

5. Material specification

5.1 40 Ni 2 Cr 1 Mo 28

Alloy steel: 40 Ni 2 Cr 1 Mo 28 [Case Hardened]

This material is used to make of shaft, gear, bolt and nut.

- I.S specification as per IS 10343: 4D, C1
- Chemical composition:

Carbon C: 0.35 - 0.45 %

Manganese Mn: 0.45 - 0.70 %

Chromium Cr: 1.0 - 1.40 %

Nickel Ni: 1.30 - 1.80 %

Others: molybdenum Mo= 0.20 - 0.35 %

- Mechanical properties:

Tensile strength: 90 – 120 kg/mm^2

Yield strength: 70 – 105 kg/mm^2

BHN hardness: 270 – 400

- Physical properties:
    - Alloy Steels for medium to high strength, applications.
    - Good strengh ductility, shock & fatigue strength.
    - Used for brackets, levers etc.

5.2 Alluminium

This material is used to make blades of rotor turbine.

- Aluminium is a soft, durable, lightweight, ductile and malleable metal with appearance ranging from silvery to dull gray, depending on the surface roughness.
- Aluminium is nonmagnetic and does not easily ignite.
- Aluminium has about one-third the density and stiffness of steel.
- It is easily machined, cast, drawn and extruded.
- Corrosion resistance can be excellent due to a thin surface layer of aluminium oxide that forms when the metal is exposed to air, effectively preventing further oxidation.
- The strongest aluminium alloys are less corrosion resistant due to galvanic reactions with alloyed copper.
- This corrosion resistance is also often greatly reduced when many aqueous salts are present, particularly in the presence of dissimilar metals.

6. Advantages and Limitations of the methods

6.1 Advantages

- It generates more power
- It is not necessary connect the same generator and also connect different generator in serious shaft
- We will use all type of generators like permanent magnet D.C. generator, synchronous generator and induction generator
- Gear box is not used, only two straight bevel or spiral bevel gear is used (driver and driven gear)
- The power output is double compare to single windmill.

6.2 Limitations

- Initial cost is high
- Efficiency low .
- Maintenance is important and high
- Design is complement for gear and rotor turbine
- It require lot of space

7. Conclusions

This paper presents a new methodology for power generation using two same generators of single rotor, further advantage of the method is cost efficient and generating high power with a same torque. Theoretical analysis and experimental work is carried out confirm validity of the analytical work. we conclude that high power produced by single rotor which is the double of the one set of DC generator and rotor.

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