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Research Paper

DIFFERENTIATION ANALYSIS OF SINGLE AND DUAL ROTOR WIND TURBINE TORQUE TRANSMISSION SYSTEM

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For the next leap in the sustainable technologies, we are under obligations not only to cope with the warming global environment but also to conserve natural ecosystem and to coexist with nature this study aims to analyse the comparison analysis of single and dual rotor wind turbine torque transmission. For this purpose, we had analysed the gearbox transmission system of single and dual rotor wind turbine. In a single rotor wind turbine system the gear transmission system has parallel or planetary gear box arrangement but the dual rotor wind turbine system had combination of planetary and parallel shaft gearbox arrangement.

Keywords: Wind power, Gears, CATIA, Torque, Betz limit, Wind speed, Shafts, Bearings

INTRODUCTION

Wind is one of the clean energy sources, and its conversion to usable energy is important to reduce fossil fuel dependency. In order to obtain energy from wind, a lot of wind turbines are being constructed. However, regions having high wind energy density are finite. It is one of the fastest growing energy resources and it is going to have remarkable share in the energy market. Thus, the consequences of the connection of wind turbine, specifically in the form of a wind farm, to the electrical grid must be investigated from steady state, dynamic and transient point of view. Different approaches have been introduced to improve the static and dynamic responses of the wind turbines. Therefore, many researches to increase energy efficiency of wind turbines have been accomplished.Generally, horizontal axis wind turbines having a single rotor are used for conventional wind turbine systems. According to Betz theory (Manwell *et al.*, 2005), the maximum energy conversion efficiency of conventional wind turbines having a single rotor is about 59%. Bycontrast, the maximum efficiency obtained by two rotors having the same area is increased to 64%. based on this results, in order to increase the

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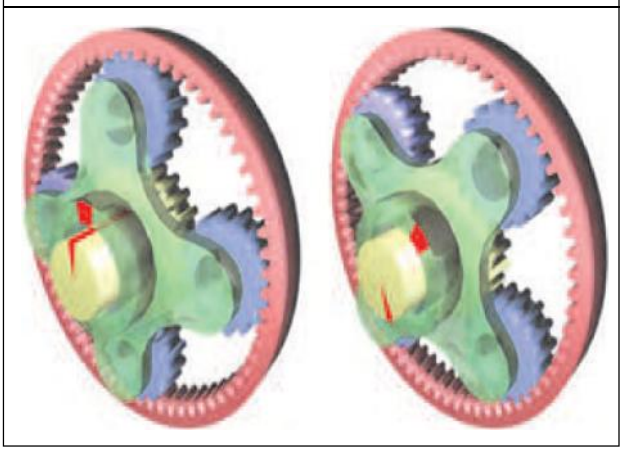
energy efficiency of wind turbines, some researches for Counter-Rotating Wind Turbines (CRWT) that have two rotors rotating opposite direction at the same axis have been progressed. Appa technology initiatives (Appa, 2002) have established a proto model of 6 kW counter rotating wind turbine in California. the rotor performance data have been measured and numerical predictions using Blade Element Momentum (BEM) method have been accomplished. Jung *et al.* (2005) has constructed a 30 kW counter rotating wind turbine system and has obtained power curve experimentally and numerically. inaddition, the effects of distance and diameter ratio between two rotors have been considered by using BEM method. Shen *et al.* (2007) has used CFD code, ellipse 3d, to predict performance of a counter rotating wind turbine having two Nordtank 500 kw rotors. All these researches mentioned above have compared the performance of a counter rotating wind turbine with that of single rotor having half number of blades. However, these comparisons are unfair because each rotor configuration has different solidity (the ratio of total blade areato rotor disk area). In this study, for a fair comparison, aerodynamic characteristics of a counter rotating wind turbine were compared with that of a single rotor having equal solidity as well as a single rotor having half solidity. Through numerical calculations of induction factors and power coefficients for each rotor configuration, the aerodynamic feasibility of a counter rotating wind turbine was considered.

METHODOLOGY

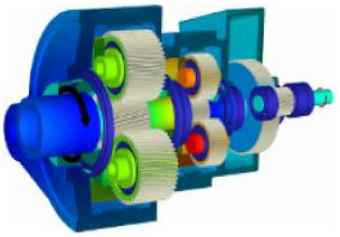
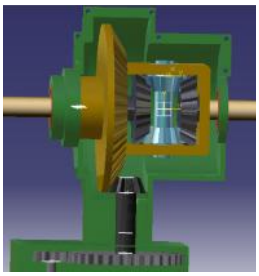
Mechanical power transmission by multiplying the angular speed under a constant transmission ratio represents the function of a large group of products known as speedmultipliers. Most wind turbines and hydro systems drive trains include a gearbox to increase the speed of the turbine shaft to the generator. An increase in speed is needed because the turbines rotors turn at a much lower speed than is required by most electrical generators. The range in which the input angular speed must be increased is 25-30 times the RPM.

Figure 1: Planetary Gearbox Arrangement



There are two basic types of gearboxes used in wind turbines applications: parallel-shaft gearboxes and planetary gearboxes. In the first case, in order to obtain higher values of the transmission ratio, multiple stages are placed in series. This arrangement increases the multiplication ratio but, in the same time, increases the overall dimension. Unlike the parallel-shaft gearboxes, the planetary gearboxes have some significant differences: the input and output shafts are coaxial, that reduces the radial and axial dimensions; there are sometimes multiple power branches, so the loads on each gear are reduced; the gearboxes are relatively light and compact.

Table 1: Comparison Analysis Table of Single and Dual Rotor Wind Turbine

S. No.	Specification	Single Rotor Wind Turbine	Dual Rotor Wind Turbine
1.	Gearbox Arrangement	It may be planetary or parallel shaft gearbox.	In this wind turbine Gearbox they are the combination of both planetary and parallel shaft gearbox
2.	Gearbox Structural design view		
3.	Power and Torque	In single rotor wind Turbine the wind energy we received is equal to $P = \frac{1}{2} \circ AV^3$ $T = \frac{P * 60}{2®N}$ This wind energy is converted into rotating energy by the help of rotor blades. Single rotor wind turbine can only convert about 1/3rd of energy. Other 2/3rd of wind energy is wasted.	Dual rotor wind turbine has advantage of extra energy capture. The wind energy which is wasted by the Front rotor can be used by rear rotor. Thus we get double torque from front and rear rotor. Total Torque on the Gearbox = Torque from Front rotor + Torque on the Rear rotor.
4.	Cut in speed	The cut in speed of a small single rotor wind turbine is about 2.5-4 m/s but for large wind turbine this increases up to 7-9 m/s.	Dual rotor wind turbine has advantage of reduce in cut in speed since the input torque of gearbox is doubled.
5.	Efficiency	According to the Betz limit the maximum energy we can extract from a single rotor wind turbine is 59% of the total captured wind energy. But practically only 30-40% of wind energy can be converted to electricity.	The wind energy from the front and rear rotor captures more energy than single rotor wind turbine. Different new Researches and studies have found that Dual rotor wind turbine had 5% more efficiency than a single rotor wind turbine. . In case of single rotor only single front rotor can convert wind energy into useful energy but in this research paper had designed a dual rotor wind turbine gearbox on CATIA which can generate about 5% more power than conventional wind turbine system.
6.	Cost	Gearbox is one of the most expensive part of the wind turbine. Single rotor wind turbine gearbox cost about 100000 dollars for a unit MW. This is about 11% of the total cost of the wind turbine.	Since in the Dual rotor wind turbine the design complication and Size of the gearbox is more than single rotor wind turbine hence the cost will be greater. But since it has been proofed in researches that about 5% of increase in efficiency in Dual rotor wind turbine hence payback period will also reduce.

CONCLUSION

In this Research paper we have studied the designing of the Gearbox of dual rotor wind turbine system. We have used CATIA software for the designing of the gearbox. But calculation for the dimensions of gear is done by basic formulae's. We assumed that the speed of wind in front rotors is reduced by 2/3rd times the original wind speed. Basic formulae's for calculating gear dimensions are discussed and tables of gear dimensions are drawn in this paper. This gearbox has two input shafts and one output shaft. The dual rotors in front and rear side capture wind energy. The captured wind energy is transformed into high speed rotational energy by transmission system. In case of single rotor only single front rotor can convert wind energy into useful energy but in this research paper had designed a dual rotor wind turbine gearbox on CATIA which can generate about 5% more power than conventional wind turbine system.

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