Wind Turbine Gear box Reliability Enhancement using Eclipse Drive

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Abstract - **The failure of conventional gearbox is mainly due to breaking of gear teeth, which is removed by using kinematic linkages in eclipse gear box. The force which is traveled from the input shaft to the output shaft, which is mechanically joined to rotor of the generator, is equally distributed by the number of links present in eclipse gear box. The necessity of only one stage instead of multiple stages in conventional gearbox for complete transmission of power improves the reliability of the gearbox. For electricity generation constant output shaft speed is required which is given by eclipse drive train. One gear rotates and provides a circular path for another gear. A rotational gear is attached on high torque shaft. Another gear is engaged with the rotating gear and translates on a circular path. The second gear is attached with linkages to a low torque shaft that resembles a crankshaft.**

Keywords- **crankshaft, eclipse gearbox, kinematic linkages, reliability of gearbox,**

I. INTRODUCTION

The fastest growing renewable energy source is wind power. Wind power is presently responsible for about 1:5% of the world's electricity use. Because of high interest in wind energy, it becomes more important to increase the efficiency of wind energy conversion systems (WECS), also called wind turbines. The complete system required to convert the energy in the wind to electricity is called a wind energy conversion system (WECS). Such a system consists of a rotor to capture the energy in the wind, a gearbox configuration to increase speed of the rotational speed of the shaft and a generator to convert the mechanical energy into electrical energy.The efficiency of the total system is not only determined by the efficiencies of the gearbox and generator, but also the energy that can be extracted from the wind. A wind energy conversion system consists of a number of components to transform the energy in the wind to electrical energy. One of the components is the rotor, which is the component that gives energy from the wind.The operating region of a wind turbine is divided into three regions. Region 1(wind speed up to 4m/s) is the low wind speed region for which the turbine does not produce any power, the rotor is stands still and the turbine is disconnected from the grid. When the turbine will be connected to the grid at low wind speeds, the generator will operating as a motor, driving the turbine. The turbine would then actually be working as a huge fan, consume energy instead of producing. The second region, region 2(wind speed 4 to 14m/s), the region between the wind speed at which the turbine operate (Vw;cut¡in) and the wind speed at which maximum power is produced (Vw;rated).

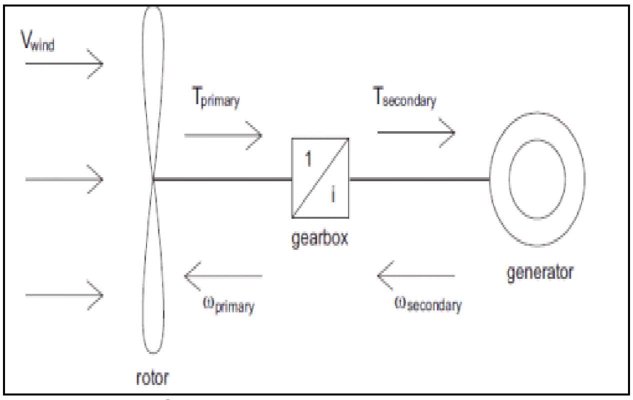

Fig. 1. Wind Energy Conversion System

This is the region for which maximizing energy capture is very important. In a typical wind turbine, region 2 operation accounts for more than 50% of the annual energy capture. This indicates the importance of efficient operation in this region. In region 3(wind speed 14 to 25m/s), which is the region from the rated wind speed to the wind speed at which the turbine is stopped to prevent damage (Vw;cut¡out).

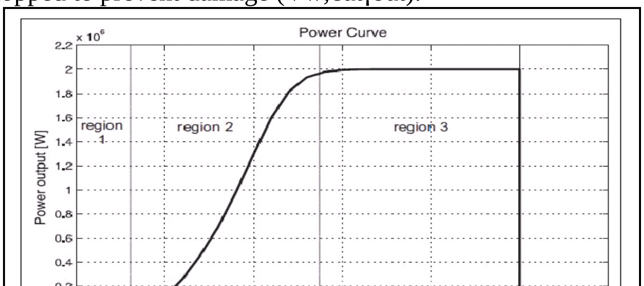

Fig. 2. Power o/p Vs Wind speed

In this region, energy capture is limited such that the turbine and generator are not overloaded and dynamic loads do not result in mechanical failure. Premature gearbox failures current major issues in the wind energy industry. Gearbox reliability problem and high repair costs combine to result in critical negative effects on the cost of wind energy production.

1) Long down-times when energy cannot be produced.

2) The substantial expense of the large crane needed to lift a replacement gearbox into place .The cost of the gearbox itself.

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II. DESIGN METHODOLOGY

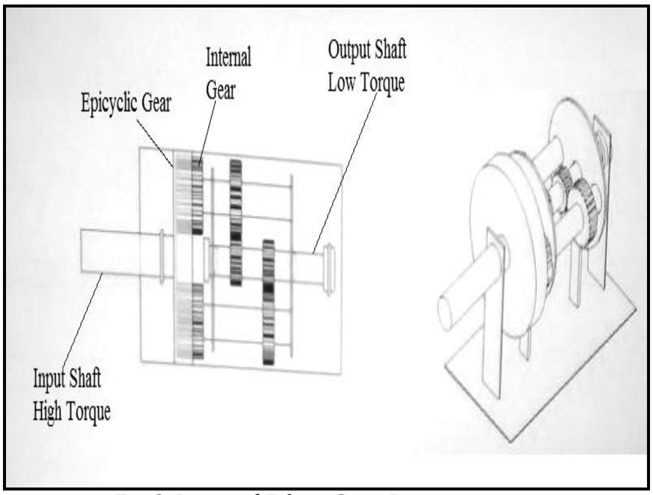

Fig. 3. Layout of Eclipse Gear Box

Epicyclic gear is connected to the input shaft (high torque). Two internal are connected to the epicyclic gear through two linkages and linkages are connected to output shaft (low torque) through gears. Motion delivered by epicyclic to internal gear in 360^0 rotation of input shaft (by one pinion) is only during forward state due to one way clutch. During 0^0-180^0 one pinion in forward transmission is continuous. Output is mainly depends on : Number of linkages, Linkages dimensions, Gear ratio of epicyclic gear and internal gear, at the same time other pinion will be in reverse state, during next phase of 180^0-360^0 condition reverse so motion gear.

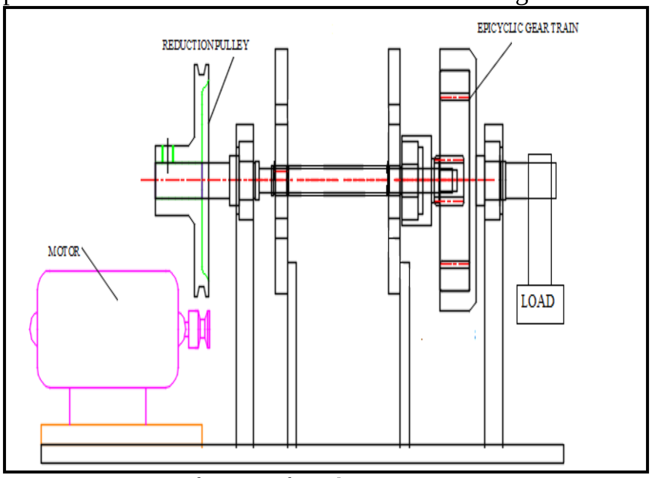

Fig. 4. Layout of Test Rig for Eclipse Gear Box

For testing purpose we take low torque shaft as i/p shaft by using motor and belt input motion is given. Two linkages are in motion through gear and epicyclic gear rotates high torque means output shaft at high torque, various loads are applied and change in rpm is noted.

Development of theory

A) System Design: This part includes the design and development for the kinematic linkage as per the geometry to produce the desired step-less speed change effect.

B) Mechanical Design: This part includes the design and development of linkages, selection of suitable drive motor, strength analysis of various components under the given system of forces

C) Fabrication: Suitable manufacturing methods will be employed to fabricate the components and then assemble the test set –up.

D) Testing: Testing activity will be done with view to comment on the capability of the machine as regards to the power transmission ability, efficiency and bearing life.

E) Facilities available: The following facilities to carry out fabrication work are available at sponsor's site

1. Centre lathe
2. Milling machine
3. DRO – Jig Boring machine
4. Electrical Arc Welding
5. Variable Speed drives for motor
6. RPM meters

F) Motor selection: Thus selecting a motor of the following specifications

Single phase AC motor, Commutator motor, TEFC construction, Power = 1/15hp=50 watt, Speed= 0-6000 rpm (variable), Motor is an Single phase AC motor , Power 50 watt , Speed is continuously variable from 0 to 6000 rpm. The speed of motor is variated by means of an electronic speed variator. Motor is commutator motor ie, the current to motor is supplied to motor by means of carbon brushes. The power input to motor is variable by changing the current supply to these brushes by the electronic speed variator; thereby the speed is also is changes. Motor is mounted and is bolted to the motor base plate welded to the base frame of the indexer table.

Input Data

Input power = 0.05kw

Input speed =1000 rpm

Center distance = 210 mm

Max belt speed = 1600 m/min = 26.67 m/sec

Groove angle (2β) = 40^0

Coefficient of friction = 0.25

Between belt and pulley

Allowable tensile stress = 8 N/mm^2

Section of belt section Ref Manufacturers Catalogue

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C/S Symbol	Usual Load Of Drive (Kw)	Nominal Top Width (Wmm)	Nominal Thickness T Mm	Weight Meter Kgf
FZ	0.03 - 0.15	6	4	0.05

Result Table

1.	**Belt Selected**	FZ 6 x 600
2.	**Tight side Tension**	T_1 =124.24 N
3.	**Slack side Tension**	T_2 = 16 N
4.	**Motor pulley did.(ϕD_1)**	D_1 =25 MM
5.	**Pulley (a) diameter (ϕD_2)**	D_2 =100MM

III. CONCLUSIONS

Energy is produced only when the rotor rotates at a minimum speed of 5 RPM; the proposed gear box achieves a higher velocity ratio than the existing hence making it possible to produce the energy even at lesser wind speed. The service life for the proposed gear box will be marginally higher as compared to the existing; around fifty years of service life is expected from the proposed one. The current i.e. Eclipse gear box amounts to approximately 10,000 pounds per MW. When successfully implemented this Gear box will be proved as much more efficient speed enhancer.

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