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On 21st & 22nd March, Organized by

Sri Krishna College of Engineering & Technology, Kuniamuthur, Coimbatore-641008, Tamilnadu, India

Reduction of Shaft failure in Wind Turbine

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ABSTRACT:The present domestic wind turbine is damaged due excess wind force acting on them from the base to the head in a uniformly varying load type (UVL).To defeat this issue we have actualized variable hub wind turbine which will pivot without any harm. In this task we acquainted swivel joint with tilt the generator setup when the wind speed surpass certain point of confinement. So we can maintain a strategic distance from shaft harm and generator disappointment because of overabundance wind speed.

KEYWORDS:Domestic Wind Turbine, UVL, Swivel Joint, Generator disappointment

I. Introduction

Power generation from wind has emerged as one of the most successful renewable energy source.The diagram below gives a guide to a typical small wind turbine system at a house.It is crucial to comprehend the wind plant design. The wind plant could be isolated to two real parts œ Mechanical Turbine and Electric Generator. The accompanying segment gives a short portrayal on the Wind Energy System including the principle segments, outline and operation. Around the above Nacelle is a packaging that houses the key parts of a windmill, for example, Gear box, Generator, Electronic Control Unit, Yaw Controller, Brakes, and so forth. The rotor razor sharp edges catch the wind's vitality and proselyte it to rotational vitality of shaft. The rotor razor sharp edges are typically two or all the more in number and are made of Glass-fibre fortified plastic or Epoxy tar covered wood. It likewise incorporates structures of Aluminium / Copper for lightning insurance and steel for the association with the centre.The centre in turn exchanges the vitality to the low speed shaft. Thedesigns operate on either the principle of drag or lift. For the drag design, the wind pushes the blades out of the way.Dragpowered wind turbines are characterized by slower rotational speeds and high torque capabilities. Lift-powered wind turbines have much higher rotational speeds than drag types and therefore well suited for electricity generation.The low speed shaft of the wind turbine connects the rotor hub to the gearbox. The low speed shaft rotates at relatively slow speed of about 19 to 30 revolutions per minute and transfers the rotational energy from the hub to the gear box. The shaft contains pipes for the hydraulics system to enable the aerodynamic brakes to operate.

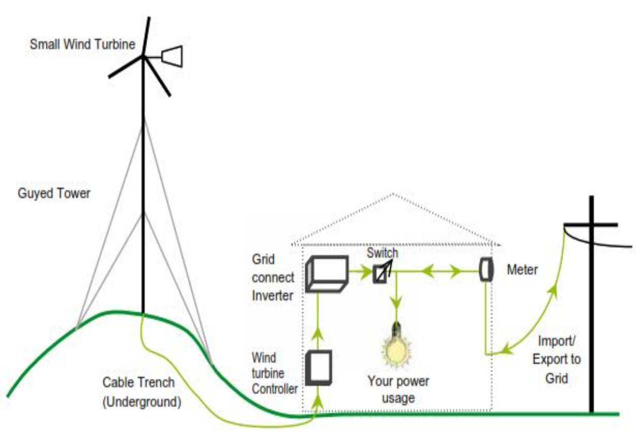

Fig. 1 The transmission line of Wind Power

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The Gear Box increases the speed and transfers the rotation energy to the high speed shaft, which rotates about 50 times faster than the low-speed shaft. Brakes are used to stop the rotation of shaft in case of power overload or system failure. The High speed shaft is equipped with an emergency mechanical disc brake, which is used in case of failure of the aerodynamic brake, or when the turbine is being serviced. In addition, it contains an oil cooling unit which is used to cool the oil in the gearbox. The yaw mechanism uses electrical motors to turn the nacelle with the rotor against the wind. The yaw mechanism is operated by the electronic controller which senses the wind direction using the wind vane. The anemometer and the wind vane are used to measure the speed and the direction of the wind.

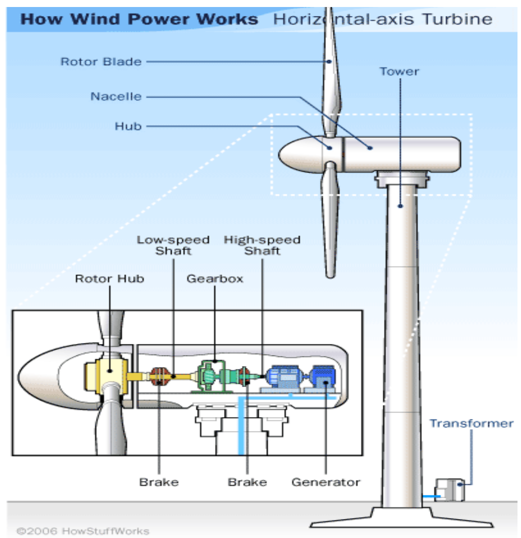

Fig. 2 Internal components of large wind turbine

The electronic signals from the anemometer are used by the wind turbine's electronic controller to start the wind turbine when the wind speed reaches approximately 5 metres per second (10 knots).The transformer, which will be located near the windmill, increases the voltage of the electric power generated in the windmill to the distribution voltage (thousands of volts).The distribution-voltage power flows through underground lines to a collection point where the power may be combined with other turbines. The tower of the wind turbine carries the nacelle and the rotor. The tower acts as a support structure to the windmill and also holds the power generation unit in a good elevated place for the good generation of power.

II. PROBLEM IDENTIFICATION

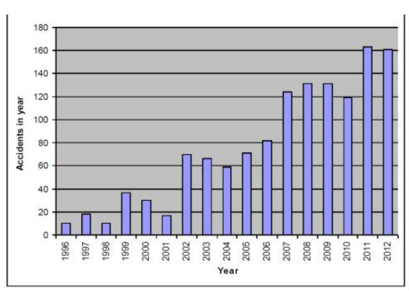

Fig. 3 Summary of Wind turbine accident data (1996 – 2013)

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- In domestic wind mill blade will get damaged due to high velocity of air
- Stress acts on the tower due to high velocity of wind.
- Bearing failure
- Carbon brush failure
- Shaft failure
- Cost of repair is high

III.SHAFT FAILURE

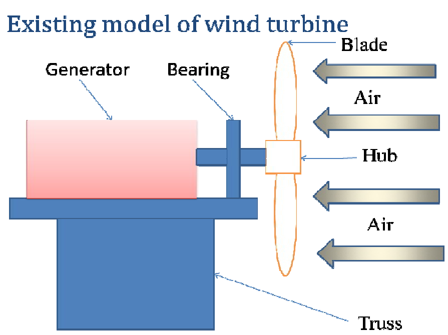

Fig. 4 Existing setup of wind turbine

The above figure shows the existing setup of the wind turbine. The generator and the bearing are fixed to the tower at an elevated level for the better power generation. The flow of the high wind affects the joints of the tower and the turbine head. This is the major source for the shaft failure of the turbines.

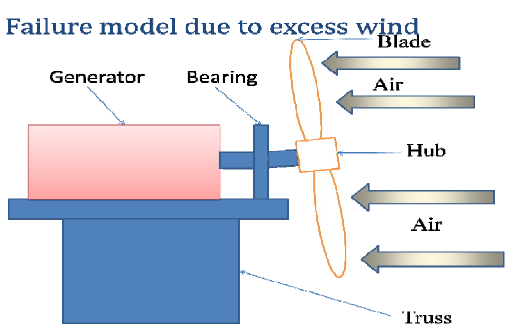

Fig. 5 Failure mode of existing setups

Every wind turbine is designed to withstand an ultimate velocity of wind. If the velocity of the wind exceeds the prescribed limit then the failure takes place. The major failure that takes place is the shaft failure because of the rigidity of the assembly. This affects the bearing life and the efficiency of the generator highly.

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IV. BREAKDOWN RISKS

Breakdown risk is one of the most common risk which results in mechanical damage to the windmill. A study carried out on the international and Indian windmill claims gives the following figure:

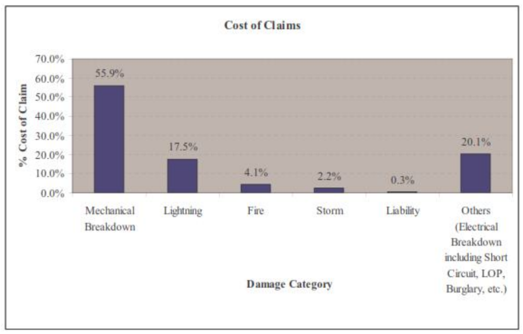

Fig. 6 Damages due to breakdowns

V. PROBLEM RECTIFICATION

- The wind turbine have the capability to with stand a specific wind velocity when the wind velocity exceeds its limit acting on the turbine, the low speed shaft of the wind turbine failures due to loads acting on it and rigidity of the shaft. To overcome this problem we introduced swivel joint in the Wind turbine it enables to operate even under excess wind velocity without any damages up to a certain limit.
- In this project, we implemented the swivel joint and a rubber stamp to avoid the shaft failure.

VI. DESIGN CALCULATION

Load acting on the hub

Load, P=0.5×swept area×airdensity×v^3 *(Formula)*

Where,
Air density =1.25kg/m^3
Velocity of air =12.5m/s

$P=0.5\times4.71\times1.25\times12.5^3$
P =5637.37N

Area of the hub
Area of hub, A=Π/4×(D^2 - d^2) *(Formula)*
Where
D= Outer diameter of hub
D= Inner diameter of hub

$A=\Pi/4\times(202^2 - 125^2)$
$A=31.55m^2$

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Stress acting on the hub

Stress=load/area *(Formula)*

=5637.7/31.55

=178.6N/mm^2

Factor of safety for steel = >1.6

FOS = 1.3

Thus the factor of safety is within the limit so the design is safe.

Load acting on swivel

No of swivel joint = 2

Diameter of swivel = 24 mm

Stress =load/area

Load acting on swivel= 3068.65N

FOS

Area of swivel = 18.8mm^2

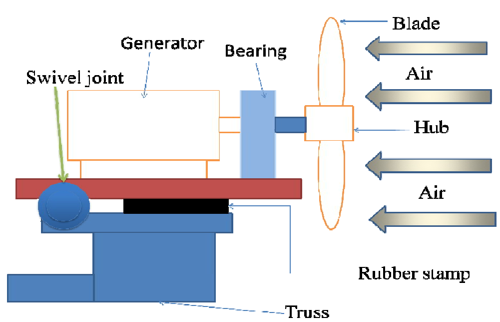
Stress = 163.22N/mm^2

Factor of safety for steel = >1.6

FOS = 1.5

Thus the factor of safety is within the limit so the design is safe.

VII. PROPOSED MODEL



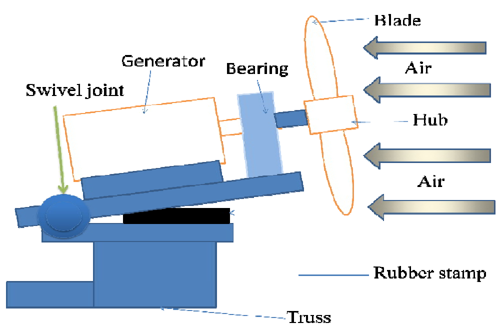


Fig. 7 Proposed ModelFig. 8 Proposed Model- Extreme condition

In order to overcome the above mentioned problem we are adding a swivel joint and rubber stamp in the existing model of wind turbine. When the wind velocity exceeds the determined value the wind turbine is tilted up due to the action of wind force by means of swivel joint. For rear balancing open coil helical spring is provided**.**The figure shows how the variable axis wind turbine tilts due to the excess wind force.

The various sections like wind energy system, wind power generation, equipments and components involved and their systematic operation. Among the above Nacelle is a casing that houses the key components of a windmill such as Generator, swing plate, swivel joint, etc. The rotor blades capture the wind's energy and convert it to rotational energy of shaft. The rotor blades are usually two or more in number and are made of Epoxy resin.The hub in turn transfers the energy to the low speed shaft.

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Fig. 9 Swivel Joint arrangement

The hub in turn transfers the energy to the generator. The swivel joint is fixed with the two swing plates, it will tilt the generator. The swing plate is connected to generator and nacelle. Nacelle is the housing for the generator and the shaft balancing bearing which is mounted on the tower.If wind velocity exceed above the prescribed rpm due to excess wind, swing plate is tilted up due to tilting action the blade will rotate at normal speed so we can avoid the shaft damage with the help of swivel joint.

VIII. CONCLUSION

In flat fading channel, we train the detector by the pilot data inthe head of source data in each coherence time. But the channelis time-variant even during one coherence time, so in our future simulation, we may use different interpolation algorithms between different coherence time to improve the estimated channel phase and amplitude information. We use linear equalizer in our present model. As well know, linear equalizers do not perform well on channels which havedeep spectral nulls in the passband. While frequency selective fading channel normally causes the deep spectral nulls, so in our future simulation, we may improve this by add Decision Feedback Equalization (DFE). In this project, we produce two different scenarios by simulate a GSM carrier frequency and bandwidth, and use pilot data to estimate the channel phase. All of these are simulated in Matlab at present. In our future model, we may integrate our model into GNU radio with USRP hardware support, which will give a practical environment to test our wireless communications simulation and our own algorithm.

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