Failures In Wind Turbine Genrating System

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Abstract- *Wind energy is a renewable and fast growing source for electricity energy and the potential to extent more in future. In an attempt to facilitate access to a potential multi-terawatt resource, a number of failures occur in wind turbine generating system. So it is necessary to understand the failure mechanism in order to have preventive measures. This paper reviews the different kinds of failure taking place in wind turbine generating system.*

Keywords- Failure causes of wind turbine systems, Gearbox and Bearing, Failures in Converters and Generators, Failure Mechanisms in Power Electronic Converter.

I. INTRODUCTION

Wind energy is playing a major role in the energy transition from fossil fuels to renewable energy. In 2015 the world saw a net increase of 17% in the installed global wind power capacity to 432GW [1]. Although extensive research and development has been successful in increasing the size and power production of wind turbines, there is now renewed focus on maintenance costs as they account for a quarter of the Level is Used Production Costs (LPC).This paper mainly focuses on the failure occurring and their mechanism in wind turbine generating system.

II. BACKGROUND

Wind power production is becoming the world's fastest growing renewable energy source. The US targets 20% wind based electricity generation, i.e. over 300 GW, by 2030 and that of China aims for 15% renewable power generation by2020. Environmental factors combined with make serious demands on Wind turbines and result in significant component failure rate. This paper reviews some failures and failure mechanisms in the wind turbine generator systems.

III. FAILURE CAUSES OF WIND TURBINE SYSTEMS

In order to understand failure rates and improve reliability we have to be aware of mechanisms occurring at that time. Due to growth of Wind power production preventive maintenance (PM) has to be taken. Periodic inspections for better performance to achieve condition assessment based on empirical and subjective measures. Such require unwanted shutdown of unit which is highly uneconomical. a survey study on wind turbine failures based on 11 years of wind turbine failure, which consist of failure data for up to 4,000 turbines in Germany and more than 1,000 turbines in Denmark were included in that study. The main conclusions he draws from his studies are as follows:

i. Direct-drive turbines do not seem to have a lower failure rate than indirect-drive ones;
ii. The failure rates of gearboxes in indirect drive turbines are much greater than the failure rate of
iii. Inverters in indirect drive turbines;
iv. The aggregate failure rates of inverters and electronics in direct-drive turbines are greater than those of gearboxes in indirect-drive ones;
v. For larger direct-drive turbines, the failure rate for generators is at least double that of the indirect-drive ones.

A number of papers in literature focus on failure mechanisms of power semiconductors and electrical generators. This paper is presenting the failures and failure mechanisms in *Gearbox* and Bearing, power electronic converters and generators in the context of their use in wind turbines.

3.1 GEARBOX AND BEARING

Gearbox fault is the leading issue for wind turbine drive condition monitoring among all subsystems.

In gearbox tooth damage and bearing faults are both common. Vibration measurement and spectrum analysis are typical choices for gearbox monitoring and diagnostics. For instance, huang et al. presented a study on vibration spectrum analysis based gearbox fault classification using wavelet neural network.

For variable-speed wind turbine operation, wavelet analysis has been recently accepted for feature extraction, as compared to faster Fourier transform (fft) and envelop analysis tools developed earlier.

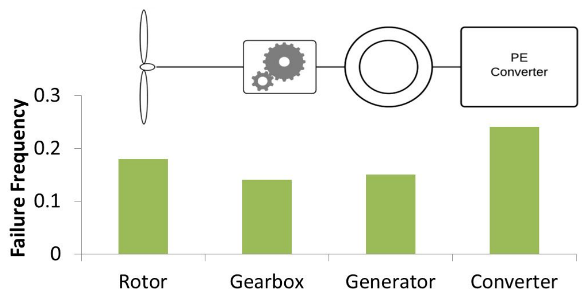

Figure 2.1 Ratio of failure in wind power

3.2 FAILURES IN CONVERTERS AND GENERATORS-

Failure rates of power electronic converters at a sub-component level with data from the WMEP Database. They reported that about half of all the faults in the power electronic converters are due to faults in semiconductors. Figure shows the distribution of failures amongst the sub-components. An industry based survey by Bryant et al. gave similar results with maximum respondents selecting semiconductor power devices as the most fragile component in converters.

Ale wine et al. has looked at failures occurring in Wind Turbine generators. They studied over 1200 generators from a wide variety of manufacturers; Figure gives the distribution of faults over the components of the generator. This distribution is for generators rated above 2MW. It has been concluded that a large portion of power electronics system failures are caused by the defects and failures of the semiconductor devices in the power electronics circuits.

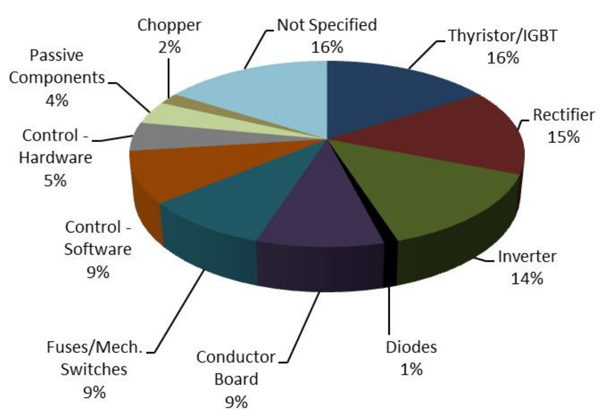

Figure 2.2 shows the distribution of failures amongst the Sub-components in power converter

3.3 FAILURE MECHANISMS IN POWER ELECTRONIC CONVERTER-

Published work has shown that failure in power electronic converters is mainly due to power semiconductors. Semiconductor switches suffer from a number of failures such as - bond wire lift-off, bond wire heel cracking, aluminum reconstruction, corrosion of interconnections, solder fatigue and voids, latch-up and cosmic ray failures and some others.

3.4 SOLDER JOINT FATIGUE –

Solder Joint Fatigue failure occurs because the solder layer is subjected to mechanical stresses under temperature cycling, because of the difference in the Coefficient of Thermal Expansions (CTEs) of the two materials between which the solder is present. Solder joint fatigue is considered a major failure mechanism in power electronic component.

3.5 BOND WIRE LIFT-OFF-

Failure of wire bonds occur as a result of fatigue caused either by shear stresses generated between the chip and wire, or due to repeated flexure of the wire These develop as cracks propagating along the bond wire-chip interface due to thermo-mechanical stresses caused by temperature cycling and the fact that aluminum (bond wire material) and silicon (chip material) have very different Coefficient of Thermal Expansion (CTE).

3.6 BOND WIRE HEEL CRACKING-

This failure, also, is due to the thermo-mechanical effect of the wire subjected to temperature cycling .Under such a cycling, the wire undergoes flexure fatigue. However, this failure mechanism is a slow process and rarely occurs in modern IGBTs.

3.7 LATCH-UP-

Latch-up is a failure inherent in the IGBT and occurs when the collector current cannot be controlled by the gate. It occurs when the parasitic thyristor in the IGBT is turned on by the parasitic transistor. This makes the IGBT lose control through the gate [13]. Latch-up is of two types, static and dynamic. Static latch-up happens at high collector currents which turn on the parasitic transistors. Dynamic latch-up occurs due to switching transients especially during turn off.

3.8 EFFECT OF WIND SPEED AND WEATHER –

The weather effects the failure rates in wind turbines. Humidity at the location of installation can lead to an increase in failures, especially in the power electronic converters and the generator. A number of failure mechanisms in the power electronic converter are caused due to temperature cycling effects. Therefore, it can be expected that the external temperature at a location could have an effect on failure rate.

IV. CONCLUSIONS

This paper has looked at the failures and failure mechanisms in the wind turbine generator systems. It has been concluded that a large portion of power electronics system failures are caused by the defects and failures of the semiconductor devices are result of and wire lift-off, bond wire heel Cracking, aluminum reconstruction, corrosion of interconnections, solder fatigue and voids, latch-up and cosmic ray failure.

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