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THE MONITORING & CONTROL BY FIBER OPTICS SENSORS IN WIND FARM TECHNOLOGY

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ABSTRACT

This paper provides the knowledge about fiber optics technology in wind power plants It is reliable and economical sensor in electrically hazardous environmental like wind farm. This paper dicusses about fiber optics for data commincation and monitoring control functions of various parts of wind farm also for use in high bandwidth and high speed telecommunications applications. Its sensors monitor the condition and strength of turbine parts to avoid failure though more than 100 Megawatt wind turbines are to be monitored.

Keywords: Fiber Optics, Communication and Monitoring Control

I INTRODUCTION

The electricity generation by wind farm are not a easily accessible as the height from ground maintenance, repair ,lightning strike challenges are to be considered The introduction of fiber optics in wind farm proved its dominance in electronic communication system with extremely high data handling capabilities over the range of Giga Bits per Second. It is the backbone of modern data traffic system. Because of electrical isolation of dielectric optical fibre, Fibre optics overcomes the common issues to fulfil the need for speed in real-time monitoring, while providing a more stable conductor and better data security than copper components. They are used in wind power system as:

Communication media and Sensors to monitor and control. It also provides knowledge about requirement of fibre optics in wind power plants, its advantages and major components of fibre optic technology. Most modern wind power plants have intelligent features to monitor and control the subsystems like rotor, gearbox, generators and yaw drive to accommodate varying wind conditions. There are more than 100 parameters that are to be monitor or set in modern wind turbines. The principles and applications of fibre optic sensors in present generation megawatt wind turbine to monitor and controlled by itself. Fibre optics is typically found in various systems within the wind turbine associated with displacement sensor, vibration sensor, ice sensors, temperature sensors, speed & wind direction laser sensors, and Fibre Bragg Grating sensors for monitoring strain on the blades etc. Outputs of these sensors are required to feed to controllers. Controllers transmit control signals to be sent to various sections of the wind turbine. One PLC controller is also placed at the bottom of tower to control wind turbine and electric substation. Any kind of duplex communication setup has to be established in this

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regards. Fibre optic communication data links became preferred choice, considering its electrical isolation characteristics.

Because of the galvanic isolation and low attenuation of optical fibre, wind turbine utilises fibre optics in two ways: as a communicating system between devices and as sensing element itself. Some of the key area in wind turbine and wind farms where fibre installations suitable are:

• Power electronic gate driver for rectifiers and inverters
• Control and communication boards
• Turbine control units
• Condition monitoring systems
• Wind farm networking

II NEED OF FIBRE OPTIC SENSORS IN WIND POWER PLANTS

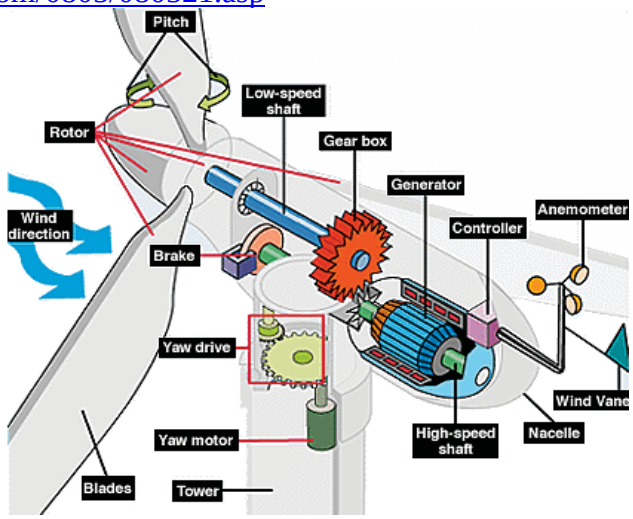
The major benefits including insulation long data transmission length ,easy installation and maintenance Fibre optics sensors becomes a preferred choice in megawatt rated wind turbine as it offers much higher voltage and current isolation properties compared to other similar counterparts. Optical fibre is used as a sensing element to monitor and control various physical parameters of the turbine. Applications within the turbine nacelle using fibre optic links insure that the turbine has a high reliability.

As shown in figure 1, some of the main fibre optic sensor application area in wind turbine includes:• Vibration of generators

• Temperature of Breakers
• Temperature of gear box
• Pitch and yaw control systems
• Strain of blades
• Wind pressure
• Stability of rotor and tower
• Ice and Moisture control

Figure 1: Fibre optics locations in wind turbine nacelle

Source: www.my-ftm.com/0805/080521.asp



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III FIBRE OPTIC SENSOR TYPES

The basic principle involving in Fibre Optic sensors is the change in light wave characteristics in the fibre waveguide by the parameter that required to be sensed or monitor. If light wave characteristics altered inside of optical fibre then it is called intrinsic sensor and if fibre is used as modulated light carrier probe, it is referred to as extrinsic sensor.

There are basically four sensing mechanism in fibre optic sensors:

a) Intensity Modulated Sensors

b) Phase Modulated Sensors

c) Polarisation Modulated sensors

d) Wavelength/ Frequency Modulated Sensors

By the way of measuring one of these variations, optical fibre sensors are suitable to measure and monitor temperature at various parts of wind turbine, strain and pressure of wind blades etc. Some of the Optical fibre sensors used in modern wind turbines are listed in table 2

Optical Fibre Sensor application in Wind Turbine

Name of fibre optic sensor	Description of Sensor type	Application in wind turbine
Temperature	Intensity modulated intrinsic optical fibre sensor, Fibre Bragg Grating sensor	Monitor temperatures at all bearings, shafts, gearbox oil, generators, yaw drive and brakes
Vibration	Intensity modulated extrinsic optical fibre sensor	Monitor vibration of tower, generator
Pressure	Fibre optic Polarization modulated sensor	Monitor wind pressure and wind flow
Strain	Fibre Bragg Grating or Rayleigh Scattering sensor	Monitor blade strain for being damage, used in large turbine blades
Displacement	Intensity modulated extrinsic optical fibre sensor	Monitor tip deflection of blades to prevent blades hitting the tower
Moisture, ice	Intensity modulated intrinsic optical fibre sensor	To prevent wind turbine degradation
Rotation	Fibre Optic gyroscope, interferometric type	Monitor pitch angle of each rotor blades, yaw angle of rotor

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IV FIBRE OPTIC SENSOR ADVANTAGES IN WPP

Fiber optics technology is only accepetable in high electrical noise environment for electrical generators or turbine, It prevents lighting strikes in wind farm installations. Fibre Optic sensors are having greater advantages in megawatt scale wind turbines. Some of the main benefits of Fibre Optic sensors are:

• Reliable, since dielectric optical fibres are immune to EM interference.

• Precise, since small variations in physical parameter can lead to measurable changes in intensity and phase, in particular, of light waves.

• Having long range of operation.

• Small in size and light weight therewith or incidental thereto.

V NEED OF FIBRE OPTIC SYSTEM MAINTENANCE

Optic Sensors are eyes and ears of the wind turbines. Any kind of malfunction in these Sensors and corresponding Fibre Optic Communication channel may lead to bigger damage in wind power generation systems.

There are two kind of maintenance for fibre optic system:

• Periodic Maintenance

• Breakdown Maintenance

The performance of fibre optic sensors decreases over the period of time due aging and environmental effects. Sensors installed at various parts of wind turbine have to be calibrated or replaced as specified by manufacturer for their optimum and reliable functioning. Light Sources like Laser diode, used in Data Communication Equipment loses its power output stability in the operating age of two years or so. The sensitivity of light detectors (APD in particular) deteriorates in the same manner. Light sources, detectors or corresponding communication equipment has to be replaced in the period of two years or as per manufacturer's specifications. Optical Fibre Cables do have aging effect under the installation conditions. Its attenuation and mechanical strength characteristics decreases and are require replacing with new cable. Fibre cables installed in turbines and in wind farm may break in excessive wind pressure conditions or accidentally. In this breakdown condition, small patch cable (inside turbine) is to be replaced and wind farm cable need to be spliced using Fusion Splicing Machine. Wind turbine performance is a critical issue in light of increasing stringent grid requirements. rich experience in power generation makes it industry leader in grid connection. provides sophisticated set of grid friendly benefits in line of conventional power plants.

VI FIBRE OPTIC WIND TURBINE CONTROL NETWORKING

The fibre optics is typically found in various systems within the wind turbine associated with displacement sensor, vibration sensor, ice sensors, temperature sensors, speed & wind direction laser sensors, and Fibre Bragg Grating sensors for monitoring strain on the blades etc. Outputs of these sensors are required to feed to controllers. Controllers transmit control signals to be sent to various sections of the wind turbine. One PLC controller is also placed at the bottom of tower to control wind turbine and electric substation. Any kind of

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duplex communication setup has to be established in this regards. Fibre optic communication data links became preferred choice, considering its electrical isolation characteristics.

Fibre Optic Selections

Since data rate in not the critical issue (Mega Bit Per Seconds, MBPS) within wind turbine and transmission distance of 100 meter or so, following could be the selection choice from fibre optic technology:

Optical fibre cable : Reinforced Multimode Glass Fibre Cable, 50/125 core-cladding ratio.

Light Source : Light Emitting Diode (LED) at operating $\lambda = 1.3$ μm

Light Detector : PIN photodiode

Signal conditioning : Hamming coded digital format

Figure 2 shows fibre optic installations in hub, nacelle and tower of typical modern wind turbine. All signals are fed from nacelle through Fast Optical Ethernet Channel Switch (100 MBPS) to Main Controller at the bottom of the tower. The PC controller at basement monitors parameters of wind turbine and control signals are sent to all the functioning units of the turbine for its health and stabilisation. In order to reduce wire complexity, Fibre Optic Couplers are used to combine various signals. Fibre optic star couplers are used to combine individual fibres at various locations. These fibre optic signals are multiplexed/ demultiplexed using Wavelength Division Multiplexing technique.

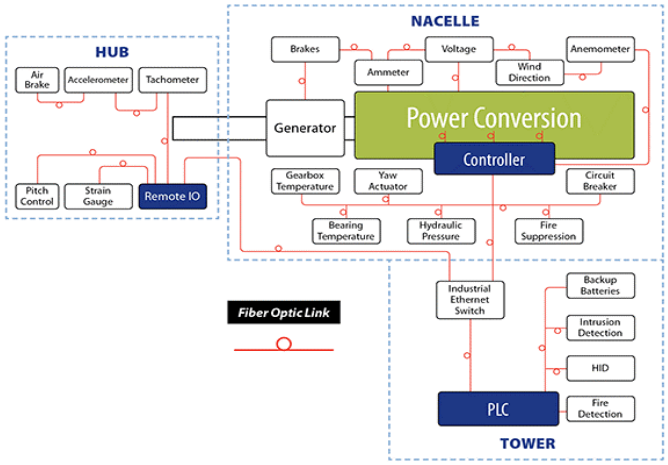

Figure 2:Fibre Optic Installations In Hub, Nacelle And Tower Of Typical Modern Wind Turbine

Source: Http://Www.Firecomms.Com/Applications-Renewable_Energy.Html

VII CONCLUSIONS

As the wind power is becoming popular renewable energy source in the overall Worldwide. The size and electrical generation capacities are growing up.as wind farm installations in onshore aswell as offshore the necessity of Electrically immune Optical Fibre finds itself in a important role to modernized the wind turbines and wind farm. The precise and handy fibre optic sensors are useful to monitor and control 100's of parameters in megawatt scale large wind turbineFor Fast and reliable fibre optic Networking resolves complications in

communicating these parameters within wind turbine and in the wind farm.The sensor monitor of different parameters operation from sensors fed to SCADA system for preventive such as vibration and outside environmental factors actions which can impact power generation safely.also data from sensors fed to SCADA system for preventive actions.

REFERENCE

1.Inernational Journal of innovative research in Electrical ,Electronics ,instrumentation and control engg vol .3 issue May 2015

2. Wind power plants and project development by Joushua Earnest & Tore wizelius

3. www.wind energy .com

4 www.Powergridindia.com