Winergy Condition Diagnostics System
Enterprise-Wide Fleet Management Roadmap to Advanced Condition Monitoring

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Overview

- Principle of Condition Diagnostics
- Winergy Condition Diagnostics System
- Wind Fleet Management Platform
- Roadmap - Advanced Condition Monitoring & Systems Approach
- Highlights
What and why?
A predictive monitoring solution which forecasts developing turbine faults and predicts lead time to action is necessary. It must be an intelligent solution with automated diagnosis based on software, not people, doing the cumbersome analysis of vast amount of real-time data from large numbers of wind turbines.

Advantages:
- Optimize Asset Management
- Increase Turbine Availability
- Reduce O&M Costs
Current Condition Monitoring Techniques

Human Sense (Hearing, Seeing, Feeling, Smelling)

Bore-Scope

Blade Monitoring

Oil Analysis

Vibration Monitoring

Easy to collect data but **not** so easy to evaluate the results
Condition Diagnostics System

- Unique signatures are continuously measured in selected operating states, and are compared to established baselines

- AutoDiagnosis™ associates deviations from baselines with unique potential fault characteristics and are, from methods collected in the Fault Library, used to express the deviation by Fault Symptom Strength

- Development in Fault Symptom Strength predicts fault development rate and generates an automated diagnosis message (AutoDiagnosis™) with a recommended action
Winergy CDS

Solution for Variable Speed / Variable Load
• Re-sampling solves the frequency smearing problem introduced by the varying speeds and loads of a wind turbine planetary gearbox

• Load Classification solves the problems of changing response level from varying load/speed

Solution for Planetary Gear Diagnostics
• Observation of planetary component health by extraction of low frequency effects from de-modulation of high frequency band vibration data
In our CDS approach, the triangle is turned upside down. We start by listing the thousands of faults that are likely to occur in a turbine. Each of these known faults are then given a symptom strength at which they reveal themselves when/if they occur.

For all of the predefined faults, the CDS acquires data ("Data acquisition"), it processes it automatically ("Signal processing") and in the event of a fault developing, an automated diagnosis ("AutoDiagnosis™") will be issued to the operator for action.
The Diagnostic Wheel
Overview of CDS Function

- Machines
- Components
- Sensors
- Signal Processing
- Signatures
- AutoDiagnosis™
- Message

- AutoSpectrum, NFFT = 1024, Navg = 45, Ovl. = 512
- Frequency
- Amplitude (dB)

- 1/3 Octave Analysis
- Frequency Band [Hz]
- Band Level [db]

- SED: Envelope Spectrum: 500 - 1500 Hz
- Frequency [Hz]
- Magnitude [mm/s²]

- Fine Structure Analysis
- Time delay [ms after trigger]
- Amplitude [mm/s²]
Overview of CDS Installation

Wind Turbines 1.. n

Nacelle
drive train

acc.
signals

CDS enclosure

Microbox

I/O Nodes

Switch

Fiber Optic

Down tower

Monitoring Center

Remote Access

Router/
Firewall

WWW

CDS Server

Plant Ethernet

Wind Park

= CDS hardware

= Additional required IT infrastructure
CDS Architecture

Data-Generation  Raw-Data-Capturing  Raw-Data-Conditioning  Signal-Processing  Automated Diagnostic

Firewire IEEE1394

Ethernet 1000Base-T
CDS Main Module Structure

CDS Enclosure

- SIPLUS CMS
- I/O Nodes
- Hardware devices
- Firewire IEEE1394

Microbox

- SIPLUS CMS
- X-Tools Software

Signal Processing Software

- OPENpredictor Virtual SPU
- Oracle DB temporary buffering

CDS Server

- Oracle DB

Optional: Enterprise-wide Fleet Management

- OPENpredictor AD
- Auto Diagnosis Software

- Ethernet
- Web Service

F.M. Server

- F.M. Internet Platform
- Winergy

- collecting and distributing of diagnosis and state messages

Wind Turbine

Wind Park

Winergy
Enterprise-Wide Fleet Management Architecture

[Diagram showing the network architecture with various components such as Head Quarter Server, Server Farm, Database, Corporate Network, Local Site-Server, Wind Park Network, Internet, and Turbine Builder. Each component is connected with firewall and network lines.]
Web Based Cockpit
User Friendly Drill Down Menus
Winergy Condition Diagnostics System

Highlights:

• Early fault detection, automatic fault diagnosis and prediction of remaining safe operational life
• Industry components based on established products
• Modular, scalable design (of +6 channels)
• Integrated or Add-on system independent of turbine make
• Uses process data via OPC interface
• Interfaces: USB, Ethernet, Profinet…etc
• Integration of Load and Oil Monitoring and turbine wide Condition Diagnostics as available
• Fleet Management – with user-friendly interface
Roadmap to Advanced Condition Monitoring
Online Load-Monitoring (Magnetostriction)
Testbench Verified 2009

Pilotproject Magnetostriction
- Torque
- Bending
- Displacement
Roadmap to Advanced Condition Monitoring
Online Load-Monitoring (Magnetostriction)
Testbench Verified 2009
Pulse Current Modulated Encoding technology (called “PCME”) applied to an already existing shaft, to measure absolute torque.

Key features of Magnetostriction Sensor Technology:
- Non-Contact sensing technology
- Measurement repeatability of 0.01%
- High signal bandwidth of up to 40 kHz
- Designed for harsh environment
- Low system complexity
- Low current consumption <10mA
- Suitable for high volume industrial applications
- No mechanical changes are necessary on the existing shaft, nor will anything be attached or glued on the shaft in any way
- The shaft keeps all of its mechanical properties
Roadmap to Advanced Condition Monitoring
Digital Fingerprinting

Winery
Component

Turbinebuilder
System

Internet

Fleet Mgmt Platform

Digital Fingerprint
No.: XYZ

Roadmap to Advanced Condition Monitoring

Turbine

Windpark

Gearbox
Controller
Generator
Converter
Electrical Equipment
Grid Access
Pitch
Yaw
Roadmap to Advanced Condition Monitoring
Digital Fingerprinting

Winery
Component

Turbinebuilder
System

Fleet Mgmt Platform

Condition Monitoring Center
Firewall

Firewall
Server Farm
Database

Trend Data

Internet

Control Room

Turbine

Windpark

Gearbox
Controller
Generator
Converter
Electrical Equipment
Grid Access
Pitch
Yaw

Acc. Sensors

SIMATIC TP
Microbox 427
CASTOMAT
SIMOTION P
DYNAVERT XL
SIRIUS
SIPROTEC
SENTRON
SINAMICS S120

Pitch Yaw Gearbox Generator Converter
Electrical Equipment Grid Access Controller Room Trend Data

Electrical Equipment

ET200S
ET200S safety
SINAMICS CU310

Windpark

Trend Data
Condition Diagnostics Implementation

- Wind Fleet Management
- Load Monitoring
- Oil Monitoring
- Advanced CM
  - Pitch, Controller, SCADA, Yaw, Converter, Elec. Parts, Grid Access
- CM Gearbox
- CM Generator
- CM Main Shaft

Services:
- Installation & Commissioning
- Application Engineering & Customization
- Support & SW updates
- Service/Reporting
- Training

Available Per Customer Request
Product Roadmap
Available Optional Services
Thank you for your interest!

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