Wind power special

EPHY MESS
Gesellschaft für Elektro-Physikalische Meßgeräte mbH

EPHY MESSAGE 02/09

E D I T O R I A L

Our main topic for 15 years: Thermal supervision of wind power stations.

For about 4000 years man has been harnessing the energy of wind. Initially the sail revolutionized the seafaring. It is said that 1700 years before Christ, the Babylonian king Hammurabi irrigated Mesopotamia with wind-powered water bucket elevators. Compared to that, wind power generators have only been in existence for a short time. The basis for the creation of modern wind power plants are the developments in the fields of aerodynamics, electromechanical engineering, control engineering, electronics and material technology. The bigger and more expensive these systems become, their monitoring will be of even greater importance. Thereby, the thermal control plays a significant role. Over 15 years ago - when other sensor manufacturers still ridiculed the wind energy sector - EPHY-MESS tackled the challenge of implementing temperature sensors into wind power plants head-on and began supplying to the first manufacturers. Together with the power plant manufacturers we developed tailor-made solutions. There is not a single important wind power system component that EPHY-MESS does not have a proven and absolutely reliable sensor technology for. Not only temperature monitoring is of our interest: Innovative electric band heaters help to prevent the highly critical lower deviation of the dewpoint and hereby prevent the formation of condensed water with all the consequences deriving from it.
That we are not resting on our current know-how advantage is demonstrated by a new development: Intelligent temperature sensors with a CAN-BUS- Interface will simplify the sensor integration and measured data transmission even further. Maybe we will see each other at the HUSUM-WIND 2010 trade fair. We are currently contemplating if EPHY-MESS should exhibit its technologies there for the first time. You will be hearing from us.

Sincerely yours
Andreas Becker
Corporate management

EPHY-MESS:
Specialized in wind power plant temperature sensors

The utilization of fossil fuels is becoming increasingly more expensive than the generation of power by wind. Until 2010 it is planned to install 3000 to 4000 MW just off the coast of Europe. The pace of the erection and enhancement of wind power plants worldwide is spectacular. The capacity for wind power plants was expanded by 20,000 MW worldwide in 2007. 10 years ago the percentage of power generated by wind energy was at 0.15%, 2006 it was already at 0.82% and BTM consulting estimates that it will climb to 4.04% by 2016. Facilities that are getting bigger all the time, (offshore) facilities that are becoming much more difficult to access and operate under increasingly critical conditions demand the highest level of reliability and safety from all components. Therefore the continuous and reliable temperature monitoring is of major importance. It is no coincidence that world market leaders for wind power plants, have been incorporating EPHY-MESS sensors into their original equipment for over 15 years.

Due to disproportionately high growth rates in recent years, new vendors for temperature sensors have entered the wind power market. For many years EPHY-MESS has been gathering extensive knowledge in temperature monitoring, for even the most different wind power plant concepts. Due to enhanced performance, the requirements for supervision and analysis have changed, so that today totally diverse temperature sensors for wind power plants are utilized for different monitoring functions.

Where EPHY-MESS sensors are utilized

Wind power plants are complex systems. An entire series of components is thereby subject to temperature monitoring. Though the focus is on the long-term maintenance of system functions and their operational safety in general. Unplanned downtimes should be avoided, service intervals optimized and the intended facility lifetime ensured. Several measuring points must be temperature monitored:

- **outside temperature**
- **control cabinet**
- **transformer**
- **generator**
- **pitch actuation of the rotor blades**
- **Azimuth adjustment of the wind turbine nacelle**
- **gear and bearing**
- **brakes**

Every single one of these measurement tasks is conducted under special operating conditions. Every temperature sensor has a specific installation condition. The strength of the EPHY-MESS product portfolio is to have the exact individually optimized sensors and electric band heaters available, or respectively to manufacture them, for wind power plant suppliers, manufacturers and service companies.

Outside temperature:

Source photograph: Deutsche Windtechnik Service

The external temperature monitoring is important to evaluate the temperature values within the facility, to activate electric band heaters in time if there is

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a pending risk of condensed water formation (for example through temperature deviations between the inside of the generator and the outside temperature) and the associated system damage risk and also to be aware of the weather situation in the proximity of the facility.

Depending on the installation position, it might be important that outside temperature sensors are installed moisture sealed. Therefore these sensors are usually manufactured as probes in sealed metal sleeves with adapted silicone hose lines and the sensor element is generally based on Pt100 resistors.

Control cabinet:

According to an analysis, it is no coincidence that control cabinets are among the most frequent causes for wind power plant malfunctions. Heat produced by power dissipation in the frequency inverters installed in the control cabinets should be monitored, because of a maximum allowed operation temperature of semiconductors or passive electronic components (e.g. aluminum electrolytic capacitors). Sensors, based on Pt100 elements are very suitable for the thermal monitoring of control cabinets. Alternatively, bimetallic switches can be used, that trigger when a predefined threshold temperature is reached. Depending on the installation position, the sensors are usually embedded into small screw-in housings with M4-M6 threaded neck, but they can also be installed as contact sensors or in the proximity of heat sink elements.

Transformer:

As a link between the wind power plant and the national grid and depending on the installation location, transformers are installed in the tower, in the wind turbine nacelle or even in control cabinets. Cooling systems that are designed for operating temperatures between -25°C and +40°C ensure a discharge of exhaust heat that derive from the transformers. To protect the transformers reliably, temperature sensors are usually already integrated into their coils during production, so that external ventilators can be switched on automatically in case of load peaks. For this unique application thermistor, Pt100, KTY-sensors or bimetallic switches are suitable as temperature sensors.

Generator:

Depending on the philosophy or requirements of the facility manufacturer KTY-, thermistor- or Pt100-sensors are predominantly implemented as temperature sensors. Bimetallic switches are also installed to a smaller extent.

The resistance sensors can be implemented alternatively or additionally at the coil-head of the generator or in the stator (as slot resistance thermometers). This also applies for gearless facilities equipped with a circular stator.
Depending on the sensor type, either spot measurements are made (whereas the hotspot should be known) or customer defined measurement sections are monitored by bifilar wound sensors, also referred to as „slot resistance thermometers“.

According to customer request EPHY-MESS offers the mechanical design for the sensor installation in the coil as shrinking tube insulated version or in metal or ceramic sleeve. For greater generator output every phase is usually monitored separately, and in particular cases sensors are implemented redundantly. In case a sensor fails, the generator can continue to operate without extensive servicing efforts by simply connecting the second sensor and thus avoiding any prolonged downtimes. In addition to the sensors, electric band heaters can be installed at the coil-heads of generators or motors. These lower the risk of condense water formation on the inside of electric machines in regions with very low outside temperatures. Hereby it is distinguished between on/off switchable (the common principle) and self-limiting band heaters. The latter ones operate similarly to thermistors, whose power consumption is regulated independently according to the ambient temperature.

Rotor blade pitch actuation or respectively azimuth adjustment of the wind turbine nacelle

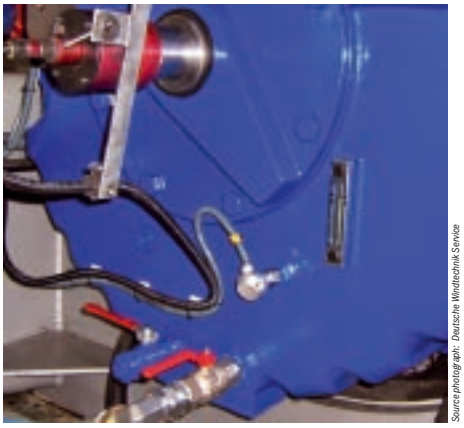
Usually hydraulic drives are employed to achieve an optimal inflow on the one hand and on the other hand to align the rotor blades with the airflow to prevent storm damages during over excessive wind speeds. This function is among the most demanding for wind power plants, since it must be ensured that the rotor blades can be brought into a position parallel to the wind flow under all imaginable circumstances to protect the system. Due to the hydraulic pressure, stainless steel (VA) sleeves are commonly used, whereas the metal housing (depending on the facility manufacturers) must be able to withstand pressures of up to 250 bar. Alternatively to sensors with metallic connection heads (MA-head or EM24/38), that can optionally include measuring transducers with an output signal of 4-20 mA, EPHY-MESS supplies sensors that have industrial plugs mounted directly to the metal sleeve.
The advantage of using this established plug type is, that for replacing the screw-in sensor just one central screw has to be loosened and the plug head can be detached without having to disconnect the supply line.

Electric pitch actuation is being implemented more and more. Hereby different temperature sensors - depending on the requirement of the system manufacturer- can be installed into the AC servo drives (e.g. PTC resistors, thermistors, Pt100). The electro-hydraulic requirements are the same or respectively similar to the azimuth actuation of the nacelle. The horizontal yaw system of the nacelle is handled by frequency controlled electric drives through multistage planetary gear sets. The directional alteration of the nacelle has the effect, that the rotor blades constantly receive their airflow from the primary wind direction.

Gears:

Even nowadays most wind power plants are still equipped with adjustable gears, which align the wind dependent rotor speed to the required constant revolution speed of the generators. Since high loads on the gears in these up to 50 ton heavy gearboxes cause thermal losses, the gear oil is heated, which in turn shortens the lifetime of the oil and causes servicing efforts. Therefore it is very important to maintain the permissible oil temperature.
Screw-in thermometers based on the Pt100 are commonly used to monitor the oil temperature.
In order to be able to neglect possible mechanical deviations or tolerances, these screw-in probes are often manufactured in an oil-proof but yet spring-mounted version (spring deflection up to 30 mm).
For these sensors EPHY-MESS offers measuring transducers with an output signal of 4-20 mA, too.

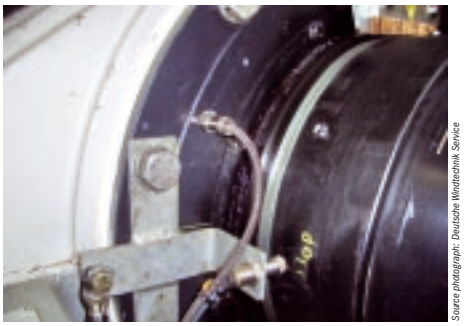
Hot oil causes servicing efforts; hot bearings evoke maintenance efforts. Thus, besides monitoring the oil temperature, bearings are also often supervised in modern wind power plants, in order to avoid unscheduled downtimes.



Source photograph: Deutsche Windtechnik Service

Bearing:

Sensors for monitoring the bearing are generally based on Pt100. Alternatively, very thin and flexible Pt100 foil sensors are available, which can be mounted or glued to the surfaces of the respective measuring point. The advantage of this solution is a low installation effort without any complicated mechanical processing of the bearings (e.g. drilling). Therefore they are also suitable for re-fitting of existing systems. Due to the mechanical design this solution is not as precise and not as robust as a temperature sensor that is thermally connected directly to the bearing. Therefore flexible Pt100 sensors should not be used for a continuous monitoring of the bearing temperature, but rather e.g. to temporarily monitor the surface temperature of gears that are suspected of having bearing damages. Combined with the appropriate analysis equipment, this can help to avoid expensive consequential damages at an early stage.



Source photograph: Deutsche Windtechnik Service

Screw-in thermometers that allow a good thermal coupling between the sensor tip and the outer ring of the bearing are well suited for the supervision of bearings. This is accomplished by using a sensor with bayonet lock, whose spring pressure can easily be adjusted manually. Additionally, varied mechanical installation depths (within certain thresholds) can be achieved with only one sensor by screwing and moving the bayonet caps on the springs. This decreases the warehousing efforts due to reduced model diversity. Screw-in thermometers with a spring-loaded measuring tube have a similar functionality as bayonet sensors, but are better used for greater insertion lengths. EPHY-MESS customers can receive absolutely tailor-made solutions: The length of the protection tube, the size of the screw-in thread (e.g. G ½“, G ¾“), the sensor head design (MA, EM-head or head form B) and the number of installed temperature sensors can be defined by the customer. Of course, fixed threaded sleeves with pre-installed industrial plugs can also be used here.

Brakes:

Hydraulic brakes are generally used to block the rotor blades for servicing work or when the wind is too strong. Temperature monitoring of the braking system is commonly handled by thermistors to avoid overheating and therefore to prevent an eventual brake failure; Pt100 sensors are employed for this type of application, too. Thermistors are mostly shrinking tube insulated, whereas the employed insulation materials must be aligned to the possibly occurring temperatures! Even for this application scenario „brakes for wind power plants“, EPHY-MESS is in contact with well-known companies that have considerable shares in the world market.

Supplier for world market leading wind power plant manufacturers and equipment providers

EPHY-MESS manufactures appropriate temperature sensors for all of the aforementioned applications! EPHY-MESS supplies large quantities to OEM customers for serial production, as well as smaller quantities for service and repair efforts! Thus, EPHY-MESS offers manufacturer-independent service companies the opportunity to purchase all required temperature sensors economically from a single source.

Future developments founded on a broad knowledge base

The shortages of oil and gas as well as recent technical developments have contributed to further growth of the wind power industry. More than ever operating safety, resistance to wear and efficiency for the entire system are required, because downtimes and repairs are very expensive.

The products developed and manufactured in Wiesbaden-Delkenheim, in close collaboration with the users, meet the highest quality requirements. Customer specific requirements such as length and diameter of the sensors, type and length of the supply lines as well as the sensor type (Pt100 / PTC / KTY / bimetallic switch) and precision (2, 3 or 4 wire circuitry) can be realized without difficulty. As a supplier for worldwide operating companies, we have been aware of the developments in wind power technology since the beginning of its intensive utilization by the energy industry.

Hardly another temperature sensor manufacturer could possess this more than 15 years of experience. Experience only, is not enough for us: We also take care of future developments: EPHY-MESS is prepared for future applications integrating intelligent temperature sensors with CAN-BUS connection, and therefore has already carried out the respective proprietary development work. In case you are interested in this, we kindly ask you to contact us for further details.

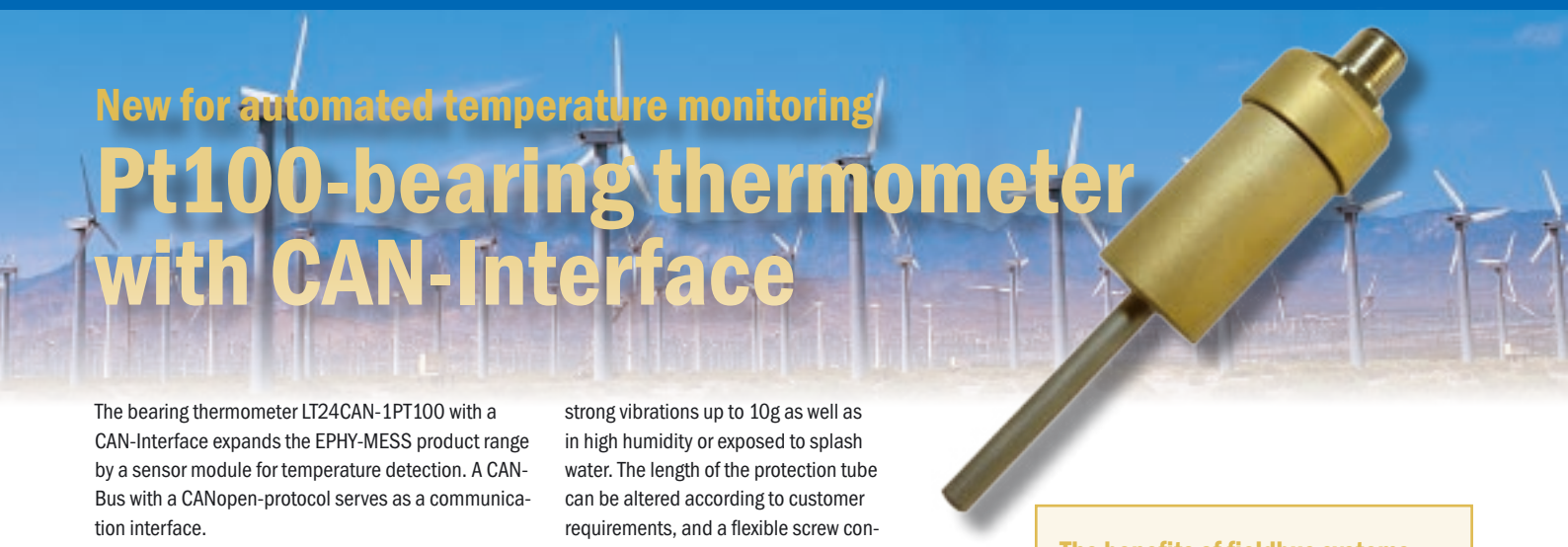
Dipl.-Ing. (FH) Werner Hix
Project Manager „wind power“
Phone +49 (0) 6122-9228-46
E-Mail: werner.hix@ephy-mess.de

Wind power in a nutshell

La Cour, a Danish meteorologist, was one of the first to not only generate power from wind, but to store this power in the form of hydrogen to illuminate his school in times of calm, over 115 years ago! 1920 Albert Betz demonstrated that, due to law of physics, only 59.3% of the wind energy can be utilized. Even today, his theory for the shape forming of rotor blades is the basis for the design of the facilities. Up to World War I, dozens of small wind power plants with a performance of 25 kW and a rotor diameter of about 10 meters were built in Denmark. After that, energy gained from fossil fuels replaced the wind power technology. Only during the first oil crisis in 1973 people did remember that wind power generators exist. When California started a large-scale wind power program in 1980, the Danish exports to the USA skyrocketed. In Germany the situation was different. The German Growian-project should have propelled the leap from the 100 kW to the 3 MW facility in the early 1980s. Aircraft designers built a gigantic rotor with a diameter of 100 meters. It never really functioned, and a machinery breakdown finally led the experiment to a permanent failure. During the following decade, the topic of wind energy in Germany was almost completely dead. Only after the „act on the sale of the electricity to the grid“ in 1991, the idea of wind power was revived in Germany. Ever bigger facilities with higher performance, adjustable rotor blades and variable rotational speed were installed, and are continuing to be installed. Not only in Germany...

New for automated temperature monitoring

Pt100-bearing thermometer with CAN-Interface



The bearing thermometer LT24CAN-1PT100 with a CAN-Interface expands the EPHY-MESS product range by a sensor module for temperature detection. A CAN-Bus with a CANopen-protocol serves as a communication interface.
This allows a universal application in many areas of the automation technology. The utilization of the CANopen-protocol ensures the compatibility of CAN-Bus-devices from different manufacturers. High-Speed-Bus, Full-CAN-Controller and CAN 2.0A telegram specification are supported; CAN 2.0B on request. The physical connection is established according to ISO 11898, CANopen protocol according to DS-301 version 4.02, device profile DSP-404 version 1.2. The integrated electronics permit the connection of different resistance sensors. The screw-in thermometer LT24CAN-1PT100 is standardly equipped with a Pt100-sensor and allows temperature measurements in the range between -50°C and +200°C with a resolution of 0.01°C. The miniaturized electronics are mounted on a circuit board with a size of 20 x 42mm. It is completely encapsulated within the bearing thermometer's compact connection head, with a diameter of 24 mm. Therefore, this sensor module can be utilized in locations with high temperature changes, strong vibrations up to 10g as well as in high humidity or exposed to splash water. The length of the protection tube can be altered according to customer requirements, and a flexible screw connection is available on request. The unit is designed for a power supply with 24 V. The sensors power supply and the connection to the CAN-Bus are made via a five pole M12 circular plug connector with a screw connection. The LT24CAN-1PT100 is momentarily in a test phase, and the series production will probably begin in the middle of this year.

For interested persons,
we have detailed technical data available.
Dipl.-Ing. (FH) Eugen Olejnik
R&D
Phone +49 (0) 6122-9228-0
E-Mail: eugen.olejnik@ephy-mess.de

The benefits of fieldbus systems

The communication between sensors and actuators through fieldbus systems offers the following advantages:

- lower wiring and installation efforts (decimation of costs)
- easy enlargement and alteration of control and measuring tasks
- relief of the central control unit through preprocessing of the measurement data in the sensor itself
- the system is diagnosable through a bidirectional data flow (increases the reliability)
- no analog input/output modules are necessary anymore for the connection between the sensors and the controller

For a fast installation and disassembly

Bearing thermometers with industrial plug head

The screw-in resistance thermometer with an industrial plug facilitates a very easy installation and has proven reliable in wind power facilities. The three pole plug is centered to prevent polarity reversal and standardly has a 1/2" thread; other threads are also available. As cable outlet a PG11 cable gland is used. By loosening the central screw, the head can be detached from the screwed-in sensor without having to disconnect the supply lines in the control cabinet.

This very compact temperature sensor is based on a standardized Pt100 or Pt1000 resistor element (according to EN 60751), which delivers reliable and precise measurements. On request the thermometer can be manufactured with PTC or KTY sensor elements. The resistance value is 100 Ohm at 0°C for Pt100 sensors, and the dielectric strength is >200MOhm/500V. The mode of connection can be realized as a 2 or 3 wire circuitry.

The installation length and the sleeve diameter are also freely selectable according to customer request. The temperature range for the 28 x 28 mm measuring sensor head may be between -40....+125°C, and for the sensor tip -40 to +260°C are permissible. The protection tube is made of VA-stainless steel.

Contact:
Dipl.-Ing. (FH) Werner Hix
Project Manager „wind power"
Phone +49 (0) 6122--9228-46
E-Mail: werner.hix@ephy-mess.de

I M P R I N T

Publisher
Andreas Becker, Dipl.-Kfm.
General Manager

EPHY-MESS
Gesellschaft für Elektro-Physikalische Messgeräte mbH
Berta-Cramer-Ring 1
D 65205 Wiesbaden-Delkenheim
Tel. +49 (0) 6122-9228-0
Fax +49 (0) 6122-9228-99
info@ephy-mess.de
www.ephy-mess.de

Editorial & layout
mbk Marketing-Beratung Kuchenmeister GmbH
D 97200 Höchberg
Tel. +49 (0) 931-40 670-0
info@mbkgmbh.de

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