Wind farms pose maintenance challenge for operators

With many wind farms now well established, operators must consider the provision of maintenance and examine the latest component technology available to protect their investment and ensure continued reliability, warns industry expert Phil Burge…

Clean power
With the attraction of clean, free renewable energy, wind power is one of the fastest growing energy sources and today one of the most economical solutions for electricity generation. This is offset in part due to the increasing costs of retrieving fast depleting non-renewable fossil fuel sources and the possible health risks and external costs of nuclear power, as highlighted by recent incidents at the Fukushima nuclear power plant.

With rising costs in energy production, the economic and environmental benefits of harnessing energy from renewable sources has pushed wind power up the political agenda, becoming the focus of investment and interest that has seen wind turbines literally spring up around our coast and countryside. Now that wind power is no longer seen as an optional alternative but a vital component in fulfilling the demand for energy, the need to support the industry with the latest innovative and robust technology is greater than ever before.

Overcoming extreme conditions
The downside of wind farms and one of the biggest challenges faced by operators is undertaking servicing and maintenance of the turbine. The operation and maintenance of offshore wind farms is far more difficult and expensive than the equivalent onshore wind farms. In particular, offshore conditions dictate operations and accessibility for routine servicing and maintenance, and with many original manufacturers’ warranties now reaching expiry this is a major concern for wind farm operators. During harsh winter conditions, a complete wind farm may be inaccessible for a number of days due to sea, wind and visibility conditions. Even when accessed, overhauling installations requires specialist lifting equipment to change out major components. This has led to increasing demands in the development of wind turbine systems and components that offer optimised long term performance and reliability.

Learning curve
As a market, the commercial exploitation of renewable energy sources is in its infancy, so engineers are still developing effective long term models for wind turbine operation and maintenance. As practical experience of the machinery begins to build a clearer picture of precisely which components are likely to fail and how to manage maintenance proactively is emerging. As with any new technology, there are many contributions still to be made by designers and engineers who are evaluating the performance of these first generations of turbines.
Gradually, a catalogue of reliable components and practices for the effective maintenance of wind turbines is becoming established. The goal for the maintenance of wind turbines, as with any other engineering industry, is to set in place a series of procedures that will increase efficiency by preventative measures, enabling operators to minimise maintenance costs and maximise turbine availability, protecting profits for operators and providing a supply of renewable, reliable energy. To achieve this goal, components must be of high quality, reliable and designed so that they are unlikely to cause failures and stoppages. Indeed, this extends to even the smallest components, as research has shown that their failure can cause as much downtime as complete gearbox or hydraulic system malfunction.

In all engineering industries, consideration is given not only to the cost and effectiveness of replacement parts but also to the implications of performing maintenance and this has a major influence when specifying parts for a wind turbine. The need to reduce maintenance by using components that are self-regulating, robust and long-serving is important, particularly when considering the environment in which wind turbines are often situated. Accessing a wind turbine nacelle is typically difficult at the best of times but becomes considerably harder when that turbine is located on an offshore wind farm that cannot even be visited until a repair vessel has been organised. Therefore, avoiding unscheduled maintenance and extending times between scheduled maintenance can save significant time and money. The best way to sidestep such problems is to specify turbines with devices that ensure reliable function for extended periods under extreme operating conditions from the outset or, where existing turbines are concerned, at the earliest opportunity.

**Designed for long life**

The industry trend toward increased turbine size calls for technology advances including reduced weight, more compact and lighter nacelles, drive trains, gearboxes and generators, which facilitate safety and keep manufacturing costs in check.

Components such as bearings play a vital role in fulfilling this ambition and in particular, the latest high capacity cylindrical roller bearings used in wind turbine gearboxes – the components widely recognised as the number one items for mechanical failure and servicing supervision – are designed for higher load carrying capacity than conventional designs of cylindrical roller bearings.

Dimensionally exchangeable with standard cylindrical roller bearings, these high capacity units feature inner ring shoulder-guided caged bearings, extra black oxidised rollers and bearings for low inertia of the roller set, effectively handling minimal load conditions, and quick acceleration and deceleration. This helps prevent smearing that causes high levels of wear, potentially leading to bearing failure. Additionally, the black-oxidised rollers improve running-in behaviour and prevent oil film build-up to ensure more stable running conditions. Separable bearing design offers the ability to remove the inner ring from the rest of the bearing components, without the risk of the rollers becoming disengaged. This feature facilitates ease of mounting and dismounting when it is necessary for top of turbine repairs to be carried out.

As well as bearing design, the type of bearing configuration is also an important factor. Large hollow main shafts that offer efficient weight reduction can benefit from new two or three point support bearing arrangements. Other bearing arrangements using double row tapered roller bearings can effectively remove the need for a main shaft altogether.

In applications such as induction generators where quiet running and high resistance to electrical current are essential, it is the bearing material that is critical. The use of all-steel bearings helps minimise structural resonance while bearings with steel rings incorporating the electrical insulating properties of silicon nitride rolling elements prevents any possibility of electrical current damaging sensitive components.

In addition, customised shaft housings using highly efficient and effective labyrinth seals and grease lubrication provide optimum protection for prolonged periods.

Externally, the bearings used on the yaw have been specifically designed to meet the relentless demands of wind turbine movement and are sealed and protected against high levels of moisture, or in more aggressive coastal locations corrosion from salt, for increased service life and reduced maintenance.

Developments to other components include longer lasting seals and sealing systems with low maintenance costs, and reductions to leakage, waste, spillage and lubricant consumption. In fact, the latest seal geometries available have further improved installation, replacement and seal lifespan as well as provided higher seal protection and reduced friction torque on main shaft bearings, gearboxes, braking, pitch control, yaw drive and generators to enhance component reliability.

The requirements for the correct lubrication at the specified amount at the right time are crucial for extending bearing service life in any situation and not least the harsh conditions found offshore. The latest quality products have been specially formulated to perform specific requirements whether for high water and corrosion resistance, superior performance at low starting torque, thermal and mechanical stability, or for low noise level characteristics.

The use of automatic lubrication systems ensures that the specified amount of grease is correctly applied at the right location, avoiding any waste or excess contamination.

**Keeping control at a distance**

The ability to monitor wind turbines remotely becomes more important when maintaining appropriate turbine availability levels. Condition monitoring overcomes the issue of accessibility while enabling wind farms to extend turbine maintenance intervals, manage resources more effectively, and avoid costly downtime.

The new condition monitoring systems have interconnectivity to a number of systems typically found in modern wind turbines, such as centralised lubrication, blade monitoring, and gearbox oil condition systems. These elements can be remotely monitored simply and accurately at any maintenance centre using internet software and webcam technology.

Vibration sensors mounted on a turbine’s main shaft bearings, drive train gearbox, and generator, enable the system to collect, analyse, and compile a range of operating data that can be configured to suit a wind farm’s specific requirements. The data collected facilitates root cause failure analysis to eliminate recurring failures and keep costs down.

**The growth in green energy**

With the growing demand by operators for greater energy output and increased reliability of wind turbines, these challenges are being met by on-going component developments, overall design improvements and the latest condition monitoring systems from leading manufacturers and specialists in maintenance services.

Although offshore wind farm operations are estimated to be in the region of five to ten times more expensive than those working on land, the overall operating costs of wind turbines are still amongst the lowest in the generating energy sector.

With a full and carefully implemented investment programme in new component and maintenance technologies, operators can effectively control the occurrence of planned maintenance and more importantly, help eliminate unplanned maintenance levels. This will have a positive impact on running costs and ensure wind power will continue to be both a viable economic solution for energy production for the future and a benefit to the environment.

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