NORWIN 54-ASR-750 kW

TECHNICAL DATA

Nominal electric power:	200/750 kW
Power regulation:	Active Stall Regulation (ASR)
IEC wind class:	IIB
Rotor diameter:	54 m
Rotor speed:	25.2 rpm at full load
Rotor:	Three blades placed upwind of tower
Swept area:	2290 m²
Tilt angle:	4°
Coning angle:	3.0° forward blade pre-bending
Blades length:	26 m
Tip speed:	71 m/s at full load
Pitch angle:	ASR control
Pitch bearings:	Slew rings (4 point ball bearing)
Air brake, normal:	Blade pitch to -20°
Air brake, emergency:	Blade pitch to -85° fail safe position
Nominal pitch speed:	7.5°/second
Mechanical brake:	Fail-safe type disk brake
Brake torque:	1.8 times of nominal torque
RPM max. value:	1600 (50 Hz) or 1920 (60 Hz), observed on the high-speed shaft
Generator:	Closed, 6/4-pole, asynchronous, induction, IP54
Generator speed:	1000/1500 (50 Hz) or 1200/1800 (60 Hz) rpm at sync. speed
Loss in generator:	3% at nominal power
Generator cut-in:	Thyristor controlled gradual cut-in
Grid connection:	50 Hz - 690 V or 60 Hz - 690 V
Yaw motors:	4 pcs. with electrical brakes built in
Yaw brakes:	4 pcs. hydraulic brakes of disk brake type
Yaw bearing:	Slew ring (4 point ball bearing)
Tower type:	Conical steel tower (40-65 m hub height)
Controller:	PLC and microprocessor based
Cut-in wind speed:	3-4 m/s
Cut-out wind speed:	20 m/s, based on 5-min. average
Mass of blade:	App. 6900 kg (total 3 pieces)
Mass of hub:	App. 4100 kg
Mass of nacelle:	App. 23500 kg
Mass total, excl. tower:	App. 34500 kg
Reference noise level:	App. 104 dBA

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NORWIN 46/47-ASR-600 kW/750 kW

- MAIN FEATURES OF DESIGN

Norwin 46/47-ASR-600/750 is an ASR regulated wind turbine with a rotor diameter of 46 or 47 m. The turbine uses LM 21.0P blades, which is the latest technological development from LM Glasfiber.

The blades can be turned to obtain optimal operational conditions at both at low and high wind speed. This system together with our intelligent control we call ASR – *Active Stall Regulation*.

ASR Active Stall Regulation!

The ASR wind turbines utilize the best things from both the stall- and the pitch regulated wind turbines.

The ASR turbine got the same regulation possibilities as the pitch regulated turbine, but by using the stall properties of the blades the large load and power fluctuations that are typical for a pitch regulated machine is avoided.

Why ASR?

By using ASR a lot of advantages is gained that a normal stall regulated wind turbine cannot offer:

- ASR will in general give a higher production because the blade angle is optimized according to the actual wind speed.
- At high wind speed the power is stabilized because problems with air density changes, double-stall and change in grid frequency is eliminated. This means that stand still due to overproduction is avoided, and that the loads on i.e. gearbox and generator is minimized, resulting in a longer lifetime.
- The possibility of feathering the blades by extreme wind speeds means that the characteristic extreme loads are decreased compared to a normal stall regulated turbine.
- It is possible for the turbine to down-regulate the produced power if the local grid has to high loading. However, this demands a special unit for grid surveillance.
- With blade regulation it is possible to make a much smoother cut-in to the grid at startup, and cutout at shut down. This will give much less noise on the grid in these situations and at the same time extend the lifetime of transmission- and electrical system in the turbine.
- The possibility of reducing the power by turning of the blades means that the switch over between the small and the large generator is taking place in a quiet and gentle manner.

The ASR system is under constant development and optimization i.e. through R&D activities supported by The Danish Energy Agency and the European Commission.

ASR and the future!

The wind turbine manufacturers knows that the future in design of more efficient and more reliable wind turbines lies in the development of better control strategies and more effective blades. Using ASR the NORWIN turbine is in front in both areas - today and in the future. With the wind turbine as centre a long-term research and development work on the ASR controller is being conducted. Some of this work is made with co-financial support from i.e. the European Commission's RTD programmes. It is worth noticing that not only the next generations of NORWIN turbines will benefit from this work. The wind turbines produced today can in principle be upgraded with newer versions of 'intelligence'. The major part of the RTD work is initiated and conducted by NORWIN A/S.

In the following some examples of the development work will be briefly described:

NORWIN by LM Glasfiber, one of the world's largest producers of wind turbine blades.

Power Optimisation:

The controller is developed to self-optimise the blade angle control for wind speeds below rated power. The main benefits are that no costly work and interference from personnel is needed during the process of pitch angle optimisation and that it is ensured that the turbine runs in the most optimal configuration. Practical tests have shown an energy production increase of more than 1%, after running a test version of the power optimisation system.

Load control:

The load on a wind turbine can vary a lot from site to site and development work is conducted to develop a Load Control system where the turbine not only is controlled to reach the nominal power, but also is controlled according to the loading history. The perspectives of using such a system is to ensure the projected lifetime of major components or to use these to a maximum within the projected lifetime. First phase of this work has been finalised, with the development of the fundamental control scheme for gearbox load control.

Laser Wind Measurements:

In co-operation with the National Institute Risø and others, the development of a laser-based wind speed device for measuring of the wind speed before it reaches the wind turbine and a control strategy to utilise this knowledge is being conducted. The potential of the system is to increase the turbine efficiency and reduce the loading by taking advantage of the knowledge about the incoming wind. Further the system could make it easier to make power curve measurements.

We do not stop here!

The blades have a crucial influence on the wind turbine performance and despite we use some of the most modern and optimised blades we would like to do it even better in the future. For this reason, NORWIN takes part in a project developing a blade especially made for optimal performance with the ASR control strategy. This means that the basic principles of ASR were taken into consideration when designing the blade. The first test set is now running on a NORWIN turbine. The work is supported by The Danish Energy Agency funds for Developing Renewable Energy.

Not all is new!

By using standard components both we and our customers gain two great advantages: You are guaranteed to get a well tested product and you are secured to have spare parts available also in 15 years, if it should be necessary.

Examples on relatively standardised parts are: Gear, generator, main bearing, blade bearings, yaw bearing, yaw gearing, control modules and so on. It takes experience and knowledge about wind turbine technology to choose the right components and to combine these with the specially designed parts that a modern wind turbine also consists of in a way to achieve a product of high quality. That is why the 19 years of experiences in construction and maintenance of wind turbines has been used in the development of the NORWIN 46-ASR-600 kW / 750 kW wind turbines.

Features of Design!

Rotor:

The blades are made by LM Glasfiber A/S. Each blade is mounted on an extender,- mounted

on a four-point ball bearing,- mounted on the hub. Each blade is with stays connected to the pitch mechanism inside the hub so that all tree blades acts simultaneously when pitching. The pitch actuator is a hydraulic cylinder placed inside the hub. The hub is mounted to the forged flange of the main shaft with bolts.

Main frame:

The main frame is a relatively flat welded design, which provides access from the tower to the nacelle directly through a manhole in the frame.

Shaft, bearing and gearbox arrangement:

The rotor, shaft and gearbox arrangement is designed to be highly flexible for movements in the yaw and tilt directions. The main shaft is connected to the main frame at the front with a roller bearing and a bearing truss. The main bearing absorbs the axial loads of the rotor. The rear bearing is integrated in the gearbox, which on both sides is connected to the main frame with a support including a rubber element. In this way it is obtained that the system is supported at 3 places, making the forces run smoothly from the rotor and into the tower.

A large cooler with external fan cools the gear oil and the oil is at the same time passing through a 10 micron filtering unit.

Generator arrangement:

The generator is mounted to the main frame behind the gear opposite to the main shaft and connected to the gear via a flexible coupling.

The standard generator is an asynchronous double-wound, induction generator. Casing IP54. The

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isolation is in accordance with classification F, utilization with classification B.

Blade turning system:

The blade turning mechanism is placed inside the hub. The actuator is a hydraulic cylinder, supplied by either a hydraulic power package, including a proportional valve, placed in the nacelle for normal operation, or a accumulator system placed in the hub, for emergency operations. The position transducer is placed in the hub parallel to the cylinder.

The power and control package has been placed in the hub, to secure that the system is easy to adjust and to do service on. The hydraulic control lines from the power package to the hub, is transferred through a rotating union placed on the back of the gearbox. The necessary electrical control lines are transmitted through sliprings also placed on the back of the gearbox.

In an emergency situation, the primary supply of hydraulic pressure will come from hydraulic accumulators placed inside the hub. Placed here, the system is well protected against a fire in the nacelle, and the system will also work in case of a complete pressure drop in the power package. The power package including separate accumulator will serve as a secondary safety system.

Braking system:

The mechanical safety brake is mounted on the high-speed shaft of the gearbox. The 'fail safe' spring type disk brake is activated instantly in the emergency situation. In the normal situation the mechanical brake is only used to hold the rotor, after the blades has brought it to stop. Hereby, heavy loads on the gearbox during braking are avoided.

Activating the pitch system makes aerodynamically braking. At normal braking the blades are pitched to -20° to take the power from the rotor and slowly decrease the rotational speed. A while after the rotor has stopped the blades will return to the nominal position, to be ready for operation. By emergency braking the blades are feathered, to make it impossible for the rotor to catch speed even in an extreme wind situation, and at the same time to decrease the thrust on the rotor.

When the blades are pitched to -85° the mechanical brake is retracted so that the rotor is able to run free. This is done to prevent high loads in the transmission system at extreme wind situations. Running free in the emergency pitch angle position the rotor will rotate slowly with a speed of up to 2 rpm.

Yaw system:

The yaw system is a combined yaw brake and active yawing system designed in a very flexible manner so that it is possible to add additional yaw brakes or motors if the turbine is to be erected on a very rough site. The connection between the nacelle and the tower is through a four-point ball bearing.

The yaw drives are electrical driven standard units consisting of an electrical motor with brake included, a helical and a planetary gear. The number of yaw drives can be determined by the conditions on the site but is normally 4. Apart from the brakes in the yaw drives, a hydraulic actuated disk brake system with a number of positive brake caliber's are used. This system has a separate warning system for leakage.

The yaw drives are actuated through soft starters, to equalize the torque between the motors, and to prevent a high peak torque in the starting situation.

Nacelle and cooling:

The nacelle is made of glass fiber with steel reinforcements, and mounted to the main frame with steel supports through rubber dampers.

The nacelle will provide standing height so that servicing may take place in protected surroundings. Noise reducing ventilating ducts is integrated.

Cooling and ventilation are controlled for nacelle, gearbox, and generator. Through control of the cooling air to and from the gear and the generator, the nacelle temperature will so far it is possible be kept at a minimum of 7°C above outside temperature, thus preventing condensation and thereby corrosion.

Tower:

The tower is a closed, conical tube tower fabricated in steel with a door at the bottom of the tower, and internal ladder and platforms at the tower connections to ease service at the connections points.

Controller:

The main control panel is placed at the bottom of the tower. With the possibility of adjusting selected parameters, authorized personnel can change operational limits of the turbine directly on the front panel.

A stationary or portable additional control panel can be mounted/connected to the top box in the nacelle for manual control of the turbine, when servicing.

A battery back up system supplies the emergency light.

Safety surveillance will monitor possible faults in the turbine and, if necessary, bring the turbine to a standstill.

Should the turbine come to a standstill due to some unacceptable conditions, it will start up automatically when proper conditions have been restored, e.g., after grid failure. When faults require service, the turbine will not be able to start up again until the fault has been corrected.

One of the special features of the turbine is that it has a number of back-up functions built in, and that the controller utilizes the possibility to operate the turbine even if a secondary secondary system has broken down. This system increases the availability and makes it easier to schedule service of the turbine. If such an error appears a message will appear on the screen and eventually on a remote monitoring device.

The turbine is equipped with an external emergency system, working independently from the electronic control system supervising speed of rotor, nacelle vibrations and manual emergency push buttons.

A circuit breaker is installed in the power section, disconnecting the turbine from the grid in case of overload current or short circuit current.

Noise:

According to experience, the high-speed shaft of the gearbox and the rotor itself are the sources eventual noise problems from wind turbines. The rotor is the main source for broad-spectrum noise, where the main problem with the gear is pure tones.

The gears used in the turbine are designed from the state of the art knowledge about how to built low noise gears, and further, each gear is tested for noise and vibration before accepted and installed into the turbine.

Ventilation air through the nacelle will go through noise damped ducts, damping the air borne noise.

1. Rotor system
2. Transmission
3. Yaw system and mainframe
4. Nacelle cover
5. Tower
6. Hydraulic station (not shown)
7. Generator
8. Pitch system