Turbine Description

REpower MM 92

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1 MM 92 - Technical Description and Data

1.1 Concept

The REpower MM 92, like its sister model the MM 70/MM 82, is based on the platform of the tried and trusted MD 70/77. The operational experience with the type MD 70/77 has gone into the development of the MM 92. The MM 92 has been developed starting from the qualities of the MD-Series such as ease of maintenance, clear, sturdy construction, generous and conservative design of the components, construction of the load-bearing structures to match the power flux, environmental compatibility, etc.

By reinforcing certain parts such as the rotor bearing, blade bearing, rotor shaft and gear and using special materials in the area of the rotor blades, the increased loads on the rotor can be safely absorbed.

The turbine with a rated power of 2 megawatts has a rotor diameter of 92.5 metres and a hub height of up to 100 metres.

1.2 Rotor

The rotor consists of three rotor blades that are flange-mounted on the cast hub via a pivoted double row four-point contact bearing. The rotor blades can thus be adjusted along their linear axis via pitch drives that rotate with the blades. The rotor is operated in a speed range from 7.8 to 15.0 +12.5% rpm. In order to ensure the continued operation of the blade tilt in the event of a power failure or turbine malfunction, each blade has its own, independent, storage battery set that rotates with the blade.

In the partial load range, i.e. when the turbine is operated below the rated power, the turbine works at a constant blade angle and variable speed to exploit the optimum rotor aerodynamics.

In the rated load range, i.e. when the turbine is operated above the rated speed, the turbine is operated at a constant rated moment. Changes in speed due to changing wind speeds are compensated by adjusting the blade angle.

Wind energy from strong gusts of wind is stored by an acceleration of the rotor and only then converted into damped electrical energy via the blade pitch and fed into the grid.

1.3 Drive Train

The geometric configuration of the load-transferring structure according to the "tilted-cone" principle guarantees an optimum transfer of the rotor loads into the tower and permits a optimum layout of the components for load transfer. The drive train is supported at three points immediately above the head flange of the tower, whose conical geometry provides a wide basis to absorb the loads. The inclination of the rotor shaft by 5 ° in connection with the 3.5° conical angle of the blade hub permits an extremely short overhang between rotor centre and tower axis, thus reducing any "head trim" for the turbine requiring a significant volume of material.

1.4 Gear Box

The gear box is designed as a planetary / helical gear. The toothing has been optimised with respect to efficiency and noise emission. Elastic bushings are integrated in the torque arm of the gear that rest on the base frame via support pieces. The elastic bearing allows an effective sound and vibration decoupling from the base frame.

1.5 Electrical System

The turbine is equipped with a variable-speed generator-converter system. A frequency inverter is switched in the rotor circuit that impresses a voltage with adjustable frequency on the rotor. This allows the speed to be adjusted within a range of +/-35% of the synchronous speed. In connection with the electrical blade pitch, the variable-speed drive train offers very good results with respect to mechanical stress and electrical grid quality.

The turbine is operated in the following operating ranges depending on the prevalent wind speed:

- In the subsynchronous range (partial load range) the generator stator provides 100 % of the electrical power into the grid. Slip power is also provided to the rotor from the converter via the generator's slip rings.
- In the oversynchronous range (rated load range) the generator stator provides 83 % of the electrical power directly to the grid without passing through the converter. The remaining 17 % of the power is fed into the grid from the rotor via the converter.

There are no physical losses and the overall efficiency and technical availability are much better.

The generator is in protective class IP 54, it is cooled via an air-air heat exchanger. Thermocouples are installed in the bearings and coils to monitor the machine temperature.

Covers ensure that no contact can be made with rotating parts. The generator housing is earthed for potential compensation. The generator is borne on sound and vibration-decoupling elements on the base frame for better sound insulation and decoupling.

Please find further information about the electrical system in the “Electrical Description”.

1.6 Brake Systems

Braking is carried out by adjusting the rotor blades in the 91° blade position. Each of the three adjustment devices on the rotor blade is completely independent. In the event of a power failure the drives are supplied via the storage batteries that rotate with the rotor.

The twist of one blade is enough to bring the turbine into a safe speed range. This leads to a triple redundant safety system. The mechanical disk brake is also activated if one of the primary safety systems fails and stops the rotor in conjunction with the blade adjustment system.

The brake systems are designed for a "fail-safe" function. This means that if only one component in the brake system malfunctions or fails, the turbine immediately switches to a safe status.

1.7 Yaw System

The nacelle is connected to the tower via a four point contact bearing. Yawing of the nacelle is achieved by means of four gear motors. 14 hydraulic brake callipers keep the nacelle in the wind direction. The brakes are active in a currentless state.

An electronic wind direction sensor with corresponding software controls the switch-on times and direction of rotation of the motors. It also ensures the automatic cable untwist if the nacelle changes its position several times in one direction with changing wind conditions.

1.8 Nacelle

To meet today's demands on an innovative wind turbine, the cabin has been designed by a renowned designer. The result is a slim, aerodynamic design.

Glassfibre reinforced plastic (GRP) was chosen as a cabin material. In addition to the sound insulation, the inside of the covering also has an insulating layer. The nacelle has been generously dimensioned to create optimum conditions for service and maintenance. Maintenance work can be carried out with the nacelle closed.

Access to the nacelle from the tower is via a hatch in the base fame. A maintenance platform has also been installed so that the components below the base frame can also be reached.

All components, such as the yaw system or the hydraulics, can be operated from the control system in the nacelle. An "Emergency Stop" button has also been installed for safety.

1.9 Tower

The tower is designed as a conical, tubular steel tower consisting of between three and five segments depending on the hub height. There is a door in the tower base that permits access to the nacelle from inside the tower (thus protected against inclement weather) via a ladder with climb protection system. Each segment of the tower is equipped with platforms and emergency lighting.

The switch cabinets for the converter are mounted in the tower base on a separate platform. The generator power is transferred to the tower base via screened bus bars. All control signals for the operations computer are transmitted via optical glassfibre cables and comply with all of today's requirements with respect to electromagnetic compatibility (EMC).

An optional lift system can be provided for higher hub heights.

1.10 Corrosion Protection

All parts of the turbine are protected against corrosion and other environmental influences by a special multilayer coating. The coating system meets all the requirements of DIN EN ISO 12944.

1.11 Lightning Protection

The wind turbine is fitted with a lighting protection system built by lighting protection experts and complies with Protection Class II as required by the international standard IEC 61024-1. It is discharged from the rotor to the tower via the slip rings and spark gaps. The lighting current is thus discharged to earth via foundation and earth electrode.

Please find further information about lightning protection in the “Description Lightning Protection”.

1.12 Control System

All functions of the wind turbine are monitored with a microprocessor-based control system. The use of optical fibres guarantees a maximum baud rate and at the same time protects against electromagnetic stray voltages.

The critical functions have a redundant control. The emergency stop is triggered by a "hard"-wired safety loop parallel to the operations computer. This allows the turbine to be brought into a safe status even if the computer fails.

2 Technical Data

Basic Design Data

cut-in wind speed:	approx. 3.0	m/s
rated wind speed:	approx. 11.0	m/s
cut-out wind speed:	24.0	m/s

Rotor

diameter:	92.5	m
swept area:	6,648	m^2
number of blades:	3	
material:	Glass fibre reinforced material GRP (CRP)	
speed range:	7.8 to 15.0 +12,5 %	min^{-1}
tip speed:	72.6	m/s
rotor axis inclination:	5	°
rotor cone angle:	-3.5	°
sense of rotation:	clockwise	
rotor position:	up-wind	

Pitch system

principle:	electro-drive, single blade pitch	
power control:	pitch and rotor speed control	
maximum blade angle:	91	°
pitch drives:	synchronised DC motors with battery buffer	

Gear Box

type:	3 stage planetary/spur gear system	
nominal power:	2,160	kW
nominal torque:	1,378	kNm
ratio:	approx. 120	

Electrical System

nominal power :	2,000	kW
generator type:	twin-fed, four pole asynchronous generator with slip rings	
inverter type:	pulse-width modulated IGBT inverter	
protection class:	IP 54	
speed range:	900 to 1,800 +12.5 %	min^{-1}
voltage:	690	V
frequency:	50	Hz

Tower

type:	coned solid wall steel tower	
hub height (prototype):	78.5; 80 and 100	m
diameter of head flange:	approx. 3.0	m
diameter of bottom flange:	approx. 4.0	m

Yaw System

type:	4 geared drives, 14 yaw brakes	
yaw rate:	0.5	°/s
bearing:	four-point bearing with external toothing	

Controller

type:	micro-processor	
signal transfer:	optical fibres	
remote control:	PC-modem, graphical interface	

Weights

rotor blade:	approx. 8.0	t
hub complete incl. pitch system:	approx. 17.0	t
nacelle (excl. rotor):	approx. 70	t