ET 210

Fundamentals of wind power plants

2E

Description

- **variable-speed wind power plant**
- **wind power plant with rotor blade adjustment and yaw angle adjustment**

In modern wind power plants, the power output from the wind is adapted to the changing wind conditions. In the strong wind range, power output is limited to protect the turbine. The rotor blade adjustment serves this purpose. By adjusting the angle, this changes the forces acting on the rotor blade. In the normal wind range, power consumption is optimised by means of variable speed generator systems.

ET 210 demonstrates a wind power plant with rotor blade adjustment and variable speed generator.

The wind power plant stands on a tower in a wind tunnel. The air flow is generated by an adjustable speed fan. A flow straightener ensures consistent and low-turbulence flow. A three-blade rotor drives the generator directly. The rotor blades can be easily replaced. The wind tunnel is closed during the experiments to ensure that the experiments are conducted safely.

In order to approach different operating points, the target speed of the rotor can be set via the software. The rotor blade adjustment is operated by means of a servomotor to change the rotor blade adjustment angle. The angle between the rotor axis and the wind direction (yaw angle) can be adjusted by means of a handwheel.

The rotor speed is precisely measured by Hall sensors built into the generator. The wind velocity is measured by a horizontally adjustable wind velocity sensor, so that the average wind velocity over the rotor surface can be recorded. The yaw angle is measured by an angle sensor. The measured values are transmitted directly to a PC via USB where they can be displayed and analysed using the software included. The software calculates the converted electrical power, the generator torque and system-specific parameters.

Learning objectives/experiments

- conversion of kinetic energy into electrical energy
- power adjustment by means of speed adjustment
- power adjustment by means of rotor blade adjustment
- behaviour in the case of oblique flow
- recording of characteristic diagrams
  - determination of the power coefficient as a function of the tip-speed ratio and rotor blade adjustment angle
  - determination of the power coefficient as a function of the tip-speed ratio and yaw angle
- comparison of different rotor blade shapes

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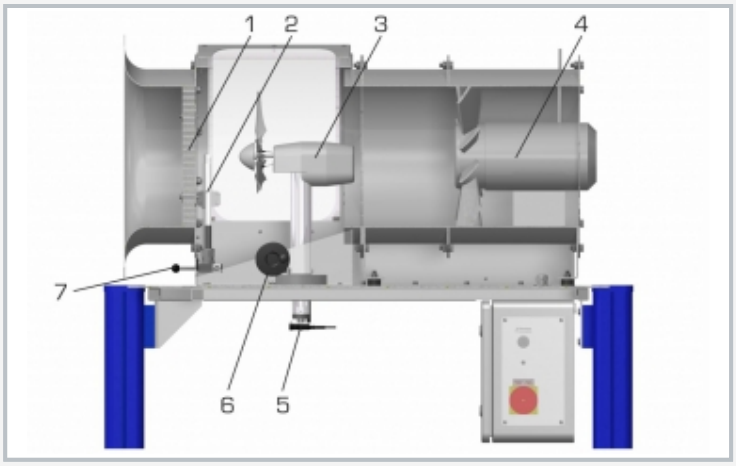
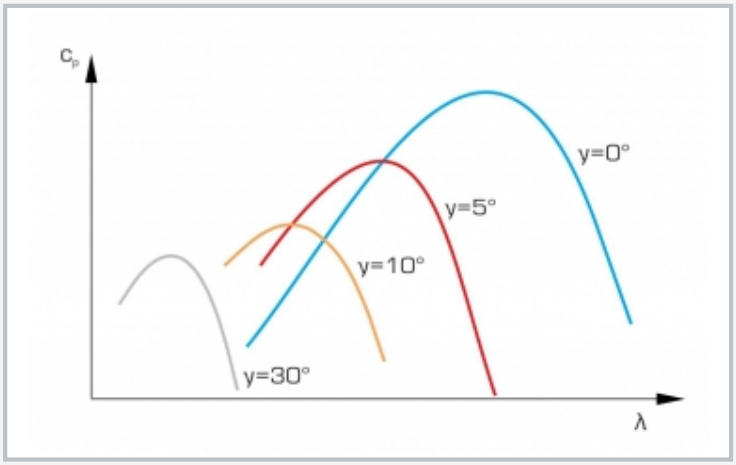
1 inlet contour, 2 experimental section, 3 wind tunnel, 4 switch box



1 flow straightener, 2 wind velocity sensor, 3 wind power plant, 4 fan, 5 yaw angle sensor, 6 handwheel, 7 lever



Power coefficient via tip-speed ratio at different rotor blade angles and constant wind velocity

Specification

[1] wind power plant with rotor blade adjustment
[2] wind power plant with yaw angle adjustment
[3] gearless wind power plant with 3-blade rotor
[4] variable speed generator system
[5] power regulation by means of rotor blade adjustment
[6] interchangeable rotor blades
[7] fan with adjustable speed to generate an air flow
[8] wind velocity, rotor speed and yaw angle are measured by sensors
[9] GUNT software for data acquisition via USB under Windows 7, 8.1, 10

Technical data

Wind power plant
- Ø rotor: 0,3m
- number of rotor blades: 3
- rated electrical power: approx. 6W
- rated wind velocity: 10m/s
- rated speed: 3400min^{-1}
- design tip-speed ratio: 4,5
- rotor blade adjustment: -5...35°
- weight: approx. 1,6kg
- nacelle: LxWxH: approx. 270x65x90mm

Generator
- rated voltage: 12V
- rated current: 2,02A

Wind tunnel
- Ø 400mm

Axial fan
- max. volumetric flow rate: 6860m^3/h
- max. power consumption: 1,1kW

Measuring ranges
- wind velocity: 1...15m/s
- speed: 0...4000min^{-1}
- current: ±2,02A
- yaw angle: ±40°

230V, 50Hz, 1 phase
230V, 60Hz, 1 phase
120V, 60Hz, 1 phase
UL/CSA optional
LxWxH: 1240x800x1340mm
Weight: approx. 140kg

Required for operation

PC with Windows

Scope of delivery

1 experimental unit
1 GUNT software CD + USB cable
1 set of accessories
1 set of instructional material