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Wind Turbines Adaptation to the Variability of the Wind Field

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WIND TURBINES ADAPTATION TO THE VARIABILITY OF THE WIND FIELD

The subject of our scientific research is wind power turbines (WPT) with the horizontal axis which were now common in the world. Efficient wind turbines work is largely determined by non-stationarity of the wind field, expressed in its gustiness, the presence of vertical and horizontal shifts of wind speed and direction. At critical values of the wind parameters WPT has aerodynamic and mechanical overload, leading to breakdowns, premature wear and reduce the life of the wind turbine.

To prevent accidents at the peak values of wind speed it is used the regulatory system of windwheels. WPT control systems provide a process orientation of the wind turbine rotor axis in the line of the mean wind. Wind turbines are also equipped with braking device used to protect against breakdowns when a significant increase in the wind. In general, all these methods of regulation are not always effective. Thus, in practice there may be situations when the wind speed is many times greater than the stated limit. For example, if there are microbursts in the atmospheric boundary layer, low-level wind shears caused by its gust front, storms, etc.

It is required for a wind power turbine adaptation to intensive short-term wind impulses and considerable vertical wind shifts that the data about them shall be obtained ahead of time. To do this it is necessary to have the information on the real structure of the wind field in the area of the blade sweep for the minimum range against the wind that is determined by the mean speed and the system action time.

The implementation of acoustic and laser traditional wind sounding systems is limited by ambient acoustic noise, by heavy rain, snowfall and by fog. There are free of these disadvantages the inclined radioacoustic sounding (IRASS) technique which works for a system of remote detection and control of wind gusts.

IRASS technique is realized as low-potential Doppler pulse radar including combined RF-acoustic antenna installed coaxially with the gondola of the wind power turbine. The work of the technique is synchronized with rotation of blades to eliminate their shielding action.

Dangerous in terms of dynamic strength is the wind load pulse, the rise time which is comparable with the period of the natural frequency of the wind turbine elements (blade, tower, rotor, etc.). The amplitude decay of resonant vibrations at critical values of the speed of rotation can be realized through the use of mechanical elastic supports with nonlinear artificial dampers. They have a high coefficient of resistance, but may cause self-excited oscillations.

We propose the way to deal with raised vibration of wind turbine elements at the expense of short-term increase of damping in the range of critical rotary axis speeds or during impulsive effects of wind loadings (wind gusts). This is possible through the use of non-linear electromagnetic dampers or active magnetic bearings. Their feature is the possibility of varying the mechanical stiffness and damping properties by changing the electrical parameters of electromagnets. The controlling of these parameters is carried out by the control system (CS) with the information feedback on the spatial-temporal structure of the wind field obtained from IRASS. In the composition of the CS can also be included the rotational speed sensor of the WPT rotor.

This approach to the adaptation of wind turbines will allow to reduce vibration and to perform early compensation of the load on their components, which arise under the wind gusts. In addition, corrections about the wind field obtained with IRASS, would increase the mean power of WPT.