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RESEARCH ARTICLE

ANALYTICAL STUDY OF THE PARAMETERS OF WIND TURBINES WITH VERTICAL SEMICYLINDRYCAL BLADES

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Abstract

Axial wind turbines with maximum energy efficiency of 0.3 – 0.4 due to multiple changes in wind direction are not more than the actual efficiency of 0.15 – 0.25. Analytical dependences to determine the torque, power and efficiency of the wind turbine with vertical semi-cylindrical blades (WTVSB) are obtained. Calculations have shown that the efficiency can reach values WTVSB 0.21. Experiments have shown its ability to run at an air flow of 1.5 – 2.0 m/s and stable operation at speeds up to 7.0 m/s. The simplicity of design WTVSB blades, absence of tower and system of orientation to the wind significantly reduce the capital cost of wind turbines and reduce their payback period by 1.5 – 2.0 times. This type of wind turbine can be used for electric power and water desalination at various facilities, including oil platforms, commercial and transport ships that greatly reduces the consumption of energy resources.

Introduction

One of the possible variants of economy of fuel resources is usage of renewable power sources, including their usage both on oil and gas rigs and on fishing vessels and floating factories [1-3]. Among renewable power sources for marine objects the usage of wind power is seemed the most promising. Wind turbines can be used both in the combination of power supply packages with renewable power sources and separately for electricity generation.

The most widespread usage axial wind turbines have received, in which 2 – 4 blade wheels with airfoil blades have horizontal axis of rotation. However, except distinctive excellences including the main feature – sufficiently high efficiency (efficiency coefficient) achieving 0.3 – 0.4, such wind turbines have one negligible disadvantage – orientation on the wind. Developers and corporations consciously conceal the fact and inform consumers only about the benefits of the devices. Power of wind turbines is estimated taking into account that the wind vector always coincides with the axis of rotation of the wind rotor in other words that the wind always blows on the reference blade face. As a consequence calculated power of wind turbines is obtained. But it is known that the wind vector is not a constant.

On figure 1 the dependence of the swept surface of a wind wheel and the power of wind turbines as a consequence from the slope angle of the wind vector to the rotation axis of the wind rotor is shown.

At the power more than 1 kW the presence of a weathercock is not an efficient technique in wind orientation. As a consequence sufficiently expensive and complicated control systems of the wind wheel ought to be arranged. The existence of the control systems make wind turbines "slow" due to long feedback, but this factor cannot be reduced anyway. The control system reacts on such alteration of the wind direction which can be constant during 15 minutes. The wind can change the direction for example by 75 % and hold it during 10 minutes and then return to the previous direction. In this case the system does not set the signal to turn the rotor and as a consequence, the rotor and the whole wind turbine will provide only 10 % from the nominal rating power in other words 10 times less and the real efficiency reduces to 0.03 – 0.04. This situation can repeat many times within 24 hours and as a result the