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RETROSPECT AND PROSPECT OF VERTICAL-AXIS WIND ENERGETICS

Article III. Prospect for further development of vertical axis wind turbines

Abstract

At present time the ridership among the different types of wind machines belongs to horizontal axis wind turbines (HAWT). At the same time, so-called H-rotor of Darrieus recently started to be widely used as small-scale wind turbines with nominal power up to 50 kW. Today about 35% of commercial wind machines have vertical axis of rotation. But among the wind turbines with nominal power from 100 to 1000 kW the only small number of wind machines are present at world wind energy market, and megawatt-powered vertical axis wind turbines (VAWT) still are not used at all. However, development of fundamental research in the field aerodynamics, strength, stiffness and dynamics of structures, as well as design practice and technological innovations leads to new estimate of H-rotor application and their ability to produce energy more efficiently than HAWT. So the study and analysis of further development of VAWT with H-rotor nowadays becomes very important.

The purpose of this publication is to discuss this problem in details. In order to reach this goal it is necessary to perform analysis of technological, economical, ecological and exploitation peculiarities of VAWT with H-rotor, and on the basis of this analysis to work out the recommendations related to more efficient use of such wind machines.

On the middle of 1980-th, when VAWT reached technical and technological maturity, and at same time the nominal power of installed HAWT was significantly increased. This facts leads to contradictory statements of who are in favor of HAWT and those who have opposite view, and the advantages and disadvantages of both types of wind turbines, as well as prospect of their development were analyzed. As the decisive criteria in this discussion were considered theoretical, economical, exploitation and ecological factors. The experience demonstrated that harmful ecological effect of both types on environment, as compared to traditional sources of power, as insignificant and there are no sufficient difference between them from this point of view.

As far as technical characteristics and structural peculiarities of HAWT and VAWT it is appeared that is no sense to look on this problem from this side. First of all, the complicate composition of technical solutions of both types does not permit to characterize them with the use of qualitative estimates. Secondly, in contemporary wind turbines were solved almost all structural and technological problems. Thirdly, now there exists a tendency to borrow principal technical solutions from each other, and it helps to increase their efficiency and to decrease the cost of produced energy. The selection of wind turbine type depends not only on their technical and economical characteristics, but on the combined factors, which permit to satisfy the consumer with provided electrical power in the framework local meteorological conditions. In this case such selection of wind turbine type can be based on completely different positions. From this point of view the comparison of both types and discussion related to their technical and economical priorities, is not productive, because all depends on the local conditions of their installation.

In order to compare the efficiencies of both types we will use the power coefficient C_p , which is the ratio of power, transmitted to the rotor of wind turbine and power of free wind stream (both powers are related to the swept area of the rotor). Power coefficient is considered as universal characteristic, which determine the technical perfection of wind machine. Contemporary HAWT reached the level $C_p = 0.54$, and VAWT is slightly lower, $C_p = 0.435$. It can be explained by the fact, that blades of VAWT are firmly fixed and blades of HAWT can be turned with respect to longitudinal axis and prevent the aerodynamic stall.

On the basis of performed analysis we can recommend two main directors in the further applications of H-rotor with fixed blades:

- small-powered VAWT, aimed at the use in the built environment;
- multimegawatt machines, which be used at onshore and offshore windfarms.

The perspective direction in the use of VAWT is the design of h-rotors with automatically regulated the blade angle of attack.

Conclusions.

1. The general comparison of HAWT and VAWT on the basis of their technical and economical characteristics cannot be considered as correct one. The reason for this conclusion are: (1) complicated compositions of technical features of both types does not permit to make their qualitative comparison; (2) for the contemporary wind machines of both types almost all structural and technological problems have been already solved; (3) both types borrow from each other the efficient technical solutions; (4) there is no sufficient difference with respect of their influence on the environment. That is why, the selection of the type of wind turbine is determined basically by the conditions of their practical application.

2. Contemporary HAWT still have higher value of power coefficient, which can be explained by difference in aerodynamics of rotor blades/

3. The perspective development of VAWT can be based on the use of small-powered units at the urban territories and the use of small-powered units at urban territories and the use of multimegawatt wind turbines at the offshore and the onshore windfarms.

Keywords

vertical axis wind turbine, Darrieus H-rotor, efficiency of wind turbine, urban wind turbine, offshore wind turbine.

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