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Current State Of Wind Power Industry

Mustafakulov Asror Akhmedovich
Associate Professor, Jizzakh Polytechnic Institute, Uzbekistan

Arzikulov Fazliddin
2nd Year Student Of The Specialty Electric Power Engineering, Jizzakh Polytechnic Institute, Uzbekistan

ABSTRACT

There are given facts about using of wind electro-energy engine with a little power in this article.Setting's technique economical calculations and efficiency are counted practically depending on the wind velocity also here.

KEYWORDS

Wind power plant, capacity, mechanical energy, coefficient of utilization of wind energy, air flow, blade.

INTRODUCTION

The wind is formed when the air flow moves, from uneven heating when the sun's rays fall on the surface of the earth, the waters of rivers, seas, oceans. Windmills, sailing ships, and structures for lifting water were used by mechanical wind energy. For the first time, such structures were used 2 thousand years ago in China, Japan, the Middle East, Egypt [1-2]. In the 19th century, more precisely in 1885, wind power plants with a capacity of 10-20 kW were widely used in Denmark. In 1880-1930 in the United States, more than 6 million power plants were used [1,2]. In 1931, a 100 kW D30 wind power plant was built in the Crimea. It was used as part of until 1942. According to calculations in 1956, there are data on the use of more than 9 thousand wind power plants in the territory of the former Soviet Union. Wind is an endless source of electrical energy, which does not require the transportation of energy reserves, the elements of the structure are relatively cheaper. These structures have disadvantages: a change in the speed and direction of the wind, a relatively small power, an abrupt change in the amount of electrical energy [2]. Wind energy was widely used in countries such as Australia, New Zealand, Latin America, Greece. The windiest place is the Twint region of the Jutland Peninsula Denmark. In 1974, a 2000 kW wind farm was built there. Each of its blades weighed almost 3000 kg, made 40 revolutions per minute and produced an alternating electric current with a frequency of 50 Hz. This power plant is not inferior to heat and nuclear power plants in terms of such indicators as efficiency and sustainability. The cost of a wind power plant is 6 times cheaper than a heat power plant [1-2]. The demand for solar and wind power plants is growing every day due to the decrease and increase in the cost of combustible resources.

MATERIALS AND METHODS

Calculation of the power of the wind turbine.

First, we calculate the kinetic energy of the air flow formed by the wind (Fig. 1).The kinetic energy EC of the air flow passing through the area of the wind turbine blades is calculated by the formula

$$E_k = \frac{m\vartheta^2}{2} \quad (1).$$

Where m is the mass of the air flow, - air flow rate. The power of the air flow will be equal to the energy of the flow passing through the area of the blades in time.

$$N = \frac{A}{t} = \frac{E_k}{t} = \frac{\frac{m\vartheta^2}{2}}{t} = \frac{m\vartheta^2}{2t} \quad (2)$$

Here the mass of the air flow flowing through a given area over time is determined

$$\frac{m}{t} = \frac{\rho V}{t} \quad (3)$$

Here is the density of air;
V – volume of air flow;
t is the time.

The volume of the air flow, S – the cross sectional area of the air flow, l-the length of the flow. The volume of air flow over time is determined by:

$$\frac{V}{t} = \frac{S \cdot l}{t} = S \cdot \vartheta \quad (4).$$

Here S is the cross-sectional area of the air flow: $S = \pi \cdot r^2 = \pi\left(\frac{D}{2}\right)^2 = \frac{\pi \cdot D^2}{4}$ (5)

r is the radius, the radius of the circle formed by the rotation of the blades, D is the diameter of the circle.

Forms $\frac{m}{t} = \frac{\rho \cdot V}{t} = \frac{\rho \cdot S \cdot l}{t} = \rho \cdot S \cdot \vartheta = \rho \frac{\pi \cdot D^2}{4}\vartheta$

Based on this formula the power is calculated as follows;

$$N = \frac{m\vartheta^2}{2t} = \frac{\vartheta^2}{2}\rho\frac{\pi\cdot D^2}{4}\vartheta = \frac{\pi\cdot D^2\rho\cdot\vartheta^3}{8} = \frac{\pi\cdot\rho}{8}D^2\cdot\vartheta^3 \quad (6)$$

It is known that the density of air $\rho = 1{,}236\frac{кг}{м^3}$, on this basis $\frac{\pi\cdot\rho}{8} = \frac{3{,}14\cdot 1{,}236}{8} = 0{,}4851$

By measuring the power in kilowatts ( ), the formula (6) takes the following form:

$$N = \frac{D^2\cdot\vartheta^3}{\frac{1000}{0{,}4851}} = \frac{D^2\cdot\vartheta^3}{2060}квт \quad (7)$$

If you take the wind energy utilization factor $\eta\ = 0{,}43 - 0{,}47$, then the power takes the form of

$$N = \frac{D^2\cdot\vartheta^3}{2060}\eta \quad \text{квт} \quad (8).$$

If the wind energy utilization rate is , тabout the efficiency of the wind turbine is 43-47 %. In theoretical calculations, this reading is practically impossible to achieve. The wind energy utilization rate includes the following data:

- Types of wind turbines;

- Changes in wind speed;

- Changes in wind direction;

- Losses in the bearings;

- Aerodynamic losses;

- The loss generated in the stator windings due to the reactive power;

- Losses formed due to the resistance of power lines.

DISCUSSIONS AND RESULTS

We calculate the power of the wind turbine of the VEU–3000 brand installed at the Jizzakh Polytechnic Institute (Fig. 2). To do this, use the passport data of the wind turbine. The wind turbine passport contains the following information:

1. Diameter of wind turbine blades D = 2.44 m;

2. rated wind speed for normal operation of the wind turbine $\vartheta_{ном} = 12\frac{м}{c}$ ($\vartheta_{\min} = 3\frac{м}{c}$; $\vartheta_{\max} = 15\frac{м}{c}$);

1. The utilization of wind energy $\eta_{сред} = 0{,}45$ ($\eta_{практический} = 0{,}43 - 0{,}47$; $\eta_{теоретический} = 0{,}593$).

Let's use the power calculation formula (8):

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$$N = \frac{D^2 \cdot \vartheta^3}{2060}\eta = \frac{2{,}44^2 \cdot 12^3}{2060}0{,}45\text{квт} = \frac{5{,}9536 \cdot 1728}{2060}0{,}45\text{квт} = 2{,}247\text{квт}.$$

Let's calculate the power that can be obtained at the minimum and maximum wind readings. By $\vartheta_{\min} = 3\frac{м}{c}$, $\vartheta_{\max} = 15\frac{м}{c}$ the power is defined as follows:

$$N_{\min} = \frac{D^2 \cdot \vartheta^3}{2060}\eta = \frac{2{,}44^2 \cdot 3^3}{2060}0{,}45 = \frac{5{,}9536 \cdot 27}{2060}0{,}45 = 0{,}035\text{квт} = 35\text{вт}$$

$$N_{\max} = \frac{D^2 \cdot \vartheta^3}{2060}\eta = \frac{2{,}44^2 \cdot 15^3}{2060}0{,}45\text{квт} = \frac{5{,}9536 \cdot 3375}{2060}0{,}45\text{квт} = 4{,}389\text{квт}.$$

Calculate the average power value: $N_{ўрт} = \frac{N_{\min} + N_{\max}}{2} = \frac{0{,}035 + 4{,}389}{2} = 2{,}21\text{квт}$.

We practically calculate the power value at the nominal wind speed. In this case, the wind utilization factor is taken as:

$$N_{теоретический} = \frac{D^2 \cdot \vartheta^3}{2060}\eta = \frac{2{,}44^2 \cdot 12^3}{2060}0{,}593\text{квт} = \frac{5{,}9536 \cdot 1728}{2060}0{,}593\text{квт} = 2{,}961\text{квт}.$$

The calculated power of the wind turbine VEU - 3000 coincides with its passport data (N = 3000 W = 3 kW).

f, (Hz)

Fig. 1. VEU-3000 installed in JizPIна территории ДжизПИ

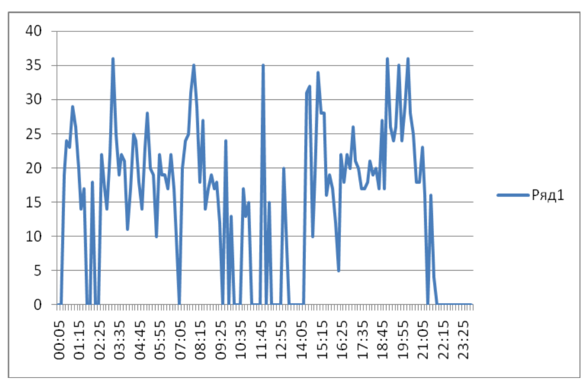

Fig. 2. Daily graph of the frequency of the wind generator

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