Increase Efficiency of Renewable Sources in Regions with Weak Wind Streams

d.e.s. Sadullaev N.N., Shoboev A.H., Nematov S.N.

Current article is stated a construction principle wind electric installation with the store of mechanical energy. For increasing efficiency of installation instead of converters and the store of electric energy store of mechanical energy is used. Thus, overall performance increases wind electric installation in the conditions of weak wind streams is provided. The principle of work of model of installation is described and proved efficiency of its work.

***Keywords**: wind electric installation, the store of mechanical energy, energy efficiency, the weak wind streams, renewable sources, an elastic cord, the potential energy, alternative energy sources.*

Nowadays actively develops years alternative energy sources on the basis of renewable energy sources in over the world. Development of these sources allows to save power resources, to raise reliability of electrosupply of consumers and to improve ecological conditions. The basic lacks of these sources is the low efficiency and high cost price of energy. Indicators of quality of the electric power in these sources depend on random factors (for example, a direction and speeds of a wind), to adjust which is practically impossible. The continuous constant stream of energy is necessary for generation of the qualitative electric power of an alternative current. Because of wide range of changing parametres stream of energy (a wind, water, etc.) The received electric power of alternating current on a generator exit becomes unsuitable to application. Therefore, this energy is usually used through accumulation in the form of energy of a direct current that leads to rise in price and reduction of efficiency of these installations (fig. 1).

The major power characteristic of a wind is its speed. The quantity of energy which wind electric installation (WEI) can develop depends first of all on the averaged speed of a wind as in time, so on the surface area, sweep off wind the wheel. There is a criterion constructed on the basis of mid-annual speed of the wind at which WEI it is profitable and pays back itself. This speed is in a range of 5,1-5,9 m/s [1]. In territories kept away from oceans seldom there are zones a wind of such speed. Thus, weak changeable streams of a wind is one of the basic problems of use wind power in territories of a continental part of continents.

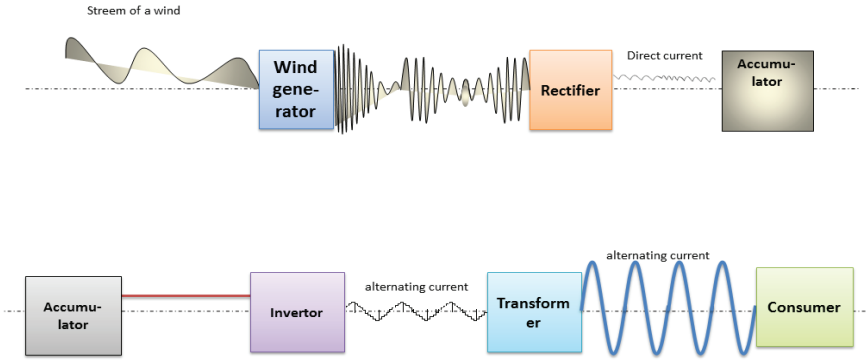

Fig.1. Stages of electromechanical transformation and curve changes of parameters power conversion existing wind generator.

It is possible to provide increase of efficiency of these cars with generating of the electric power after accumulation of weak and changeable streams of energy of renewable sources during absence of a current consumption. The sequence of transformation of energy in wind installation is for this purpose used by more rational, i.e. to generate the electric power after accumulation of mechanical energy from renewed sources. The saved energy is spent by a powerful and constant stream which provides generation of an alternating current with higher efficiency. It allows, will exclude from wind turbine rectifier, accumulator and the inverter, accordingly raises efficiency of these sources (fig. 2). In process of receipt of mechanical energy from alternative sources, energy in elastic elements of the wind machine gradually collects in the form of potential energy. Regulation of a stream of capacity of the saved up energy at the expense provides generation of the electric power of an alternating current with constant frequency and amplitude of sinusoidal voltage. It allows to receive the electric power of an alternating current within standard indicators of quality of voltagee. The source consistently works or in a mode of accumulation of mechanical energy, or generating of electric energy.

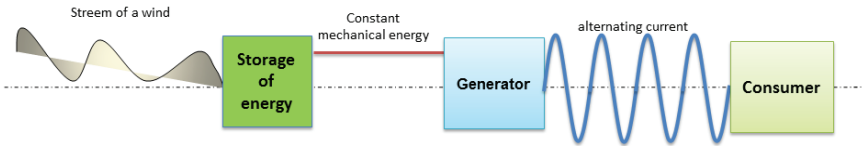

Fig.2. Stages of electromechanical transformation wind turbine with the store of mechanical energy

The basic part of a design of installation consists of the store of mechanical energy. Model of installation in the form of sports training apparatus it is shown on fig. 3 which consists of the case 1 in which it is placed two disks 4 with drums 2 and 3 with the different diameters, connected among themselves with elastic a cord 5. The drum 2 has more diameter, than a drum 3. Disks 4 have the rigid tooth transfer providing opposite rotation since identical angular speed (frequency of rotation) for a rewinding эластической a cord 5 from one drum on another. The disk 4 is set in motion gear by transfer 10 and a pedal of a foot drive 12 (or an alternative energy source, since a wind, a stream of water, etc.). For lack of alternative kinds of energy the device can work from a foot drive 12. At rewind in one turn the flexible material is stretched on distance - Δl, defined by the following formula:

$$\Delta l = \pi(D_2 - D_3) \qquad (1)$$

Where D_2 and D_3 - accordingly, diameters of drums 2 and a disk 3, *m*;

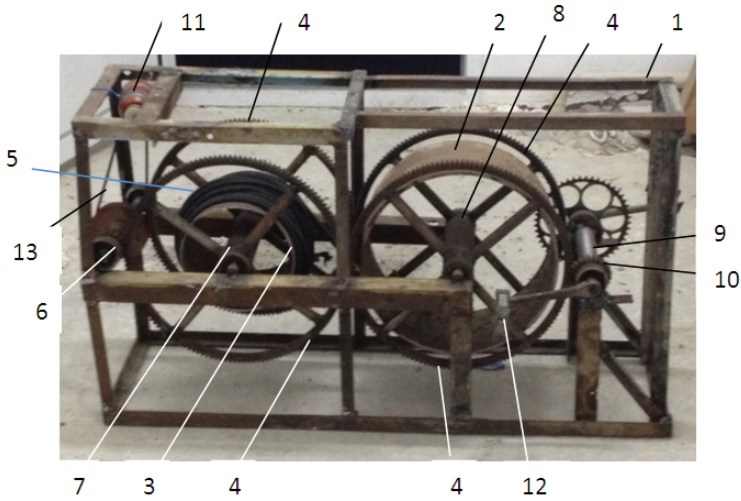

Fig.3. Model of wind installation.

Thus there is a constant force of draught (stretching)-F_s or the moment of rotation of M which are defined by following formulas:

$$F_s=k\cdot\Delta l \quad (2)$$

$$M=\frac{F_s\cdot D_3}{2} \quad (3)$$

Where k-factor of rigidity of a flexible material, N/m;

Energy-W_r, accumulated at elastic rewind in one turn, is defined under the following formula, kWh:

$$W=\frac{k\cdot\Delta l^2}{2} \quad (4)$$

The saved up mechanical energy, after full rewind, kWh:

$$W=\frac{n\cdot k\cdot\Delta l^2}{2} \quad (5)$$

Where n_{ly}-number of layers of winding, piece;

At a mode of generation of the electric power disks 4 fall and the generator rotates with a speed which is defined under the following formula:

$$\frac{d\omega}{dt}=\frac{1}{J}(M-M_r) \quad (6)$$

Where the J-total moment of inertia resulted on a shaft of the generator, kg·m^2; M and M_r - the rotating moment and the resistance moment on a generator shaft, N·m.

Operating time the device in a generating mode:

$$t=\frac{W_{mech}}{P_{mech}}, \quad (7)$$

Where P_{mech} - mechanical capacity on a generator shaft, kW.

$$P_{мех} = M \cdot \omega \quad (8)$$

Where *M* and ω - frequency of rotation and the moment on a generator shaft
Electric power of the generator are defined under the following formula:

$$P_{el} = P_{mech} \cdot \eta_{gen} \quad (9)$$

Where η_{gen} - the generator efficiency.

For generation of the electric power the generator 11 incorporates шестерной 6 and disks 4 by means of the saved up potential energy of an elastic cord 5 rotate in the opposite direction. As, elastic a cord it is wound from a constant by a tension the generator through V-belt transfer rotates in almost constant speed and generates a variable a current of almost invariable frequency and amplitude of pressure. Speed of rotation is counterbalanced by the moment of resistance of the generator and defined under the following formula:

$$\omega = \frac{P_{mech}}{M} \quad (10)$$

In this the device electromechanical transformation to occur only once. Therefore, efficiency this the device will be maximum and will be above from alternative sources having devices of transformation and accumulation of electric energy. Traditional the wind generators speed of a wind should be not less than 3-4 m/s, and also for the maximum speed wind turbine blades a wheel should be minimum. In the offered installation parameters of the generated electric power not to depend on parameters of a stream of a wind or water (as, in this time will not be electric power generation), but only from quantity of the saved up mechanical energy. Therefore, for increase efficiency wind turbine the number of blades can be increased to greatest possible.

As, the device cannot work continuously, it is offered to use the device as a reserve source at failure of electro supply or consumers of small capacity (to 1 kW) on a small time interval (till 1 hour). For continuous work the device should be united several stores in one cascade scheme.

There are the some consumers of the electric power being far from electric networks and working in a short-term mode. Creation for these consumers of the alternative sources, using renewable kinds of energy provides a demand of these sources in manufacture. For example, electric drives of latches of dams of water channels work all some minutes. Usually for drives of these installations stretch an electric network with the transformer which 99 % of time in the single work. Accumulating energy of a stream of water in these dams, during necessary time it is possible to generate the electric power for need of these electric drives or for other consumers.

REFERENSES

[1]. Marc Schwartz, Donna Heimiller, Steve Haymes, and Walt Musial. Assessment of Offshore Wind Energy Resources for the United States. Technical Report NREL/TP-500-45889 June 2010.