ENERGY INDUSTRY

DOI: 10.32743/UniTech.2022.102.9.14234

SELECTION OF THE TYPE OF ELECTRIC GENERATORS FOR A WIND ELECTRIC INSTALLATION

Nijat Mammadov
Senior laboratory,
Azerbaijan State Oil and Industry University,
Azerbaijan, Baku
E-mail: nijatms@gmail.com

ABSTRACT

The generator is the main element of the electrical equipment of the wind electric installation. In addition to the main purpose, the generator must perform certain functions for stabilizing and regulating parameters that characterize the quality of the generated electrical energy. Therefore, the choice of a generator is the main condition for a wind turbine. This paper presents comparisons of electrical generators used for wind turbines. The advantages and disadvantages of electric generators are indicated, which simplifies the choice of the type of generator for a wind electric installation.

Keywords: WEI, synchronous generator, asynchronous generator, two-speed asynchronous generator, renewable energy.

Introduction

Currently, in the development of the energy sector, much attention is paid to renewable (non-traditional) energy sources. The local placement of wind installation, ease of installation of the mechanism and application are clear advantages relative to conventional energy sources [1]. A wind electric installation (WEI) or a wind generator is installation that converts the kinetic energy of the wind flow into the mechanical energy of the rotor rotation with further conversion into electrical energy. The development of various types of generators for wind electric installations currently plays a very important role. It is necessary to systematize data on the use of different types of generators for wind turbines of different capacities, depending on the operating conditions and the type of load [2]. This will allow the maximum use of the potential of the wind flow. It is necessary to analyze and establish the dependence of the influence of wind speed on the amount of electricity generated by various types of generators and to establish which type of generators has more stable energy characteristics at low wind speeds. Three main factors influence the choice of a generator for wind electric installation:
1) Output power (kW), determined only by the power of the converter (inverter) and independent of wind speed, battery capacity. This parameter defines the maximum number of electrical appliances that can be connected to the electrical supply system at the same time. It is not possible to simultaneously consume more electrical energy than the power of the converter allows. Several inverters can be connected at the same time to increase the output power.

2) The time of continuous operation in the absence of wind or in light wind is determined by the capacity of the battery and depends on the power and duration of consumption.

3) The battery charge rate depends on the power of the generator itself. Also, this speed is found depending on the wind speed, mast height. The more powerful the generator, the faster the battery will be charged, which means that electrical energy from the battery will be consumed faster [3]. For wind electric installations, the following types of generators are used:

   1. Asynchronous generators with short circuit rotor
   2. Asynchronous generators with a phase rotor
   3. Two-speed asynchronous generators
   4. Synchronous generators with magnetoelectric excitation
   5. Synchronous generators with electromagnetic excitation
   6. Asynchronous synchronous generators, etc.

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Synchronous generators with magnetoelectric excitation and with electromagnetic excitation used in WEI

Synchronous generator with magnetoelectric excitation. This generator has a simple design, is easy to maintain, reliable and has a high efficiency. Thanks to the use of high-permeability permanent magnets, the characteristics of this generator are improved. At the same time, there is a difficulty in regulating and stabilizing the voltage. Therefore, it is also called a permanent magnet synchronous generator.

Thanks to the regulation of reactive power, which enters the generators from the capacitor, voltage stabilization is carried out. In SG with magnetoelectric excitation, a gearbox is important, which means additional losses. Despite this, this synchronous generator is the most common wind turbine generator. Today, various studies are being carried out to improve the design and performance of a permanent magnet synchronous generator.

Advantages:
1) Elimination of sliding contact,
2) Impossible control of regime parameters, which is very important in gusty winds,
3) In autonomous modes, an autonomous source of reactive power is important,
4) The presence of a sliding contact, which leads to a decrease in reliability.

**Asynchronous generator with short circuit rotor.** This generator has the same disadvantages as the AG with a phase rotor. Consider the advantages of this generator:
1) Easy and reliable in maintenance,
2) Low cost,
3) It has very low fluctuations in power output, electromagnetic torque and current in parallel operation and variable wind speed.

**Two-speed asynchronous generators.** A two-speed asynchronous generator is an asynchronous generator that operates in two speed modes. Step adjustment is provided by series-parallel switching of the stator windings. Unlike standard asynchronous machines, these machines have additional rotational speed designations. With this design of a two-speed generator, the overall and connecting dimensions are identical to standard electric motors. These generators are used to drive gearboxes, geared motors, fans and other applications that require a change in speed. The main of these installations is the wind electric installation [5].

As previously stated, in order to increase the efficiency of wind application, stepwise speed control began to be used. For this, two windings with a different number of pole pairs are placed in the generator stator. At the lowest wind speed, in order to maintain optimal speed, a low speed of rotation of the wind wheel is used and the winding with the largest number of pole pairs is included in the generator. When the wind speed rises above a certain limit, it switches to the lowest value of the number of pole pairs and an increase in rotation speed is allowed.

Consider the advantages of a two-speed generator used for wind electric installation
1) Low noise level
2) Minimum vibration
3) High performance
4) High starting torque
5) Simplicity and reliability of design
6) Ability to work at two speeds

**Conclusion**
Thanks to all the advantages and disadvantages we have considered, we can come to the following conclusions. In autonomous electrical networks, when using wind turbines with a power of up to 200 kW, it is recommended to use synchronous generators (SG) with permanent magnets (SGPM), which have advantages in terms of power, economic indicators, low losses and efficiency. The SG has a rigid dependence of the frequency of the generated EMF on the shaft speed. If the wind is gusty, then high values of variable components in the regime parameters are formed in the generator and, together with the network, the operation of such generators deteriorates. This limits, and in regions with sharp variable winds, makes it impossible to use the SG for direct connection to the network. With such work, a semiconductor frequency converter is installed between the generator and the network. Two-speed wind electric installations are widely used because their circuit is quite simpler than circuits with converters. The use of a two-speed asynchronous generator makes it possible to increase the generation of electrical energy at low wind speeds from 3.5 to 5 m/s. Therefore, at present, in wind electric installations, the use of two-speed asynchronous generators is the best.

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