Comparative Analysis of Different Types of Dynamic Solar Tracking Systems

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Abstract - In this paper is considered the importance of solar tracking systems, the main types of their implementation are described, as well as types of drives and control algorithms. There are formed conclusions on the feasibility of using one or another system depending on the size of the SP (solar plant).

Keywords – Solar Tracking System, dynamic tracking system, drive mechanism, control algorithm, sensing device.

Introduction

Nowadays, the problem of environmental pollution is acutely faced by all countries of the world. Along with traditional energy sources, alternative energy sources are actively developing, among which solar energy can be identified as the most environmentally friendly.

The main problem of solar energy is its unstable nature, in particular for the highest efficiency of solar panels, the sun's rays must be perpendicular to the plane of photocells. This problem can be solved by the solar tracker device, which provides the optimal angle of incidence of sunlight, falling on the surface of the panel from sunlight throughout the day [1].

1. General types of tracking systems

Solar tracking systems can be of two general types: static and dynamic. Static systems are systems in which the angle of the panels relative to the sun is fixed (like being placed on the roof) or varies with a periodicity 3-4 times during the year. Changing the angle of this type of system is done manually, by adjusting the length of one of the sides of the mechanism, on which the panels are fixed. Dynamic systems are systems where is a constant change of the angle depending on the position of the sun in the sky. Systems of this type can be unidirectional and biaxial. Unidirectional dynamic systems make it possible to change the angle in just one plane and are used mainly for watching the sun throughout the day. Two-axis dynamic systems make it possible to choose the most optimal angle in two planes. The main elements of dynamic systems are the tracking device, the microcontroller, the control algorithm and the drive mechanism. At present, a large number of studies have been conducted, in which the effectiveness of static and dynamic systems was compared. The results were virtually identical - under identical conditions, the performance of dynamic systems compared with static ones is 35-80% higher [2]. Therefore, in the future, it is reasonable to consider only dynamical systems.

2. Types of dynamic tracking systems and their engines

The function of constant correction of the angle of rotation / inclination of solar panels in dynamic systems is performed by the drive system. Depending on the design features, the region where the tracking system is installed, the number of panels that the system employs and also the cost of the project use various actuating mechanisms.

Electric drive - the most common type of drive, usually used in conjunction with a mechanical gearbox. The main advantages of this type of drive are cheapness, simplicity of construction and high reliability.

Hydraulic drive - the second most popular drive type. The advantage can be attributed to the fact that for the same size of systems for hydraulic drive can install an electric motor of less

power than for a similar system with electric drive. The disadvantages of this system are high cost, complexity of the system, constant operation of the engine in the case of non-leaky system.

Pneumatic drive - the least common type of drive. The advantages and disadvantages of this type are basically similar to the hydraulic drive, and to the disadvantages it is still worth adding the details of high accuracy in the manufacture of drive elements.

Each of these types is driven by an electric motor. For various types of drive mechanisms, electric motors of certain types are used. This is due to the peculiarities of the design and characteristics of the engines themselves. For an electric drive, DC motors, step motors, servo drives and asynchronous motors with frequency converter can be used as drive motors. In pneumatic and hydraulic drives, asynchronous motors with frequency converter, synchronous machines are used both with permanent magnets and with an electromagnetic actuator. DC motors, in these systems, have an advantage over alternating current motors, since they do not have losses on the conversion of DC into AC.

3. Management algorithms

There are two types of control algorithms - the astronomical algorithm and the real-time light intensity algorithm. Astronomical algorithm is a purely mathematical algorithm based on astronomical references. The real-time light intensity algorithm is based on light intensity indicators derived from solar intensity sensors [3]. There are many approaches to the implementation of data sensors, in particular the definition of the highest light intensity with the help of the image of the sky [4], a device that uses the direction of the shadow to determine the most illuminated area, etc.

Conclusions

Having considered the existing types of tracking systems, types of drives and management algorithms, we can form conclusions about the feasibility of using them for certain types of solar stations. In particular, for domestic sunshine (up to 35kW), it would be advisable to use a two-axis electric drive system and a control system that will operate under real-time algorithm. For medium-sized SP (up to 500 kW), it is most advisable to use single-axle trackers with a hydraulic or pneumatic drive. As with a low-power VPS, it is best to use a real-time algorithm. For SP, whose power is more than 500kW, it is not advisable to install a tracking system that will monitor the position of the sun in real time. This is due to some factors, in particular, the economic and complexity of designing such an SP. The best option is to install a single-axis system with astronomical algorithm and electric drive.

References

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