GEOTHERMAL ENERGY AND ITS DEVELOPMENT PROSPECTS

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Abstract. *The paper considers the prospects of geothermal energy, its use and varieties of geothermal fields, as well as types of geothermal power plants.*

Keywords: *geothermal energy, heat, steam, energy, geothermal power plant.*

Renewable energy sources (RES) are currently receiving a great deal of attention around the world. With the reduction of oil and gas resources, many countries around the world began to pay more and more attention to renewable energy sources. According to experts, in the near future, traditional energy sources such as oil, natural gas and coal will be replaced by renewable sources, that is, the transition from old energy to newer energy. Such a transition is referred to as the Energy Transition.

An Energy Transition is a structural change in the energy system in which there is an increase in the share of new energy sources and a gradual reduction or complete displacement of old sources. There are four energy transitions in total. Now the world is in the process of the fourth transition: the transition to "green" energy.

Renewable energy sources are energy resources that are renewable or inexhaustible. The principle of using such sources is to generate electricity and heat from constant natural processes in the environment, as well as to apply them technically. Renewable energy sources include sunlight, wind, tides, biofuels, and geothermal energy from the earth. The latter, in turn, holds great promise for the future.

Geothermal energy is a type of renewable energy sources based on the heat generated in the earth's interior. The relationship between the temperature of the Earth and the depth is called a geothermal stage, and it is as follows: for every 30 meters the temperature of the Earth increases by about 1K. A simple calculation reveals that at a depth of 3000 m the temperature will be about 100°C. This means that at this depth water would boil. Consequently, the average depth of a geothermal power plant is 3-5 km. But in some places the geothermal stage can be smaller. For example, areas near volcanic sources are characterized by a geothermal stage of 2-3 m, and sometimes even 0.5 m.

Thermal waters are divided into three categories according to their temperature index:

1. high-potential (with temperatures greater than 100°C);
2. medium potential (with a temperature of 70-100°C);
3. low-potential (temperature below 70°C).

According to the type of geothermal energy source deposits, a geothermal power plant is designed. There are only three types of basic geothermal power plants.

Hydrothermal plant

The operating principle of a hydrothermal plant is based on the spinning of a generator turbine. Reservoir hot steam rises up, spinning the generator turbine blades, and then rushes into the Earth's atmosphere. This is considered the ideal condition. In most cases, steam and water mixtures with a temperature above 150°C come from the reservoir. In such a situation, a separator is installed upstream of the turbine. The separator separates the steam from the water, thereby directing the steam into the turbine. The residual hot water flows into the expanders, where the low pressure separates the additional steam.

Binary geothermal plants

Binary geothermal plants are built when the temperature of the geothermal sources is below 100°C. Here, in addition to the turbine, special fluids are also used. The fluid from the reservoir does not flow to the turbines, but to a heat exchange chamber, where the heat of the reservoir water is transferred to the working fluid, which has a much lower boiling point than water. The working fluid turns into steam, spins the turbines, condenses and flows back to the heat exchange chamber, and so on in a circle. For example, freon can be used as the working fluid, or more precisely one of the types of freon, fluorodichlorobromomethane, which boils at 51.9°C.

Petrothermal Station

With the example of binary geothermal stations, we can understand that there are not many fields with heated underground sources. This drastically limits energy production, so a different approach to energy production was found. Since there is no water in the reservoir, it is injected there. Consequently, the principle of a petrothermal plant is to inject water into a heated rock well. Once in the heated rock layers, the water turns into steam and enters the turbines. Several wells have to be drilled in order to pump water into the stratum through one of them and steam-water mixtures through the others. Thus, we have an artificial hydrothermal principle of energy generation.

The main advantages of geothermal energy are its inexhaustibility and its independence from the environment and time of day. Such energy can be used to generate electricity, provide heating and water supply. Greenhouse gas emissions into the earth's atmosphere will be reduced and the need for hydrocarbons (oil and gas) will be regulated. We should also consider the economic efficiency of this approach. The cost of electricity generated at geothermal stations is 3 times cheaper than at wind power plants and 10 times cheaper than at solar power plants.

But it is also worth considering that geothermal energy has disadvantages. To obtain geothermal energy it is necessary to drill a well, which destroys the soil and vegetation cover of the earth; the probability of micro-earthquakes during hydraulic fracturing increases; it is necessary to re-inject the selected water into the underground aquifer; the

emergence of flows of various toxic substances such as mercury, sulfur, ammonia, arsenic and other toxic substances. The solution to these effects is the introduction of a circulation system. This integration will reduce the number of complications and accidents in the geothermal energy production process. The withdrawn water from the well will be re-injected into the reservoir, which will not create pressure differentials in the formations from which the water was pumped out, and will also reduce the possibility of gas leaks during operations. However, a circulating system requires power, and solid deposits in pipelines and wells contribute to their rapid decommissioning.

Consequently, the negative impact and consequences of geothermal energy on nature and humans are minimized. The demand for geothermal energy at present is high. This is due to: firstly, the depletion of hydrocarbon reserves; secondly, its economic efficiency worldwide; and thirdly, the wide range of applications in various industries. In such a situation, geothermal energy has a prospect of further development.

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