Alexey LYMARENKO

Poltava National Technical University, Ukraine

NON-TRADITIONAL ENERGY AND ECOLOGY

Introduction

The rapid development of civilization in the last decade, which is inseparably linked with the constant increase of resource consumption, raises once again the question of optimal consumption of fuel resources.

In Ukraine there are 20 times more of explored geothermal resources [1] than of all together calorific natural resources (oil, gas, condensate, coal, peat, wood, vegetable and biological masses).

Despite the seeming simplicity and availability of geothermal energy use with the help of turbines and turbogenerators connected to them, the technical and environmental implementation of this method of generating electricity is a complex scientific and technical challenge. Technologically and economically developed countries such as the USA, the Philippines, Mexico, Italy and Japan for the last 20 years have increased the costs of creating new geothermal technologies up to 2 billion US dollars.

Object, purpose and tasks of the research

The object of the research is geothermal well and operation of geothermal heat station for heat and cooling of facilities of housing and communal services.

The purpose of the research is to determine the factors that affect the environmental safety of use of geothermal resources in Ukraine.

Given the purpose of the research, the authors have set the following tasks:

- to determine the geothermal potential of Ukraine;
- to examine the economic performances of hydro-thermal resources;
- to indicate promising areas of their development;
- to consider the scope of use of geothermal resources;
- to identify the main advantages and disadvantages of use of geothermal waters.

Identification of the main environmental factors while using geothermal resources

Ukraine has a considerable potential of geothermal energy. This is due to the geothermal peculiarities of the relief and to the peculiarities of geothermal resources of the country. The geothermal resources include, first of all, thermal water and the warmth of the heated dry rocks. Promising for use in commercial volumes are the resources of thermal water, which is extracted along with oil and gas on the respective fields.

Scientific and practical research work in Ukraine is focused now only on geothermal resources, which are represented by hot waters. According to various estimates, there are about 8.4 million tons of oil equivalent per year of economically viable energy sources of hot water in Ukraine. There are enough geothermal areas in Ukraine with potential for high temperature (120-180°C), which allows the use of geothermal fields with high temperature for electricity production.

In Ukraine, there were sunk more than 12 thousand wells to determine the thermal field, most of which have been studied in detail by leading scientists and researchers of Ukraine. On the basis of these data the atlas of geothermal energy at different depths has been compiled.

The thermal energy of the Earth, as described in [2], is an energy resource. Solar energy resources of Ukraine on the projected depth characterize the thermal-physic parameters of the Earth, namely, the temperature and the density of the heat flow. According to the conducted researches, it is possible to separate two areas of distribution of geothermal resources (35-50 mW/m^2) and abnormal (60-130 mW/m^2) on the territory of Ukraine.

The most promising regions of Ukraine for the development of geothermal energy are Luhansk, Kharkiv, Donetsk and eastern part of Dnipropetrovsk regions (about 12 million people) with the depths of the wells up to 3000 m; western part of Dnipropetrovsk, Poltava, Chernihiv and Sumy regions (about 5.3 million people) with the depths of the wells up to 3500 m. On the west of the country: Lviv, Ivano-Frankivsk, Chernivtsi and Zakarpattia regions (about 6.2 million people) with the depths of the wells up to 3000 m. On the south there are Odessa, Mykolaiv, Kherson and the whole Crimean peninsula (about 7.5 million people), where wells will have the depth of 3000 m [3].

Every fourth well in Poltava and Ivano-Frankivsk regions can be used to receive energy. Large-scale use of this type of geothermal resources doesn't require any preliminary preparatory works, separate geological exploration, drilling of industrial wells or substantial investment.

Cost-effective for use in future are the resources of low-grade heat of natural and anthropogenic origin, which can be utilized by heat pumps, and are estimated at 22.7 million e.f. at the level of the year 2030.

Among all types of geothermal energy, the best economic indexes have hydro-geothermal resources – thermal waters, steam-water mixtures and natural steam [4].

Experts of the state agency for efficiency and energy saving of Ukraine note that if the entire world switched to the use of geothermal energy, to decrease the temperature of the earth's interior by only half a degree would take 41 billion years.

Hydro-geothermal resources, which are used to produce electricity, account 4% of the total explored reserves, that is why their use in the future should be viewed along with heating of local facilities.

Large-scale use of geothermal energy is determined by several factors: the need to finance the construction of wells, the price of which increases with increase of the depth. Thermal waters can be used in two ways: fountains (hot water is discharged into a local pond) and circulations (hot water is re-injected into the well).

The first way is simpler and requires less financial costs, but it is environmentally unsafe, the second way is more expensive, but its use ensures the preservation of the environment [5].

Today, Ukraine attaches a lot of importance to the problem of energy conservation and efficiency, to solve it is on the first place for its strategic development. This issue has become particularly sensitive after the gas crisis between Russia and Ukraine on "blue fuel" supplies. As is known, Ukraine belongs to the energy deficient countries. Annual technically achievable energy potential of geothermal energy in Ukraine is the equivalent of 12 million tons e.f., its use would allow to save about 10 billion m^3 of natural gas [6].

The development and use of alternative energy is important not only because of the exhaustion of fossil fuels, but also because of the devastating global impact on the environment. An important aspect of the use of alternative energy sources is their environmental friendliness.

Developing countries will increase the share of energy consumption three times, and the volume of carbon dioxide emissions will annually increase by 2.1%. This scenario represents a real threat to global man-made climate changes, that is why the importance of renewable and environmentally friendly alternative sources of energy will certainly increase [7].

International congress on geothermal energy in the city of Florence found it in comparison with other alternative energy sources as the most advantageous, environmentally clean, safe and cheap.

Geothermal energy source influences on the environment in different ways. The additional amount of dissolved in geothermal waters compounds of sulfur, boron, arsenic, ammonia and mercury is discharged into the atmosphere; steam appears; humidity increases; emissions of steam are accompanied by acoustic effects; failures of the earth's surface; the geothermal brine enters the soil.

The advantage of use of geothermal power plants is their environmental friendliness. Waste waters are pumped back into the well, it would ensure the environmental safety of the region and the stability of the engineering procedure. Geothermal power plants produce significantly fewer harmful emissions into the atmosphere – a geothermal station produces CO_2 emissions on 1 mW/h of the produced energy at a rate of 0.45 kg, while the thermal power plant fueled by natural gas – 464 kg, on fuel oil – 720 kg, on the coal – 819 kg [8].

To install a geothermal power plant there is a need in a relatively smaller plot of land than for the construction of thermal power plants. They can be placed even in a resort area.

Geothermal power plants have a negative impact on the environment during the development of the field, steam pipeline installation. This impact is usually limited to the area of the field.

Hot water or steam is produced by means of wells, which are drilled to a depth of 300 m to 2700 m. Under the influence of geostatic pressure the heat carrier rises to the surface, where it is used in turbines [9].

The negative effects of extraction of geothermal heat carriers are failures of soil and earthquakes. Failures of soil can be observed throughout the field, due to the lowering of the lower layers of soil, which are pressured by the upper layers. The production of geothermal sources may be further reduced.

Increased seismic activity may be a sign of existence of the thermal fields, it is often used in exploration.

However, there is no reason to believe that the production of geothermal resources can lead to an increase in seismic activity in the region. Since the number of earthquakes in the area of development of geothermal fields caused by volcanic action is much less than the intensity of the earthquakes that occur as a result of crustal movements along the faults.

The technological process of the production of electrical energy on geothermal heating station does not require burning fossil fuels. Therefore the amount of harmful gases emission to the atmosphere is much less than on the thermal power plants and its chemical composition differs from the emissions of stations on a gaseous fuel. Produced by geothermal stations steam is essentially water vapour. 80% of gas impurity is carbon dioxide and a small proportion of methane, hydrogen, nitrogen, ammonia and hydrogen sulfide. The most dangerous and harmful is hydrogen sulfide (0.0225%). The composition of geothermal waters includes the following dissolved gases: SO_2, N_2, NH_3, H_2S, CH_4, H_2 [10].

Cooling water consumption on geothermal plants (per 1 kWh of electricity produced) is 4-5 times higher than on the heat power plant. It is because of a lower coefficient of efficiency. Cooling of used heat carrier in local reservoirs can lead to their thermal pollution, the increase of concentration of salt, sodium chloride, ammonia, silica, and of such elements as boron, arsenic, mercury, rubidium, cesium, potassium fluoride, sodium bromine and iodine albeit in small quantities. With increasing depth of wells the concentration of these harmful substances can grow [11].

During exploitation of geothermal heat plants, the contamination of surface and groundwater aquifers is possible due to the release of solutions with a high concentration during drilling operations. Discharge of the used heat carrier can lead to waterlogging of the areas in high humidity climate, and in the areas with dry climate to increase of the salt concentration. At the break of the pipeline a large amount of brine can get on the surface of the soil.

Efficiency of geothermal power plants is 2-3 times lower than that of nuclear power plants and thermal power plants, and they emit 2-3 times more of the heat. To reduce the harmful effects on the environment the use of a circular circulation of the heat carrier on geothermal plants should be encouraged under the scheme system "well – waste-heat recovery units – well – layer". In turn, this will enable us to reduce the flow of heat carrier to the surface of the soil, in the groundwater aquifers and lakes, will enable to keep reservoir pressure, to exclude ground failures and to reduce seismic activity.

Adverse environmental impacts of geothermal energetics:

- alienation of land;
- changes in the level of groundwater, soil failures and waterlogging;
- gas emissions (methane, hydrogen, nitrogen, ammonia and hydrogen sulphide);
- release of heat into the atmosphere or into surface waters, which create a local increase in humidity and is accompanied by an acoustic impact;
- reset of the poisoned water and condensate, contaminated with small quantities of ammonia, mercury and silica;
- pollution of groundwater and aquifers, soil salinity;
- emissions of large amounts of brine at break of pipelines;
- emissions of radioactive elements together with the steam;
- changes in temperature fields of layers.

Conclusions

As the result of the conducted researches there has been determined:

1. Geothermal potential of Ukraine, the main promising regions for the use of geothermal energy.
2. In order to reduce costs for the construction of geothermal wells it is proposed to use depleted oil and gas wells.
3. The causes that complicate the use of thermal water in the heating energy sector have been described.
4. The main spheres of the large-scale use of thermal waters for heating, hot water supplies, cooling and extraction of valuable chemical components have been determined.
5. The advantages and disadvantages of the use of geothermal energy and the typical diverse impact of geothermal sources on the environment have been analyzed.
6. The most harmful toxic gases, contained in dissolved form in geothermal waters, such as hydrogen sulfide, sulfur oxide, nitrogen, ammonia and methane have been revealed.
7. A comparative analysis of the coefficient of efficiency of geothermal station with nuclear power station and warm power station has been conducted. There has been discovered that the efficiency of a geothermal station is in 2-3 times lower, but at the same time there are 2-3 times less of heat pollutant emissions.

References

[1] Beloselskii B.S. (2005). *Technology of fuel and energy oils*. Moscow: publishing office. University, 346.

[2] Klavdienko B.P. (2006). *Alternative energy in the EU*. Moscow, Science, pp. 42-43.

[3] Sibikin U.D. (2008). *Renewable energy sources*. Moscow, 228.

[4] Shydlouski A.K. (2007). *Energy efficiency and renewable energy*. Ukrainian encyclopedic knowledge. Kyiv, 559.

[5] Belaev L.S. (2004). *Energy XXI Century: Terms of development, technology forecasts*. Novosibirsk, Science, 356.

[6] Denis O.B. (2008). House "zero" energy ... because Earth and the sun does not bill. Lviv, 336.

[7] Dakovski V.M. (2007). *On energy for consumers and skeptics*. Ekoinform, 212.

[8] Zabarnii G.N. (1999). *Technical and economic feasibility study of industrial development for the purpose of heating the thermal waters Transcarpathian region*. Kyiv, 247.

[9] Kudra S.O. (2007). *Prospect 4s for the replacement of traditional energy resources by energy generated at the Alternative Energy*. Energy saving. Ukrainian scientific and technical journal, pp. 14-22.

[10] Luescher M. (2004*). Temperature distribution in karst systems: the role of air and water fluxes*. Terra Nova, 350.

[11] Klimenko P.P. (2000). *Tehnoekologiya*. Odessa, 542p.