# COMPARATIVE ANALYSIS OF METHODS FOR PRODUCING PETROTHERMAL ENERGY

**Kolbina Tatyana**

Student, Naberezhnye Chelny Institute of Kazan Federal University, Russia, Naberezhnye Chelny

**Samigullin Almaz**

Senior Lecturer, Department of High Energy Processes and Units. Naberezhnye Chelny Institute of Kazan Federal University, Russia, Naberezhnye Chelny

**Abstract.** The article discusses ways to solve problems associated with the use of various types of resources. New methods for extracting petrothermal energy from the bowels of the earth are proposed, and an analysis of methods for producing petrothermal energy is carried out.

**Keywords:** petrothermal energy, heat power, renewable resources.

**Introduction.** Energy is an integral part of human life. Excessive use of non-renewable resources is a huge problem today. As reserves are depleted, people are looking for ways to extract resources that are not yet affected, which could have a positive effect on the planet as a whole.

In modern times, people are looking for ways to more economically consume non-renewable and renewable energy sources and various fuels. Most countries are developing rapidly, so they need to do their best to find energy. The alternative must fully comply with the requirements of the modern world. [4,5]

**Main part.** I think the solution to the problems of the present world is to extract heat from rocks that are underground. This section of geothermal energy is called petrothermal.

The introduction of petrothermal energy is likely for both isolated and remote consumers of thermal energy.

The technical situation of the heat-generating equipment and energy supply systems of the state contains a sharp contrast, equipment continues to operate in some areas and areas with low thermodynamic efficiency, which is associated with the difficulty of recruiting large investments, as a result of which there are a large number of emergency situations with repair costs.

Deep-seated rocks have a huge supply of energy, due to constantly occurring processes in the depths of the bowels of the earth.

The thermal potential of the earth is supported by:

- plate tectonic displacements and changes in the earth's crust;
- decay of radioactive elements
- continuous physico-chemical processes.

The considered thermal phenomenon is available anywhere in our planet.

The idea of using petrothermal energy was proposed in the 20th century. Petrothermal power plants have a place to be and already exist in France, the USA, Germany and other developing countries.

It is worth noting that the other direction of geothermal energy is hydrothermal. Hydrothermal energy is more popular as it is easier to implement. However, its introduction is quite likely only where there are favorable geothermal waters. As for petrothermal energy, its systems can be formed at every point on the Earth. The resources of petrothermal energy are practically inexhaustible, easily accessible everywhere, convenient to use, unlike solar and wind energy. [2,3]

By type of heat dissipator, 3 types of resources are distinguished larger:

- vapor-hydrothermal resources. These resources have been used since ancient times as self-flowing waters. The superiority of these resources is easy accessibility. The limit is the location of the sources, the need for cleaning before operation, in some cases the likelihood of thermal or chemical pollution of the environment.
- petrothermal energy resources (HotDryRock). The latest trend in energy, which is based on the extraction of solid rocks from the bowels of the earth. In comparison with steam-hydrothermal resources, they are the most elementary, since thermal manifestation is available everywhere. The disadvantage is the difficulty of extracting heat from deep wells, but this is not so critical.
- magmatic resources. In fact, magmatic resources are not geographically limited in any way, but technological processes for the purpose of drilling wells reach even depths with magma. Unfortunately, the population does not have the technology to study the strongest high potential sources.

Scientists use the calculation and experimental method to obtain information on rock temperatures, the acquired data highlight the probability of building maps with temperature fields and isotherms. An analysis of the constructed maps can help to find more favorable spaces for the introduction of an alternative type of energy. Based on experimental high-precision temperature measurements in solid and super-deep wells done on the lands of Tatarstan, maps of isotherms are constructed, which are shown in Fig. 1 and Fig. 2 on the roof of the crystalline basement and at various depths up to 12 km. For all depths, the brightly embodied heterogeneity of the thermal field is characteristic. Zones with increased temperature values, indicating large thermal jets from the bowels, and, in accordance with this, the highest degree of fragmentation and fracture of rocks and the presence of intense processes of convective heat and mass transfer, can all be recommended for deep drilling. [1]

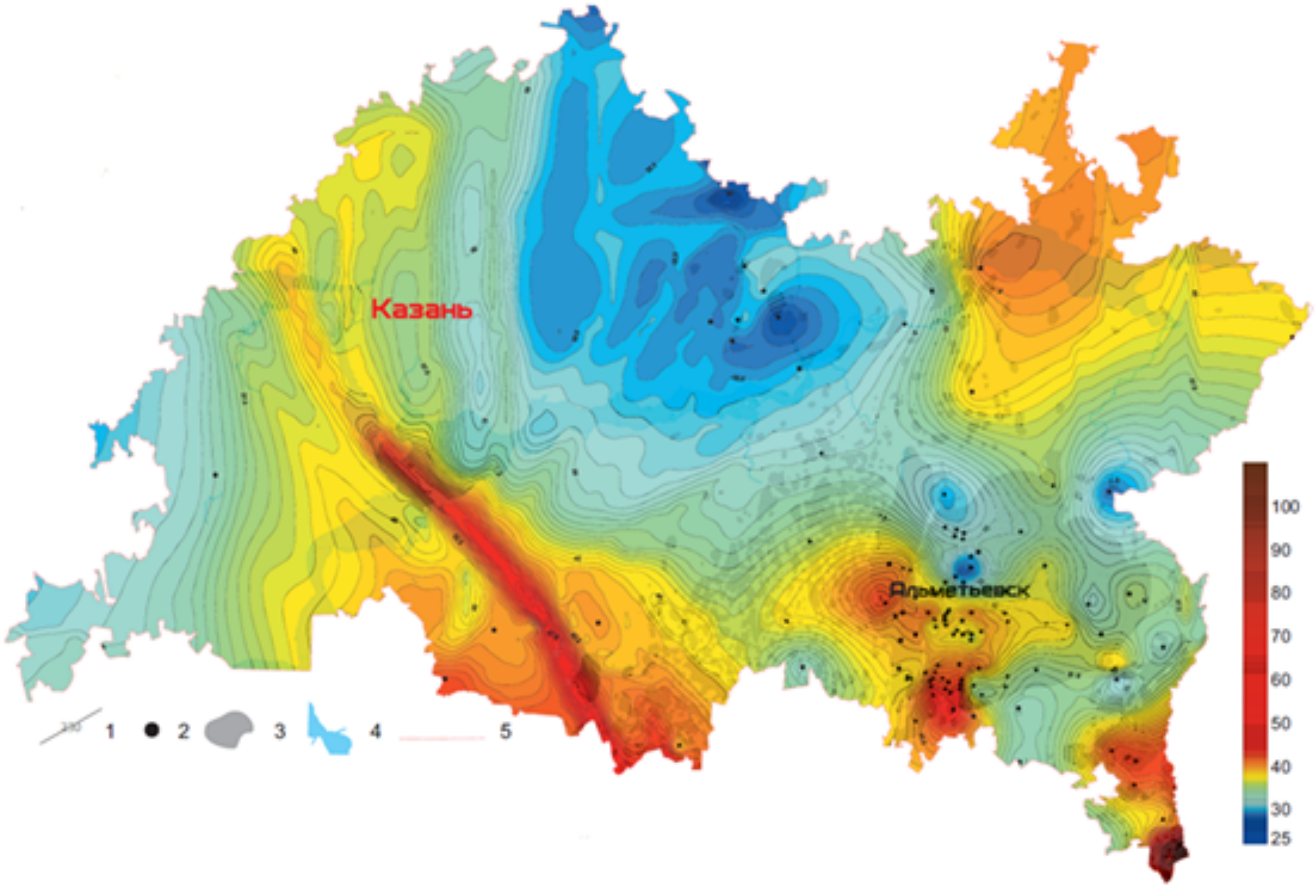


***Figure 1. Map of isotherms on the roof of the crystalline basement***

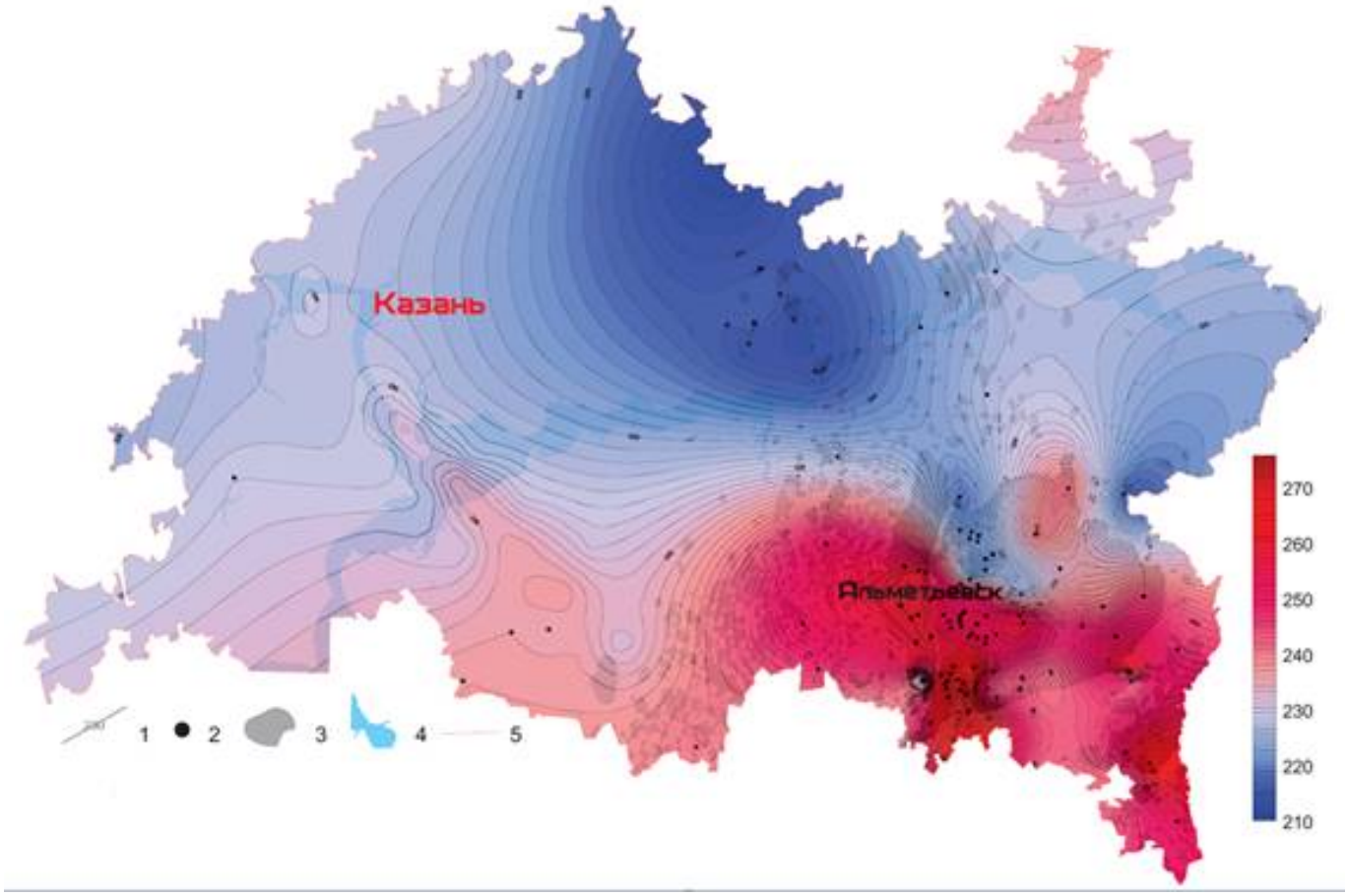


***Figure 2. Map of isotherms at an absolute mark of -12000m***

**Methods of pumping petrothermal energy from the bowels of the earth.**

Extraction of energy from the bowels of the earth is a very difficult process, however, it is possible to apply all kinds of methods for pumping petrothermal energy.

Heat exchangers are considered a significant object for the development of the project during the study, due to the fact that both cold and hot heat carriers will be pumped through them.

One such method is “pipe in pipe” Fig. 3. This method has no problems with transporting the deep heat of the earth's rocks to the surface. In practice, a method of extracting deep heat is used everywhere, based on direct contact of the heat carrier with the bowels. The concept of cracks is created in an array of high-temperature rocks by means of artificial fracturing, which guarantees independent circulation, as well as heating of the thermal carrier. The pipe is installed at a depth of 5-10 km. Further from the bowels of the earth comes hot water through a pipe. Hot and cold fluids move in two different channels, heat exchange occurs between the walls. [6]

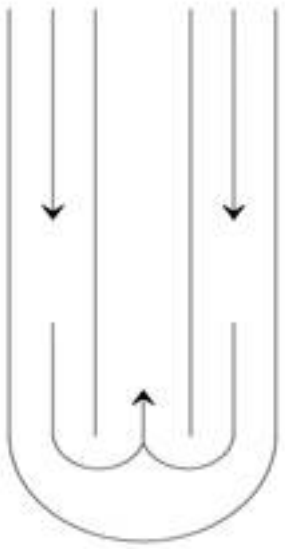

***Figure 3. The scheme "pipe in pipe"***

Also relevant is the “U-shaped pipe” method, which is shown in Fig. 4. Due to the heating of the pipe in the bowels of the earth, hot water enters. Heat exchange occurs between the two environments.

In devices similar to U, free temperature extension of pipes is guaranteed: any pipe has the ability to expand independently of the casing and adjacent pipes. The temperature difference of the pipe walls along the paths in these devices should not exceed 100 ° C. In an unpleasant case, critical temperature stresses may appear in the tube sheet due to a temperature jump on the joint part of its 2 parts.

The superiority of the apparatus system in similarity to U is the probability of repeated extraction of the tube bundle to clean the outer plane of the tubes or the absolute replacement of the bundle. It should be said that the outer surface of the pipes in these devices is inconvenient for mechanical cleaning. [7]

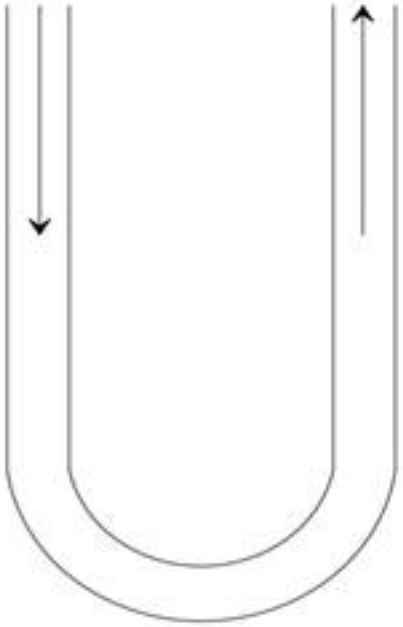

***Figure 4. Scheme "U-shaped pipe"***

**Conclusion.** According to the information review, it is revealed that the production of petrothermal energy is considered poorly studied. In this paper, 2 methods of energy production are proposed, as well as an analysis of methods for producing petrothermal energy. It is worth noting that each method does not require large expenses and is considered economically viable for the whole world.

**Bibliography:**


1. N.N. Khristoforova. Analysis of geothermal maps and prospects of oil and gas potential of deep deposits (on the example of the Republic of Tatarstan) / N.N. Khristoforova, A.V. Khristoforov, M.A. Bergemann // Scientific and technical journal Georesurs. -3 (26) .- 2008.-S.10-12.

2. S.V. Grigoryev. Energy supply of isolated and remote consumers through the use of petrothermal energy sources. / S.V. Grigoryev. // Thesis for the degree of candidate of technical sciences. Moscow, 2014.

3. GOST R 56909-2016. Alternative technologies. Geothermal energy. Terms and Definitions..

4. Yu.D. Sibikin, M.Yu. Sibikin. Non-traditional and renewable energy sources: a training manual / Yu.D. Sibikin, M.Yu. Sibikin.-M.KNORUS, 2010-232s.

5. S.N. Udalov. Renewable energy sources [Text]: [textbook] / S.N. Udalov. - Novosibirsk: Publishing House of NSTU, 2007.-432s.

6. O.D. Samarin. Thermophysics, energy saving, energy efficiency. /

7. O.D.Samarin. // Library of scientific developments and projects of MGSU.-2014.-280s.

8. 7.V.V. Litvak.Energy saving / V.V.Litvak, M.A. Wagner.// Textbook.-Tomsk.-2012.-212c.