GEOTHERMAL ENERGY – RENEWABLE ENERGY SOURCE

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Abstract*: Considering the improvement in the living standards, which have a direct link with the energy use per person it is necessary to find renewable energy sources which are affordable to as many people as possible. The global energy crisis has determined the search for new energy sources.*
As such, renewable energy sources such as geothermal energy become more important and offer an affordable and certain long term solution.
Geothermal energy comprises of various categories of thermal energy which can be found in the earth's crust. Studies in this field have determined that 99% of the earths' interior has a temperature of over 1,000°C and 99% of the other 1% has a temperature of over 100 °C. As such, it could be inferred that the earth's interior represents a renewable energy source that should be taken advantage of.

Key words*: geothermal energy; renewable energy source; thermal energy; energy technologies*

INTRODUCTION

Considering the improvement of peoples standard of living, which has a close connection with the energy used for each person, it is required to find some unpolluted resources of energy at accessible costs for as many as possible. The world energy crisis determined the research of new energy resources.

That way, the renewable energy sources, as also the geothermal energy, becomes even more important and offers and accessible and guaranteed solution for a long period.

The geothermal energy represents different particular categories of thermal energy, which crust contains. Studies in that field remarked the fact that 99% from Earth inner part it may be reached at a temperature of more than 1000 C, and 99% of the remaining 1% it may be reached at a temperature of 100 C. From this research it could result that the inner part of the Earth represents an energy renewal source which has to be exploited as much as possible.

More than that the geothermal energy may contribute at diminishing the consumption of fossils fuels, based on energetic technologies which assures diminishing of the chemical and physical pollution processes.

In other words, the geothermal energy represents the heat from underground fluids and rocks, it isn't noxious, renewable and may be used in different purposes: heating places, industrial field or for producing electricity.

MATERIALS AND METHODS

The author of this study applied as a working method: date collection, processing, analyse and formation conclusions.

RESULTS AND DISCUSSIONS

The geothermal boilers, which are at a few kilometers deep down in the Earth, may be used for direct heating, application which it is called direct using of geothermal energy, and fields of

direct utilization are: places heating and preparing of house hot water, industrial utilization (greenhouses, aquaculture, fish field, drying of timber, of line, milk pasteurization), balneology. The field of using depends of the geothermal fluid temperature.

The peoples have used the hot sources since thousands years ago, for supplying the bath water or for cooking. In our days the water from sources is collected and used in the resorts.

In ancient times the geothermal resources were well known during the Roman Empire best period, during the Middle Age was in decline, and at the end of XIX century restated the intensive exploitation of geothermal sources. The phenomenon has magnitude at the beginning of XX-th century when energetic technologies based on renewable source began to improve.

So, renewable energy represents a valid and practical solution for consumption actual level, and until the year of 2050 may be supplied 80% from the energy needed by the whole world, the condition being that all governments to implement necessary policies in this field.

It may be also estimated that until the year of 2030-2050, the new technologies in the field of geothermal energy will allow a significant production of electricity in many countries which today aren't known as having important geothermal resources.

At commercial level, geothermal energy and the hot water sources have been used during the past centuries for washing and heating places, and in 1904 have been registered for the first time the utilization of these in order to produce electricity (a generator which supplied 4 bulbs. Starting with 2911 and until 1958 existed one geothermal plant, it is now when New Zeeland joined the producers of electricity from geothermal energy.

The geothermal energy may be found as volcanos, sources of hot water, geysers, Waimangu from New Zeeland was the geyser with the highest water outbreak - 460 meters and have been active between 1899 – 1904, and the biggest active geyser in the world it is known as Steamboat Geyser, and it is situated in Yellowstone National Park from USA; the jet of hot water may reach 90-120 meters.

The majority of geothermal layers are located near the contact areas among lithospheric plates. Europe has a high geothermic level, associated with the existence of some areas with worm or hot rocks. The studies concerning supplying of geothermic flux in Europe, indicates some areas on the continent where this perimeter is over the value of 150mW/sqm, for example in Iceland (18% from energy needed it is covered from geothermal energy), France, Italy, Greece and Turkey. Among the countries which frequently use the geothermal energy there is New Zeeland, Italy (the first country in the world where it has been constructed an geothermal plant – 1904), Japan, Iceland, Philippine, USA, France, Russia, Mexico and Lithuania.

In Romania, a number of 200 drillings for hydrates found at depth between 800 and 3500 m geothermal resources of low and medium enthalpy (40-120C); experimental exploitation of almost 100 drillings during the last 25 years, allowed some evaluations of the energetic potential of this type of resource.

Use of extracted geothermal energy is in almost 37% for heat, 30% for agriculture (greenhouses), 23% in industrial field, 7% other purpose.

From a number of 14 geothermal bores dug, between, 1995-2000 at depth of 1500-3000 m, only two bores have been unproductive, being registered a success rate of 86%.

Geothermal prospecting realized by measurements of the temperatures allowed elaboration of a geothermic map for the whole territory of Romania, emphasizing the temperature distribution at depth of 1,2, 3 and 5 km.

These maps indicates as favorable areas for geothermal resources concentration the circumscribed surfaces of 60-120C (for exploitation of geothermal waters for producing thermal energy), and surfaces in which the temperature it is above 140 C at a depth of 3 km (possible areas for geothermic energy exploitation for obtaining electric energy).

For the first type of resources (geothermal systems dominant convective) are characteristic the areas from West Plain, while for the second type are characteristic the geothermal systems dominant conductive placed in the development area of neogene -quaternary volcanism from Oriental Charpatians:Oas Gutai-Tibles and respectively Calimani-Gurghiu-Harghita. (the map).

Areas with geothermic potential in Romania

Exploitation of geothermal resources from our country began since 1960 of the past century, when started an complex research project of the hydrocarbons tanks, moment when have been discovered eight areas which presented a real geothermic potential: six of these are situated in the west side of the country, and the others in the south side [Airinei 1981].

In these areas have been realized over 200 of bores at depth between 800-3500m, which demonstrate existence of some geothermal resources of low enthalpy (25-60C); respectively medium enthalpy (60-120C) [Airinei 1981]. But the antecedents are even much older. The first bore in Romania has been drilled in 1885, in Felix resort, near Oradea. The bore had a depth of 51m, a flow rate of 195 l/ s and a temperature at the wellhead of 490C. Then were the bores from Caciulata (1893-370C); Oradea (1897-290C), Timisoara (1902-310C), etc.

Geothermal resources for which Romania disposes are situated mostly in the west side of the country (Fig.2) [Negoita 1970, Brandrabur et al 1982, Cadere 1985, Burchiu et al 1998, Cohut and Bendea 2000].

In the present work have been investigated two geothermal aquifers placed in Bihor County, of which hydrogeological and hydro chemical characteristics differs significantly. It is about triassic geothermal resource from Oradea and the potian inferior from Sacuieni. The two thermal aquifers are placed in Pannonia Basin, the wealthiest region in geothermal resources at the level of our country.

Existence of geothermal resources in our country is the result of existence of some areas with high thermic flux, as it is mentioned in Fig 4 [Negoita 1970, Cadere 1985, Milcoveanu 1984, Velciu 1987, 1998]. The heat excess manifested by a high thermic flux has its origins in magmatic sub crustal processes and is manifested due to some regional characteristics connected to lithosphere structure. The presence of this thermic flux it is the principal result of thinning of the Earth's crust from the inter Carpathian basin, so that is why in the area of Pannonia Hollow, the Mohorovicic discontinuity is situated at a depth of 20-25 km considering the 30-35km – medium depth at which it is situated this discontinuity in Europe [Paal 1975, Paraschiv 1975].

Pannonia Hollow that is in the north area of our country, including Banat and the west of Apuseni Mountains and territory of Hungary and of ex-Yugoslavia it is an abundant area in geothermal resources. It have drilled around Oradea and the geothermal waters were exploited in therapeutic purpose for more than 100 years. In the last quarter century have been initiated systematic actions of research and evaluation of the geothermal resources as also of hydrocarbons resources from that part of the country. The conclusion was that in the West Plain, in all geologic types may be found aquifer layers with various thermo physical properties and capacities. At the surface thermic flux have values of 85 MW/sqm, higher than the ones from other areas. The most important thermal aquifer system of Pannonia Hollow it is marked by the system from the superior Pannonia base, distinguished by drillings. The waters from this system in general manifest eruptive, due to the high content of dissolved gasses. The thermic level of geothermal waters from the west side of the country it is reduced: 30-90C. From that reason, these may be used especially in therapeutic purposes, preparing of house hot water. In Bihor county, respectively in Oradea Municipality it is supplied hot water for 800 apartments, heat for 12 apartments, bathrooms, greenhouses, swimming pools, hotels. Here the geothermal waters are exploited for over 100 years in therapeutic purposes. Beius is the only town in Romania which in present functions with geothermal resources to heat the houses. Drillings realized in 1995-1996 have discovered the existence of a rich source of geothermal water at over 2.500 m depth. By the help of a project elaborated by European Union, the resource have been researched and evaluated, then the project finished with a feasibility study elaborated by Icelandic and Germans specialists. The things went well and on the first stage of exploitation (a well), have been connected to the network the districts and the main institutions of the town. The towns needs requested the drilling of the second well, during 2002-2004. Since 2008, by accessing not reimbursable European funds, the chance of development on long term of Bihor municipality it was a sure fact. Until now, 20 million euro have been invested in implementation projects or which are during implementation, data mentioned by

Beius City Hall. Every year in Beius is consumed over 200.000 Gcal, produced only from geothermic source. Under the name " Beius geothermal town", the local authorities have started a project of 4.3 million euro which scope is the most efficient use of the locality resources . The project supposes the improvement of thermic comfort and capacity of thermal energy production, new work places, involving the local and regional business area in the process of revaluation of geothermal resource. Also, Beius scope is to realize a spa center supplied with geothermal water. The center will offer treatment and tourism, but will also offer various activities to spend the free time.

In Timis County, the geothermal water it is used for heat, for therapeutic purpose, for hot water. Discovering these resources in the west area of Romania (Banat, Apuseni Mountains, Bihor) could signify a green chance for the area, but the investment are still expected.

Exploitation of geothermal sources in the country with scope of producing electric energy it is impossible, as a geothermal generator supposes a high initial pressure and temperature over 150C of the work fluid. Romanian geothermal potential have been revealed by drillings and experimental drillings from the last 25 years; it isn't exclusively specific for the west area, and exists such resources in other regions of the country. Success rate of the geothermal bores dug between 1995-2000 at depth of 1500-3000 m it was of 86% (in fact, only two bores have been unproductive).

Places for geothermal applications

The places for geothermal applications watches distribution of geothermal water resources in the area, according to the maximal temperatures of emergency of 120C, respectively 140C. In both situations the predominant applications are the thermal ones.

The main areas for thermal applications, especially with geothermic heat pumps, are the following ones: Felix (1 Mai) Oradea; Baia Sprie – Cavnic; Toplita, Miercurea Ciuc – Jigodin; Geoagiu; Herculane; Caciulata – Olanesti; Mangalia.

According to the temperatures registered at hydro-geothermal sources (revaluated by drilling and extraction) from Romania, geothermic of "low enthalpy" is registered at deep waters (with temperatures between 25C and 60C) and, respectively, geothermic of medium temperature, (mesothermal waters), with temperature from 60 C until maximum of 125C.

Geothermal resources of low enthalpy are used at heating and to prepare hot water for consume, in houses, industrial annexes, tertiary – services (offices, education and teaching places, commercial and social areas, hospitals, etc) or agro-zoo technical constructions (greenhouses, solariums, farms for animals). The drilling economic limit for geothermal waters doesn't exceed, in general, 3300 m and was reached only in few areas (for example, the geothermal basin Bucharest North or the areas Snagov-Balotesti).

In Romania in 1990 have been under current exploitation 64 bores, for diverse local use, and exploitable energetic potential under economic conditions is over 100 thousands tep/year. Equivalent energy produced and supplied to consumers connected to the exploitation end of the bore is over 30000 tep, with a yearly medium degree of use of the maximum potential of over 20%. In actual stage there are under conservation or stand by a relatively high number of bores with attested economic potential.

In order to assure a long term energetic development, taking into account also the protection of the environment, because this industrial branch has a very low impact on the environment, if we compare with the energetic one based on fossil resources, must be intensified the promotion of renewable energy resources and of support industrial technologies, being also considered the geothermal energy.

The European Union policy on that field, expressed by White Book and European Directive 2001/77/CE regarding producing of energy from renewable sources, mentions that, until 2020, extended European Union to insure the necessary of energy in a percentage of almost 20% by revaluation of renewable sources.

In order to reach this target, have been elaborated lots of new directives which affect energetic industry and the field of public and private constructions. The objectives of European energetic policy are synthesized as 20-20-20% and refer to:

- Diminishing with 20% of energy consumption of fossils fuels by using efficiency and saving measures of energetic consumption as, thermal insulation of the buildings, or use of economic bulls.
- Producing of minimum20% form the necessary energy by using renewable resources;
- Reaching both objectives until 2020.

At European Union level, over 40% from current energy is used by constructions (residential, public and industrial), so, have been elaborated a new directive, regarding constructions energetic performance. This directive requests for all buildings to adopt the solutions of energetic efficiency. The buildings will be evaluated and will receive an energetic efficiency certificate which becomes obligatory in any sale-buy contract of immobile. More than that the use of energetic efficiency solutions, will be obligatory for authorization of all new constructions or in case of renovation of the existent constructions.

This directive suggests a tax calculation systems and duties according to energetic performance of the building the same with tax system for auto vehicles according to their pollution degree. Positive evaluation of the residential buildings is conditioned by adopting solar heating systems and photovoltaic systems of producing electric energy.

In that context, in many developed European countries (France, Italy, Germany, Austria), having geothermal resources similar with the ones in Romania (Calimanesti, Felix, Cozia, Caciulata, etc) the concerns have been materialized by revaluation on local or regional area, by conception and realization of durable and efficient technologies, which leaded towards a profitable exploitation, on the part of resources exploitation (drilling technologies and extractions from geothermal bores) as on surface energetic installations. The most adequate areas for placing the platforms for geothermal extractions are the ones with volcanic eruption and frequent earthquakes.

The largest geothermal drilling platforms in the world are pumping hot water and steams at a depth of 4 kilometers.

Also, by Kyoto protocol, European Union committed itself to reduce gasses emissions which have greenhouse effect with 8% until 2008-2012, but nothing significantly happened in that way. Only Germany has imposed to reduce gasses emission with greenhouse effect with 21%. So, an important financial assistance for research development, accompanied by a series of fiscal measures, subventions and guarantees from the state, loans for investments, specific local and regional programs represented the portfolio offered to green energy adepts in Germany. It begun to be revaluated the new and renewable various energetic resources – wind energy on water and onshore, photovoltaic pile, biomass, solar energy, geothermal and urban wastes.

CONCLUSIONS

Advantages and disadvantages of geothermal energy

The geothermal energy has a low impact on the environment. For example, the geothermal energetic platforms are smaller than the hydrographic ones.

The advantages of geothermal energy are known from ancient times. We have to remember that the Greeks and Romans used them as hot water and even with healing purpose.

The geothermal energy is used in three energetic ways: heat, electricity and geothermal pumps.

Pure energy comes from natural sources of Earth – solar light, the waves, the flux, the wind and the geothermal heat. As energy source, has two important advantages: is inexhaustible, doesn't pollute the planet and doesn't contribute to the climatic changes.

Renewable energy is versatile. May comply with a large spectrum of energetic needs – from supplying energy to large towns until supplying with energy reduced places, from isolated areas, where there is no connection to an electric network. The large scale of pure technologies

allows as for almost each community exist an adequate solution – and has the advantage of being executed where it is needed and where it will be used.

It came the time when we have to give up for the energy obtained from fossils fuels combustion and from use of other technologies which affects the clime and the surround area.

When resources of geothermal water are close to the surface, the hot water may be transported by pipes where it is needed. In the areas where geothermal resources are not easily accessible, a heat pump may supply the heat to the surface and into the buildings. This method functions almost everywhere and the technology may be used also for cooling: because the underground temperature keeps constant almost the entire year, the same systems which supplies heat in the winter may cool the house during the summer.

Supplying of geothermal energy doesn't pollute and doesn't produce gasses with greenhouse effect. Doesn't use fuel – it is practically renewable all the time. It is also silent and very secure. Geothermal electric plants produce electricity 90% of time, compared with plants based on fossils fuel, which produce electricity 65-75% of time.

The potential of geothermal energy is exploited in a small proportion; it isn't used at real capacity, even in countries with important resources of geothermal energy.

Among the advantages of geothermal plants it is numbered the fact that the obtained energy is pure for the environment and renewable. Another advantage is that geothermal plants are not affected by meteorological conditions and cycle day / night. The geothermal energy is cheaper than the one resulted from fossils fuels.

Although the geothermal energy is part from the category of the energies less polluted, geothermal resources management and exploitation must be realized with maximum attention in order to avoid negative effects over the environment and human health, which could be the result of chemical contamination (with different chemical substances) or physical (radioactive, thermic).

The results of this study indicates the presence of some potential factors of risk for the environment and human health, as the result of geothermal waters exploitation from the two perimeters. It is about the presence in significant quantities of chloride ion (Sacuieni), sulfate (Oradea); ammonium, of petrol hydrocarbons (Sacuieni), of phenolic compounds (Sacuieni), of radium (Oradea), as of high temperature of geothermal waters at overflow (Oradea).

The only problem of exploitation of thermal energy consists in difficult access towards the sources.

Soil instability due to drillings and injections with fluids and their extraction. In some cases it may be discussed about low scale earthquakes.

Even if it is an inexhaustible source, it needs a time period for resource regeneration, more specific reheating the area and geothermal water resources regeneration.

Geothermal energy according to consumer and to the heat / illuminated surface, may be or may be not the only supplying source with energy of the location. Generally it is needed the existence of a secondary system of supplying electric energy.

Among the geothermal plant disadvantages it may be considered the increase of soil instability in the area, may be caused even earthquakes of low scale intensity. The areas with geothermal activity are cooling after few decades of using, so it cannot be about an infinite source of energy, but surely we meet with renewable sources. An explanation for cooling of the areas with geothermal activity could be also that the geothermal plant installed it is higher than the heating capacity of the area.

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