TREATMENT AND USE OF GEOTHERMAL WATER WITH LOW ENTHALPY

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Abstract
One of the most important problems of nowadays society is the one of the pollution cleaning of the soil, the waterways and the atmosphere. The cleaning process of wasted geothermal waters is of real interest and topicality.
In the western part of Romania, the domestic heat energy is being obtained from geothermal waters, with the use of heat exchangers, where conversion takes place. The resulted wastewater is being disposed at temperatures varying between 35 and 40 degrees Celsius.
A modality to decrease the pollution level and protect the environment, is the adoption of newer geothermal water treatment technologies.

Keywords: water geothermal, low enthalpy, solar energy, ion exchange.

THE USE OF THERMAL WATERS

The following studies were done on the well no. 4795, situated on Calea Aradului in Oradea and they are being monitored by TRANSGEX. The well is situated into the Triasic collector. The supply of geothermal water by the users is being done directly from well, thanks to a gusher flow. The well is equipped so that it products under natural eruption and that is due to initial installation of production pipes, prior to well main piping. The well exploitation by an eruptive system has been found to be with great advantages from the energetic point of view, and that is due to two effects: the thermo-lift effect (density difference) and the gas-lift (greater mobility of gases at the boiling point toward the soil surface).

The well is being equipped with one extraction head of only 150 mm. On its arms there are two types of valves (closing and oil-saver type), thermometer housing and pressure gauge fitting. In the standard operating scheme, the water that comes out of well extraction head, goes to the buffer tank for the degassing process that takes places at the ambient temperature.
The initially mounted degassing device has been removed so that the well works under its own pressure sending the water directly to the user's installations.

The reduction on water temperature towards the surface becomes more obvious by the reduced extraction debit. The measurements done at Calea Aradului well no. 4795 had shown large temperature drop (36 deg. C) at said low extraction debit.

The geothermal water that reaches the user, arrives at station where it goes through a heat exchanger (Fig. 1), thus the geothermal energy is transformed into thermal energy, ($\Delta T \approx 40\ ^0C$). The still high temperature of the geothermal water (40 deg. C) is then passed through a second heat exchanger, where the hot residual water is being produced. The above mentioned second heat exchanger is connected in parallel with solar panels, which are good supplement of thermal energy on sunny days.

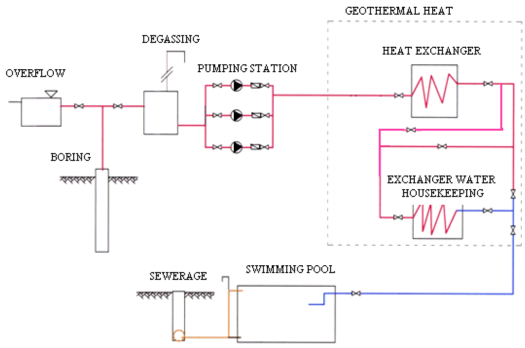

Fig. 1. Heat exchanger of the user

THE TREATMENT OF GEOTHERMAL WATER WITH LOW ENTHALPY

Usually, the thermic used geothermal water is discharged into waterways [9]. The national and EU standards require the same to have certain quality level, which is achieved by chemical treatment, namely ion exchange method [1].

The study for the thermic used geothermal water treatment has been done on modern water treatment technologies using ion changing resins of anionic, cathionic and mixed type. These technolgies can be applied using the equipment produced by a British company named ARMFIELD (W9). The mentioned equipment offers the possibility of demineralising and deodorising study [5].

The ion exchanging resins on the present study have a maximum working temperature range between 60 and 130 degrees Celsius.

After the treatment process, the result showed the reduction on thermic used geothermal water durity and concentration of anions and cathions as well [7].

The following are the results of ion exchange treatment method of thermic used geothermal water [8]:

- In accordance with the EU and nationl standards on quality and they do not harm the environment;
- It can be used directly as hot residual water.

THE PROJECTION AND SIZING OF SOLAR PANEL INSTALLATIONS

In order to be able to efficiently exploit the solar panel installations, these must be properly projected and sized in advance. The solar coverage must be taken into account when a smaller project with an up to 30 m^2 collector, designed for a family house is being drawn. The reason is that the right dimensions are required so that the above mentioned solar panels covered residual hot water 100% on summer months (May to August), and 50% to 60% as overall yearly average [3].

The annual mean radiation range figure, on a plain surface in Central Europe is 900 to 1400 KWh/m^2.

The places with the richest solar radiations are situated on south, south-east and center of Romania. Depending on location, the maximum solar energetic efficiency on square meter surface can reach 350 up to 650 KWh.

The following factors exercise an influence on the size of the collector surface and the boiler volume:

- Geographic position and solar radiation;

- The daily consumption of hot water;
- The incling angle of the collector and its direction;
- Abstraction profile;
- The nominal and maximal values for hot water;
- The required solar coverage;
- Whether suplementary cover for heating system is required
- The heating system of the building
- The required temperature of heating system

Using previous experience and values used in the past, over dimensioning can be avoided at the time of drawing the project. Nowadays, computer aided design (CAD) helps to achieve exact calculations and gives very good results, when the required performance level is known.

INSTRUCTIONS FOR IMPROVEMENT OF SOLAR ENERGY COVERAGE

In order to avoid useless thermic use of the system and for a better recharge of the installation, it is required to avoid as much as possible of the so called "dead zones" of the collecting field, by a proper sizing .

When a system is being designed to supplement the bulding heating system, the use front collectors (façade collectors) are considered better due to the annual yield evolution which is more expedient, even though their annual yield is only aproximate 30% of the plane collectors of the same dimensions and fixed at an optimum angle. The solar efficiency is knowingly stored during the transit months of spring and autumn. The minimum production during the pick season of summer minimize the overheating of the system by defficient reception of heating [4].

During the summer months, the excedent heat can be used for swimming pool heating. The stored quantities that come from the collector surface, with a production of 90 l/m^2, do not increase the solar energy coverage. Past experience and former studies have shown that heating systems with low working temperature are best used for home systems that suplement the heating along with the heating of the drinking water. The return heating water temperature must be low when it is being directed to the boiler. This can be achieved by using the following:

- Thermostat valve
- Separate connection of return NT system at installations with different temperature systems
- The use of overflow non-return valve on return line

Using an optimal hydraulic connection, of second drinking water heating system, an improved yearly energy efficiency can be achieved. The lower standard values for second heating installation, the higher solar energy efficiency.

When an estimated design of a thermo-solar water heating installation, the following rule of thumb maybe used:

- Collector surface equal 1 to 1.3 m2 per person
- Boiler volume equal 80 to 100 ltrs per person or equal or bigger 60 to 80 ltrs/m2 collector

Following conditions must be met:

- Smaller installation, up to 15 m2 surface per collector
- Installation on one or two family house
- Maximum angle deviation to south direction of collector surface to be between 10 and 15 degrees

- The optimum inclining angle of the collector should be between 40 and 45 degrees

The average daily hot water consumption at 45 degrees Celsius per person to be at 50 ltrs (corresponding to 35 ltrs at 60 degrees Celsius)

Hot water boiler is usually designed at 1.5 to 2 times the actual required hot water flow. Its size determines the size of the collector surface. Smaller surface does not cover the boiler requirements, while a bigger surface increases the solar energy coverage but brings too many stops of installation, thus useless charge with thermic energy of the system.

The correct dimension of the collector surface has been found to be 1.25 to 1.65 m2 for each 100 ltr of boiler volume. This is valid when the optimum inclination of the collector is at 30 to 50 degrees and when its direction is the south. Depending on the direction and inclining angle of collection field, the collector surface is being increased by the following additions:

Table 1.

Correction factors for solar surface size based on inclining angle, for water heating

Direction	Incling	Affix
South	0-15	No affix
South-West	15-25	Aprx 10%
South-East	25-60 60-75 75-90	No affix Aprx 10% 30 – 50%
West-East	0-15 15-30 30-50 50-75 75-90	No affix 15-20% 20-30% 30-50% 50-80%

As previously explained, the use of computer aided design programme on determining the proper dimensions is the right thing to do.

The standard of the building insulation, which in turn determines the required heating level, and the type of the heating system, exercises a great deal of influence over the design process, hence over the solar installation as a whole.

WATER STORAGE

Heat energy intended for later use at temperatures below 100 ^{0}C may conveniently be stored as hot water, owing to the high heat capacity of water (4180 J / kg ·K or 4.18 × 10^6 J / m^3 · K at standard temperature and pressure), combined with the fairly low thermal conductivity of water (0,56 J / m · s · K at 0 ^{0}C, rising to 0.68 J / m · s · K at 100 ^{0}C).

Most space heating and hot water systems of individual buidings include a water storage tank, usually in the form of an insulated steel container with a capacity corresponding to less than a day’s hot water usage and often only a small fraction of cold winter day’s hot water usage and often only a small fraction of a cold winter day’s space heating load. For one family dwelling, a 0.1 m^3 tank is typical in Europe and the United States . A steel hot water container may look like the one sketched in Fig. 2. It is cylindrical with a height greater than its diameter in order to make good temperature stratification possible, an important feature if the container is part of a solar heating system.

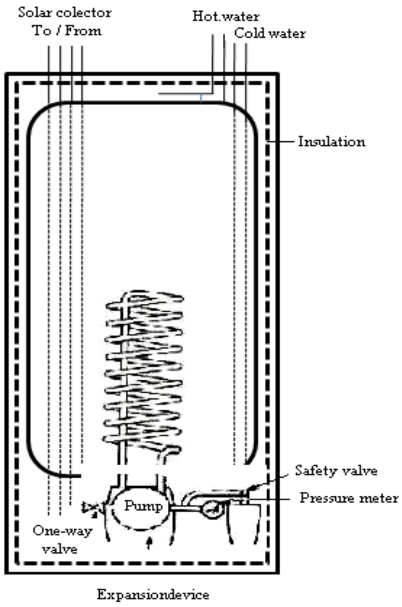

Fig. 2. Water container for heat storage with possibility of temperature stratification (e.g. for use in connection with solar collectors)

A temperature difference of up to 50 ^{0}C between the top and bottom water can be maintained, with substantial improvement (over 15%) in the performance of the solar collector heating system, because the conversion efficiency of the collector declines (Fig. 3) with the temperature.

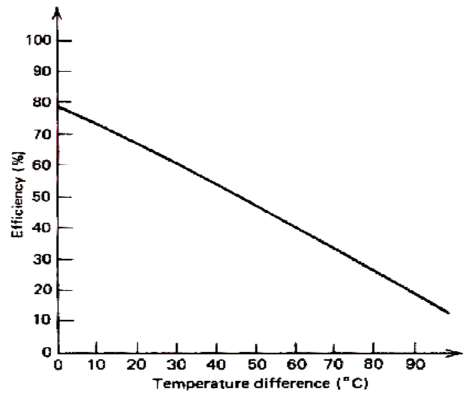

Fig. 3. Efficiency curve for flat-plate solar collector as a function of the temperature diference between the average temperature of the fluid, which is removing heat from the colector, and the ambient, outside air temperature

The efficiency is the percentage of the absorbed solar radiation, which is transferred to the working fluid. The curve is based on measurements for a selective-surface collector, tilted 45 ^{0}C and receiving 800 W / m^2 of solar radiation at incident angles below 30 ^{0}C. Wind speed along the front of collector is 5 m / s.

Thus, the water from the cold lower part of the storage tank would be used as in put to the solar collector circuit, and the heated water leaving the solar absorber would be delivered to a higher-temperature regionof the storage tank, normally the top layer. The take-out from the storage tank to load (directly or through a heat exchanger) is also from the top of the tank, because the solar system will, in this case, be able to cover load over a longer period of the year (and possibly for the entire year). There is typically a minimum temperature required for the fluid carrying heat to the load areas, and during winter, the solar collector system may not always be able to raise the entire stored tank volume to a tempertaure above this threshold. Thus, temperature stratification in storage containers is often a helpful feature. The through water-filled „radiators” and „convectors”, but only 25 – 30 ^{0}C for water / filled floor heating systems and air – based heating and ventilation duct systems.

CONCLUSIONS

Developing energetic of geothermal water with a view to heating the living space described in the study being increased with additional heat obtained from solar panel. Proper sizing of the heating installation has resulted in obtaining cost for obtaining heat. For further installations of heating and water heating, they are very appropriate especially with the heating temperature.

Using geothermal water waste heat can be achieved in the process of treatment with ion exchangers resin. Hardness was decreased and the concentration of anionic and cationic water geothermal waste heat to the quality norms laid down by the force, so water can be used directly as hot water housekeeping.

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