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# The Soil of The Seedlings in Greenhouses Heating by Geothermal Energy

**Pirnazarov Ilkhom Islamovich**
Doctoral student of the Djizakh Polytechnic Institute

**Abstract:** The work depicts the systems which use the sources of geothermal energy for heating greenhouses. The benefit of geothermal energy for conventional purposes is highly acceptable and is an excellent choice of energy source for the greenhouse design. Even though the sources are not available in the whole area of the Republic of Uzbekistan, they can be very useful and profitable on the locations where they have been found. The analysis of known technologies of greenhouse heating shows the advantages and disadvantages of some of them. The aim is to get to know the soil heating technology with geothermal energy which, by its further improvement, brings considerable economic benefits.

**Keywords:** Geothermal energy, greenhouses, soil heating.

## Introduction

Many authors have discussed possibilities of geothermal energy application. Lund and others talk about the areas of application of geothermal energy. Greenhouse heating, according to him, covers 8 % of the total use of geothermal energy.

Even though this percentage is small, using geothermal energy makes it possible to greatly reduce the heating costs. The application of thermo gens for floor and air heating of greenhouses of 500 $m^2$ demands the device of 109 kWh capacity, consumption of 12 l of fuel oil/h and with max. strength, in case the outside temperature is - 10° C, the stated daily temperature of plants 20° C, at night 16° C (tomatoes). In this case, when calculating energy costs per kg of tomatoes in autumn-winter period and winter-spring period, it is 60 % - 65 % for continental part of Uzbekistan. Due to constant increase of prices of oil products, this share will increase, and therefore, make the use of geothermal energy more interesting. Geothermal application as a renewable source of energy decreases environmental pollution as well as emission of $CO_2$.

## Materials and Methods.

Heating of greenhouses is one of most common direct uses of geothermal energy. Greenhouses can directly use temperature of hot water ranging from 50 °C – 80 °C. The quantity of hot water demanded will depend upon the optimum growing temperature for the selected crop (Table 1), size of the greenhouse, and the lowest outside temperature expected in the area. The main advantage of geothermal energy used for heating greenhouses is its eco-friendly approach and lower prices than those of fossil fuels.

The main drawback of using geothermal energy for greenhouses is limited resource areas. Each greenhouse construction project includes drilling of the new geothermal well, which is very risky because of high costs of drilling that questions the profitability of the project. In order to avoid the mistakes, the greenhouse construction projects must be planned in the areas with existing sources of geothermal energy. Quality construction and installing quality equipment into the heating system will surely ensure high efficiency which is the main aim of starting such projects in the first place .

Table 1 Growing temperatures for typical greenhouse crops.

| Produce | Day Time Temperature(°C) | Night Time Temperature(°C) |
|---|---|---|
| Tomatoes | 21 - 23 | 13 - 15 |
| Cucumber | 25 - 28 | 18-20 |
| Lettuce | 24-26 | 20-22 |

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In practice there are three kinds of heatingsystems:

1. Coercive heat convection by recuperator sunder the greenhouse roof
- at higher temperatures of geothermal water,
- at lower temperatures
2. Surface heating – system on the ground
- ribbed pipes
- system of smooth pipes
3. Floor heating in combination with recuperators

In most geothermal applications, a heat exchanger is required to separate actual heating equipment from the geothermal fluid. This is because of the scaling and corrosion associated with most geothermal fluids. Generally, the heat exchanger is placed between two circulating loops, the geothermal loop and the clean loop. The heat exchanger is placed between two circulation circles (the geothermal circle and the circle with clean water). The circle with clean water is a separate, closed system which is used exclusively for transmission of energy from geothermal water. As result of using the heat exchanger, the temperature drops depending on the exchangertype (Table 2).

*Table 2 Heat loss depending on the heatexchanger construction*

| Exchanger type | Loss of watertemperature |
|---|---|
| Plate construction | 4 °C do 8 °C |
| Pipe- cover | 13 °C do 17 °C |
| Non-commercial construction (home - made) | 18 °C do 38 °C |

Non-commercial exchanger construction is not recommended because often cause malfunction in the greenhouse heating system.

The first comprehensive researches into floor heating in greenhouses were conducted in 1972-1974 and were focused on the use of low temperature sources, such as geothermal and solar energies. Technologies for plant growing and greenhouse heating had to be adjusted to use these energies. This resulted in learning that heating the soil instead of the air, together with lower energy input, achieves better rises results. Earlier ripening with the same or betterappearance was spotted in many plants.

This knowledge started numerous experiments about changes in plant growing technologies. The habit of heating the entire area had to be changed, and the habit of heating the root system had to be adopted. Besides, soil heating requires about 30% less energy than air heating.

Ribbed tubes are most commonly made of steel or copper, with fixed ribs made of aluminum or steel which may have a square, circular or rectangular shape. The comparison of prices of different rib materials and dimensions are presented in the table.

Table 3 The comparison of lengths and costsof ribbed tubes

| Combination of materials (tube/ribs) | Outer tube diameter (mm) | Number of ribs per meter |
|---|---|---|
| steel / aluminum | 19,05 mm (3/4 in) | 108 |
| steel / aluminum | 25,40 mm (1 in) | 108 |
| steel / steel | 31,75 mm (1 ¼ in) | 108 |
| steel / steel | 31,75 mm (1 ¼ in) | 131 |
| steel / steel | 50,8 mm (2 in) | 78 |
| steel / steel | 50,8 mm (2 in) | 108 |

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## Results

In the past, tube materials were generally copperor steel. Because of corrosion and expansion problems with these materials, nonmetallic materials have seen increasing application in recent years. The most popular of these ispolybutylene. This material is able to withstand relatively high temperatures (up to 80 °C) and is available in roll form for easy installation. PVC piping is only available in rigid form and is limited with respect to temperature. Polyethylene and similar materials are available in flexible roll form, but are (as PVC) generally limited in terms of temperature handling ability.

Tubes are smaller in diameter (25 mm), with wall thickness up to 4 mm. They are fitted directly onto the greenhouse floor, in parallel lines, taking into consideration the distance between the tubes. Ifthe tubes are laid too close to one another, heating efficiency decreases due to the reduced heating area potential (picture 1).

Picture 1 The heating system with smooth tubes

Similarly, if the space between the tubes is too large, heating efficiency decreases, and the soil surface is not sufficiently heated.

The project of the heating system is based on the medium water temperature in the working area. Heat output from the floor occurs by two mechanisms: convection and radiation. The procedure for designing a floor system consists of:

- Determining the heat load for the greenhouse
- Calculating the required floor temperature to meet the load
- Calculating the required size, depth and spacing of the tubes

This system is applicable in greenhouses with plants which can stand higher temperatures at the level where the plant grows from the root into the stalk. An example of this heating system is growing tomatoes and peppers, as they can stand suchheating conditions. This system is rarely used as the primary way of surface soil heating as the required tube length increases considerably in order to achieve the approximately equal heating power as with the ribbed tube system.

## Discussion

This heating system includes the use of the greenhouse floor as a big radiator. The tubes, with circulating hot water, are buried in the ground. The floor system is of prime importance for heat production, and the recuperator is used to meetthe need in the heating peak during colder months.The amount of heat required during colder months depends on the soil temperature, air temperaturein the greenhouse, and also the average temperature of the unheated surfaces of the greenhouse (walls and the roof).

Tube spacing and size is dependent upon the available water temperature. Generally, depth is more a function of protecting the tubes from surface activity than system design. Since it is the purpose of the floor panel system to use the floor as a large radiator, it follows that the installation of the tubing should result in as uniform a floor surface temperature as possible. This is accomplished by two general approaches: (a) placing smaller diameter tubes at close spacing near the surface of the floor, or (b) placing larger tubes spaced further apart at a greater burial depth. The theory behind this approach is to reduce the difference between the distance heat must travel vertically (from the tube to the surface directly above it) and laterally (from each tube to the surface between the tubes).

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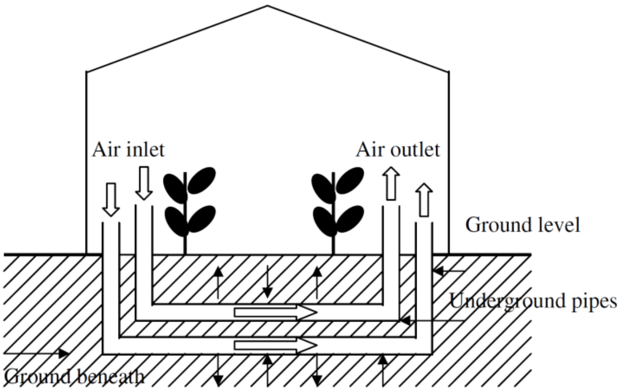
It is important to point out that, because of the soil temperature increase in this heating system, one should make sure that the soil temperature does not rise above 30 °C. This soil temperature is much too high for most vegetables, whereas for some flowers, it can be suitable (picture 2).

Picture 2 The heating soil by geothermal energy

Depending on the tube laying (picture 3), it is possible to ensure quality level of heat exchange with soil.




*Picture 3*

If the expected temperature drop is below 8 °C, single tubes are installed. In order to avoid the temperature drop (in circulation) above 8 °C, double loop tubes are installed, which will ensure the suitable temperature (within limits) for plant growth. Tubes should be buried deep enough because of the surface activities, the common depth being 50 to 150 mm .

As daytime temperatures increase due to seasonal and/or daily temperature changes then the flow of geothermal water to the greenhouse heat exchangers would be cut back. Heat load requirements would be automatically adjusted using signals from temperature sensing instrumentation. A regulation of the heat input into the greenhouse is achieved by bypassing a portion of the return cool fluid into the input leg of the heating system. A 3-way auto control valve, using data from temperature sensing instrumentation located inside and outside to the enclosure, controls the amount of fluid by- passed and thus the temperature of the circulating water through the heating pipes.

## Conclusion

Thermal water temperatures and lower mineralization can be successfully used for irrigation and or heating of greenhouses, which can only be heating the soil, air only, or the heating of soil and air. The use of thermal energy in greenhouses to reduce production costs, which amounts to 35% of the total costs of production. One of the major disadvantages of using geothermal water in greenhouses is the high investment cost. The solution of the problem is finding other consumers of geothermal water (eg for space heating or hot water), which would reduce the cost of heating greenhouses. The disadvantages of using geothermal energy for heating greenhouses is also limited areas where there is geothermal wells, which is sufficient for use in such projects, the cost of exploration and drilling wells is large, the high content of carbonates and iron in the water, and expensive geothermal water purification system.

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