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Simple analysis of soil structure effects based on geothermal exploitation

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Abstract. You should leave 8 mm of space above the abstract and 10 mm after the abstract. The heading Abstract should be typed in bold 8,5-point Times. The body of the abstract should be typed in normal 8,5-point Times in a single paragraph, immediately following the heading. The text should be set to 1.15 line spacing. The abstract should be centred across the page, indented 15 mm from the left and right page margins and justified. It should not normally exceed 200 words. 1 Introduction

1 Introduction

With the deepening of people's understanding of new energy, geothermal has become more and more "hot." Henan's abundant geothermal resources will be an important resource pillar for the future economic growth of the Central Plains. Its development and utilization will be one of the important measures for energy conservation and emission reduction, optimization of energy structure, reduction of air pollution and improvement of people's living standards. However, with the development and utilization of geothermal resources, the soil structure will be affected to a large extent[1][2].

The development of shallow geothermal energy in Henan Province is mainly realized by heat pump units, which are divided into two methods:geothermal heat pump groundwater heat exchange system and ground source heat pump buried pipe heat exchange system.The vertical buried pipe heat exchange system can obtain low-grade heat energy from the soil in the formation.Vertical buried pipes are generally installed between 50-120 meters underground.The underground U-shaped PE pipe is connected with the ground heat pump unit. The fluid medium or antifreeze in the closed PE plastic pipe transfers the underground heat energy to the heat pump, and then the heat pump unit raises the low-grade heat energy to the building. It is suitable for heating and cooling of larger buildings.Zhengzhou A area is located in the alluvial plain of Yellow River. The stratum is mainly silt and silt sand, suitable for shallow geothermal vertical buried pipe heat exchange system. Heating and cooling area reaches 100,000m^2.

This analysis is to analyze the influence of the operating temperature of heat pump unit on soil structure. The soil samples are taken from the different positions of heat pump unit operation to determine the total number of microorganisms, soil potassium, organic carbon and total phosphorus in the soil at different temperatures. Changes in potassium content [3][4].

2 Test content and method

This experiment used control variable method and single factor experiment.

After collecting soil samples, the physical and chemical properties of the original soil such as the total number of microorganisms, organic carbon content, total nitrogen content, total phosphorus, and potassium content were determined.

Simulate soil temperature change: place the collected soil stored in the sealed bag in a constant temperature water bath, change the temperature of the constant temperature water bath, simulate the temperature gradient to 30℃, 40℃, 50℃, 90℃, soil samples in each Keep it for 4 days in temperature.

The total number of microorganisms, organic carbon, total nitrogen, total phosphorus and potassium at different temperatures were determined. details as follows:

2.1 Total number of microorganisms

10 gram of the collected soil was weighed into 90 ml of sterile water, shaken and allowed to stand for 20 minutes; inoculated with beef paste-peptone medium on a clean bench; cultured in a 37 ° C incubator for 48 hours; total bacterial community statistics were performed.

2.2 Determination of organic carbon

Adopting "HJ 615-2011 Determination of Soil Organic Carbon - Potassium Dichromate Oxidation - Spectrophotometric Method"Weigh 0.4gram of soil sample in a 50ml plug colorimetric tube; add 0.1g mercury sulfate and 5.00ml potassium dichromate

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solution, shake separately; then slowly add 7.5ml concentrated sulfuric acid and gently shake it; After the colorimetric tube is wrapped, it is placed in a high-pressure steam sterilization pot, digested for 45 min at 134 ° C, and cooled; the volume is adjusted to 50 ml with water, and allowed to stand for 8 hours; the absorbance is measured at 585 nm; Also do a blank experiment.

2.3 Determination of total phosphorus in soil

Adopting "HJ 632-2011 Determination of Total Phosphorus in Soils - Alkali Fusion - Molybdenum Antimony Anti-Spectrophotometry" weigh 0.2500 gram soil sample in the crucible; wet the soil sample with a few drops of absolute ethanol; add 2 gram sodium hydroxide solid to the surface of the sample, cover the sample, cover the lid; put the crucible into the muffle furnace. When the temperature rising to about 400℃, hold for 15 min.

Then continue to raise the temperature to 640℃, holdingfor 15 min and take out it and cool. Then add 10 ml of ammonia-free water to the crucible to heat to 80℃. After melting, Transfer all the solution to a 50 ml centrifuge tube and wash it with 10 ml of 3 mol/l sulfuric acid solution three times. Then rinse with distilled water and transfer all the washing solution to the centrifuge tube.Then centrifuge at 2500 r/min for 10 min and let stand transfering the supernatant Dilute to 100ml volumetric flask. Pipet 10 ml soil suspension into 50ml plug colorimetric tube and dilute to the mark with water adjusting pH to 4.4. Next add 1ml ascorbic acid solution and shake.Then add 2 ml molybdic acid.The salt solution was shaken well.After standing for 15 min, the absorbance was measured at a wavelength of 700 nm, and a blank experiment was performed.

3 Test results

3.1 sampling point position

The sampling point locations are shown in table 1 and figure 1.

Table 1. Zhengzhou A area samplingpoint layout table.

Position	Temperature	Abbreviation
No.1 hole Surface	32.8℃	No.1
No.1 hole 20cm	28.6℃	No.2
No.2 hole Surface	26.4℃	No.3
No.2 hole 20cm	26.0℃	No.4

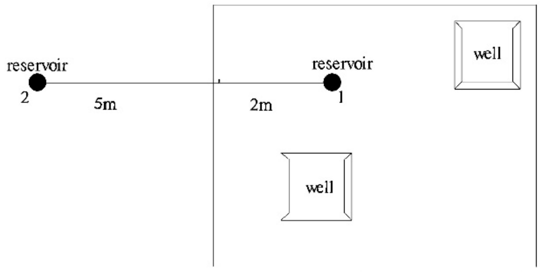

Fig1. Reservoir sampling point plane position map in Zhengzhou A area.

3.2 test results

3.2.1 Microbiological test results

The effects of reservoir temperature on microorganisms in Zhengzhou District A are shown in Figure 2 and Figure 3.

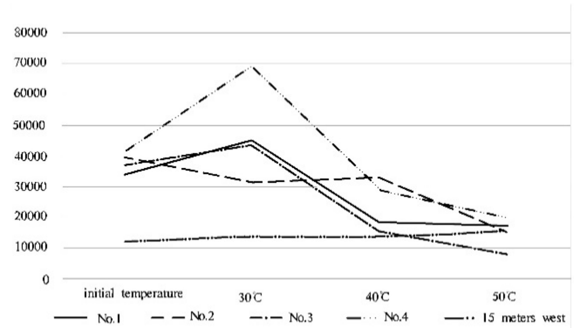

Fig2. Total number of microorganisms changing treng with temperature.

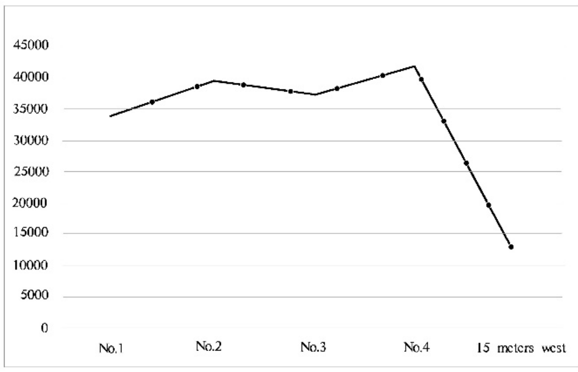

Fig3. Total number of microorganisms changing treng with distance.

Table 1, Figure 1, Figure 2 and Figure 3 show that:

(1) When the initial temperature being less than 30°C, the number of microorganisms increases rapidly with the increase of temperature.

(2) When the temperature reaching 40°C, the number of microorganisms reaches the highest value. With the increasing of temperature, the number of microorganisms grows slowly or decreases.

(3) The closer to the reservoir or the water well, the more obvious the change of microorganisms is.

(4) When the initial temperature exceeding 30 °C, the change of microorganisms with temperature is slightly

lower than that of the reservoir, and it changes slowly when it being far away from the reservoir.

This shows that: the continuous development of geothermal resources has a certain impact on soil microbes. The microorganisms in the soil are mainly bacteria. Among them, the amount of bacteria in the soil accounts for 70% to 90% of the total amount of microorganisms in the soil, and there are many kinds of bacteria, mainly heterotrophic bacteria, and a small amount of autotrophic bacteria [5].

The various types of fungi that are present in the surface soil are mostly semi-infected. The presence of many microorganisms in the soil has a positive effect on soil fertility and soil structure improvement. When the soil temperature is suitable, the humidity is appropriate, and the ventilation is good, many aerobic microorganisms in the soil proliferate and move, which promote the decomposition of humus in the soil and release a large amount of nutrients for the ground plants to absorb and use.Other fungi such as soil can Decomposition of lignin, cellulose and pectin plays a positive role in the natural circulation of other substances in the soil [6].

Humus in soil plays an important role in the normal growth of vegetation on the surface. Humus is a dark brown colloid. It is usually combined with other mineral particles in the soil. It is the main component of soil organic matter. It can improve soil fertility [7] [8].

The increase of soil temperature causes the soil microbial metabolic rate to increase and requires more oxygen, causing some microorganisms to be hindered or killed under the action of thermal potency.

The function of other biological enzymes will be affected, causing problems in metabolism, leading to regional ecology and the destruction of balance.

3.2.2 Soil organic carbon test results

The effect of reservoir temperature change on soil organic carbon in Zhengzhou A area is shown in Figure 4.
It can be seen from Figure 4:

(1) The organic carbon content increases fastest between 30 °C and 40 °C.

(2) When the temperature reaching 40 °C, excep for No.4, the organic carbon content reaches the maximum value.

(3) Then with the continuous increasing of temperature, the organic carbon content increases slowly or decreases.

(4) The closer to the reservoir or the water well, the more obvious the change is in organic carbon content.

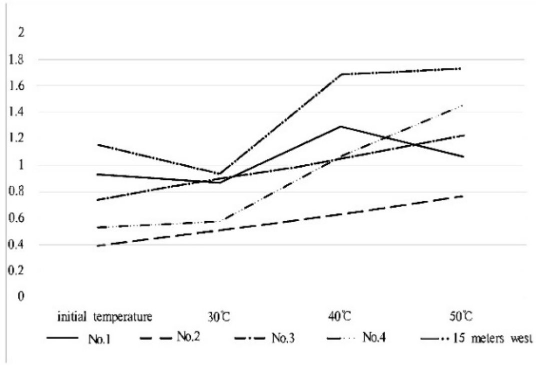

Fig4. Trend of organic carbon content in soil with temperature of the reservoir in Zhengzhou A area

It can be seen from Figure 4:

(4) The organic carbon content increases fastest between 30 °C and 40 °C.

(5) When the temperature reaching 40 °C, excep for No.4, the organic carbon content reaches the maximum value.

(6) Then with the continuous increasing of temperature, the organic carbon content increases slowly or decreases.

(4) The closer to the reservoir or the water well, the more obvious the change is in organic carbon content.

3.2.3 Soil total phosphorus test results

The effect of reservoir temperature change on soil total phosphorus in Zhengzhou A area is shown in Figure 5.

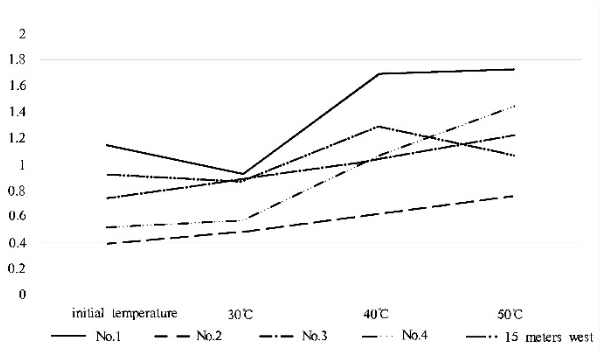

Fig5. Trend of total phosphorus content in soil with temperature in Zhengzhou A area.

It can be seen from Figure 5:

(1) The total phosphorus content is on a downward trend between 30 °C and 40 °C.

(2) When the temperature reaching 40 °C, excep for No.3, the total phosphorus content is keeping increasing slowly.

(3) with the continuous increasing of temperature, the total phosphorus content decreases slowly or keeps increasing.

4 Conclusion

From the above analysis, the following conclusions can be drawn:

(1) With the continuous development of geothermal resources in Zhengzhou A area, the total amount of microorganisms, organic carbon and total phosphorus in the soil all changed with the increase of temperature.

(2) The number of microorganisms growed faster with the increase of temperature and reached the highest value up to 40 °C .As the temperature continuing to rise ,the number of microbes growed slowly or on a downward trend.

(3) The organic carbon content increases fastest between 30 °C and 40 °C. When the temperature reaching 40 °C, the organic carbon content reaches the maximum value. Then, with the continuous increase of temperature, the organic carbon content increases slowly or decrease. The closer to the reservoir or the water well, the more obvious the change is in organic carbon content.

(4) The total phosphorus content is on a downward trend between 30 °C and 40 °C. When the temperature reaching 40 °C, with the continuous increasing of temperature, the total phosphorus content decreases slowly or increases.

Therefore, in order to avoid the influence of temperature changes on the soil structure, it is recommended to put insulation materials around the wellhead and the reservoir to prevent the lowest loss temperature from exceeding 30 °C .

Acknowledgments

Henan Province geological research project "Study on Thermal imbalance of Shallow Geothermal Energy Development in Typical Areas of Henan Province " (Yu Guo Tu Zi Letter [2017] No.237) and "Research on Exploration and Evaluation Technology of Concealed Hot Dry Rock Resources in Henan Province" (Yu Zi Ran Zi Letter [2020] No.542).

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