Geothermal Resources Target Optimization in Heilongjiang Province Tailai County

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Abstract: This paper research on geothermal field characteristics in different depths and the deposition conditions of different formation units, clarify the geothermal reservoir characteristics of the study area, analysis the hydrogeology characteristics of the groundwater, evaluate the geothermal resources. Based on the calculation results of geothermal resources, in order to be more intuitive determine the distribution of geothermal resources, opt the target area, calculate the geothermal resources abundance, that geothermal resources in the plane of the distribution, for every square kilometer of area contained heat. The results of geothermal resources abundance distributions Tailai County range $0\sim28.3\times10^{12}$KJ/km^2, distribution trends in the plane of its performance for the eastern high, westward gradually smaller.

Keywords: geothermal resources; geothermal field; geothermal reservoir; geothermal resources abundance; Tailai County

Introduction

Currently, both domestic and international explore the geothermal resources in this region, in order to achieve resource advantages into economic advantages purposes [1-3]. Songliao Basin is rich in geothermal resources, Tailai County is located in the Songliao Basin, off the west stage area, has a good heat, heat storage conditions [4]. In order to solve the Tailai County exploration and development of geothermal resources exist in the lack of precision of specialized geothermal exploration data, comprehensive studies are not sufficiently effective development and other issues, this study opt the target area of Tailai County to guide the rational development and utilization of geothermal resources in the future.

I.   Geological Background

Tailai County is part of Qiqihar City, Heilongjiang Province, located in Heilongjiang Province in the southwest, and located in Heilongjiang, Jilin and Inner Mongolia provinces (regions) the junction area of 3996 square kilometers. Study area is located on the western slope of the district tectonic Songliao Basin, northwest view from the secondary tectonic of the study area is covered with ultra-west, northeast of Taikang uplift zone, the south western slope. Existence early deep mantle uplift the role and late plate seductions [5]. Due to the nature of the transforming power of two basins with tension and pressure duality in the development process, the performance of the early rift, mid-and late-fold depression characteristics [6]. According to drilling data revealed that the study area is mainly formation sequence from the bottom up development of the Jurassic Huoshiling, Cretaceous Shahezi, Yingcheng, Denglouku, Quantou, Qingshankou, Yaojia Nenjiang Sifangtai, clear water group, Daan group tertiary, Taikang groups, and Quaternary.

II. Characteristic of Geothermal Field

Geothermal gradient is the parameter reflected in the temperature variation with depth. Generally change every meter is standard. Calculated as follows:

$R = (T-T_0) \times 100/(H-H_0)$

The formula: R-geothermal gradient (℃/ 100m);

T-measured temperature (℃);

T_0-thermostat with temperature (℃);

H-measurement point depth (m);

H_0-thermostat with depth (m).

According to a large number of measured data and the surrounding areas thermostat with temperature, depth, and the average annual temperature data analysis to determine the depth of the zone thermostat with 20m, with thermostatic temperature of 4.5 ℃. Using the above formula for oil exploration wells to calculate the measured temperature data, the results indicate that the eastern part of Taylor County geothermal gradient higher than the west. Distribution is 3.1~5.0℃/100m. Combined with results of previous studies, geothermal resources are mainly distributed in the Songliao Basin Yaojia, Qingshankou, Quantou three main strata. This study, using Tailai County coring drilling and other data, combined with geothermal gradient and terrestrial heat flow conditions, by studying in depth the situation of different formations underground to determine the temperature characteristics of the geothermal resources produced three main layers: Temperature distribution throughout the layer trend east to the west, the east Yaojia highest temperature can reach 50℃, the west between 7.5~10℃. Qingshankou formation temperature distribution is between 10~ 55℃. Quantou formation temperature distribution is between 15~62℃.

III. Geothermal Reservoir Characteristics

1) Geothermal reservoir systems division

According to sources of heat, geothermal reservoir and regional impermeable layer, cover the distribution of water layer can be divided into four sets of segments in the study area geothermal reservoir portfolio: 1) a combination of deep geothermal reservoir: the Jurassic strata and Denglouku composition; 2) Fuyu-Yangdachengzi geothermal reservoir combination: the springs three, four formations composition; 3) a combination of high geothermal reservoir table: from green two , consisting of three sections of the formation; 4) Saertu-Putaohua geothermal reservoir combinations.

2) Geothermal reservoir sedimentary characteristics

Quantou sedimentary characteristics: For shallow lakes-delta system. Tailai fluvial facies mainly developed eastern region, the western region of sand pinch. Sand thickness of 15~130m, large areas of the main river channel sand body thickness growth, the central region of sand thickness of up to 140m, sand thickness in most areas less than 40m.

Qingshankou sedimentary characteristics: retrograding as a whole sedimentary sequence, with the type of development is complete, off the western tip of sand, from the west to the east were fluvial facies-deltaic plain phase-delta front-shallow lacustrine; Sand thickness of 10~120m, a large development in the Delta region and the main river channel sand body thickness of up to 100m.

Yaojia sedimentary characteristics: overall plot sequence is a product of a retreat into the product cycle, the western tip of Tailai for the sand off, from west to east delta plain development phase-delta front-shallow lake phase, all District fluvial dendritic growth; sand thickness of 10~25m, sand thickness larger southern and northern small.

IV. hydrogeology Conditions of Groundwater

Water supply in the study area is mainly supply the Nen River, atmospheric water supply, diagenetic water supplies. By Tailai and the surrounding water wells were analyzed in the study area is located in an active area of water and water alternately cross the transition zone salinity in 2400~7500mg/L, PH value between 7.0-9.0, sodium bicarbonate water type of water type, $CaCO_3$ content in the water is saturated, prone to calcite precipitation is alkaline water, the water quality is better.

V. Geothermal Resources Target Optimization

1) Geothermal resource calculation formula:

$$Q_R = C \cdot A \cdot H \cdot (T - T_0) \tag{1}$$

2) Ground water geothermal resource calculation formula:

$$Q_W = C_W \cdot \rho_w \cdot A \cdot H \cdot \phi \cdot (T - T_0) \tag{2}$$

Where:

Q_R-geothermal resource

J, C-hot water in the reservoir rock and the average specific heat capacity, $J/m^3 \cdot °C$

ρ_w ρ_R -water and rock density, kg/m^3

ϕ -rock porosity,%

A-geothermal reservoir area, m^2

H-geothermal reservoir thickness, m

T-thermal reservoir temperature, °C

T_0-heated layer temperature, °C

By the Yaojia, Qingshankou, Quantou geothermal gradient plane after the determination of the distribution of computing resources in the area of geothermal heat reservoir for different grid, divided into a number of 1km × 1km sand unit; combination of sand distribution, there is a place of sand body distribution formula for calculating resource utilization of each small unit, then resource accumulation of these small units would get a layer of sand resources of a body segment, and finally all the layers of sand the amount of heat accumulation in the body of water they get geothermal resources Tailai County. In the calculation results of geothermal resources on the basis, in order to be more intuitive determine the distribution of geothermal resources, preferably a favorable exploration area, we carried out in this study, the abundance of geothermal resources calculation, that geothermal resources in the distribution of the plane, the area of each square kilometer of the heat contained in the unit is $10^{12}KJ/m^2$.Taylor County abundance of geothermal water resources distribution in the range of $0 \sim 28.3 \times 10^{12}KJ/km^2$, the distribution trends for the eastern high performance, westward gradually smaller.

VI. Conclusions

1) Taylor County Qiqihar geothermal gradient distribution of values in the range of 3.1~5.0°C/100m. Overall, eastern, northern high geothermal gradient gradually decreases toward the west. Yaojia geothermal reservoir temperature of 7.5~50°C, Qingshankou is 10~55°C, Quantou is 15~65°C.

2) the abundance of geothermal resources Taylor County: $0 \sim 28.3 \times 10^{12}KJ/Km^2$, distribution performance becomes higher from west to east, near the Nen River's eastern region is the exploration and development of geothermal resources in favorable areas, but the development and utilization of geothermal resources also should be combined with local economic, cultural and other factors considered, rational development and effective use.

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