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The Water Soluble Helium Extraction Technology Research in Single Well Geothermal Station

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ABSTRACT

Helium is a kind of rare mineral resource on the earth, which is widely used in spacecraft launching, low temperature superconductivity, laser technology, infrared detect, nuclear industry, national defense and medical fields. Weihe basin is abundant with geothermal resources and high concentration soluble helium gas resources. Accordingly, it is significant to discuss the water soluble helium extraction and concentration techniques. Gas quality test in single well wellhead and gas extraction operation test, gas purification, dehumidification, gathering and storage experiment have been done successfully. The 85m3 of feed gases were collected and stored. Based on the studying, a comprehensive resource evaluation system of single well geothermal station with helium has been established. As well, the field test of soluble gas extraction, collection and storage technology in single well station was implemented. A serial of the innovational researches have been implemented, such as gas purification, dry gas gathering, high-pressure membrane dehumidification and high-pressure gas gathering, single-well water soluble helium gas gathering and storage and etc. The experimental results indicated that it is feasible and effective to extract water soluble helium through gas and water separating and dehumidifying gas from low to high pressure and membrane separation, which has laid technical foundation for soluble helium resource concentration test, established a new industry chain and obtained the comprehensive economic benefits for geothermal resources development in the future.

1. INTRODUCTION

Helium (He) is a kind of rare earth mineral resources. It is widely used in areas such as space launch, low temperature superconducting, laser technology, infrared detection, nuclear industry, national defense, medical and etc. Because of low helium content in the air, the cost of helium separation from the air is too high. The helium is mainly from nature gas containing helium in the world market.

The helium is less in China. The proven reserves of natural gas generally helium content is rare. There is no recycling economic value. Only the helium content in Sichuan Weiyuan Gas Field keeps 0.18%, the annual output of 5 x 104 m3. Presently, the mining has over 40 years. We depend on purchasing helium from other countries. With the high-speed development of national economic construction and national defense construction, it is unbalanced between production and demand of helium in China. Therefore, it is urgent in searching the new helium sources.

In March 2008, one test had been tested successfully in 3 # Geothermal well in Xinyang,Shaanxi, being named "The Test of Gas-Water Separation and Concentration of Helium Technique ". It is first to extract the industrial helium from natural gas samples, which provides the physical evidence for the existence of water soluble helium in Weihe basin

2. GEOLOGICAL BACKGROUND

The Weihe basin is a Cenozoic fault basin, located in the areas between the Ordos basin and the Qinling orogenic belt. Geophysical data analysis show the Weihe basin with the typical double-layer structure, complex composition of basin basement, which is controlled by basin basement faults and the intruded by granite rock and other rock. Basin basement control fractures include Chang'an - Lintong fracture, Yuxia – Tieluzi fracture , Weihe fracture, Qingling north piedmont fault rupture ,Weihe Basin rim frature and etc. (figure 1).

The data of natural gas , geothermal water drilling data and field formation outcrop shows that the basin is covered by the Cenozoic sediments of 6000 -7000 meter thick. There are the Quaternary loess and diluvium, Neogene Zhang Jiapo group, Lantian group, Bahe group, Gao Ling group, palaeogene Bailuyuan group and Honghe group from top to bottom.

The most thick tertiary can be up to 6, 900 meters in area of this research and the quaternary is 1352 meters. The upper tertiary was covered by huge thick mudstone cap rock (780 m) with low thermal conductivity, which is easy to gather the heat flow. The lower sandstone layer is thicker, with the good permeability and conditions of groundwater storage. Therefore, the basin is rich in geothermal resources.

The natural gas with helium was found during the development of geothermal water in Weihe River basin. The rich helium gas is mainly dissolved in geothermal water. The helium is one of components of geothermal water. Reservoir is the helium layer.

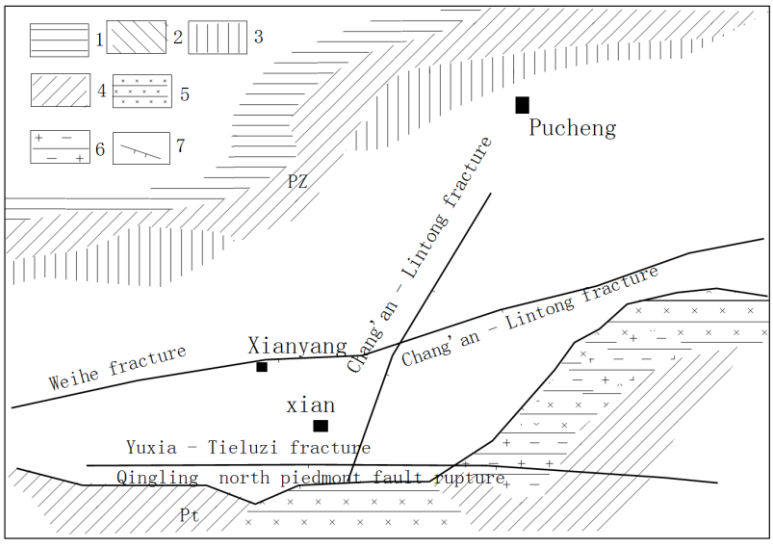

Fig. 1 Geologic sketch of Weihe Basin
Pz. Paleozoic; Pt.Proterzoic;
1.Mesozioc 2.Upper Paleozoic 3.Lower Paleozoic 4.Qing ling Group Metamorphic Rocks
5.Taihua Group Metamorphic Rocks 6.Granite 7.Fault

3 .RESOURCE OF WATER SOLUBLE HELIUM IN WEIHE BASIN AND TESTING WELL

3.1 Resource of water soluble helium in Weihe Basin

In project research results, two methods were adopted for the calculation of the water soluble helium gas resources in the Weihe River basin.

The calculation of containing helium is achieved by the quantitative evaluation of underground hot water resources (thermal storage method, analogy method, the static reserves method, dynamic analysis method). The quantitative evaluation includes water soluble gas resources and water soluble helium resources, in which the ratio of geothermal water and water soluble gas is 1:5 in the place of the depth of 2500 meter, being achieved by the analogy method and the simulation test and data of soluble gas in the downhole from Songliao and Qaidam oil field

The calculation of radioactive decay of uranium is another method, which is done by the figuring out the resource quantity of decay uranium first and calculating the helium quantity by the decay formula of uranium 235 ( ), in which the quantity of decay uranium is achieved by making sure the geological age, distribution, thickness, density and content of isotope of the granite rock with rich uranium in the peripheral basin and inner basin and the formula of absolute geochronology （ (λ for decay constant, N for the rest of the uranium isotope, D for the isotopic content of decay).

The calculation results show that the 1141.3 x 108 m3 of helium is in Weihe River basin, a large water soluble helium area, which manifests an unexpected development and utilization prospect.

3.2 Helium Resource in Test Well

Test well - 3 # geothermal water soluble gas component analysis shows that there are the rich helium.

The stability of water soluble helium resources exists in a long-term relates to resources reliability and project development. Dynamic monitoring results in 3 # geothermal as follows:

(1) The general stability of water soluble gas although it fluctuates in the heating period and no heating period.

(2) The gap of geothermal water flow, wellhead pressure is bigger in the heating period and no heating period. They are the factors such as big water flow, less pressure. Flow is inversely proportional to the pressure. The change of flow and pressure does not influence the water soluble shelium.

(3) The stable water soluble helium concentration

Dynamic monitoring results show that water soluble helium gas resources are not affected by seasonal water, gas, pressure. The helium content is very stable.

4. INTRODUCTION OF WATER SOLUBLE HELIUM EXTRACTION

4. 1 Technological Process of Test

This test is developed through the 3# geothermal well was finished in 1998, the depth of 2975 meters, the initial static water level + 55 meters. Test process is as shown in figure 2.

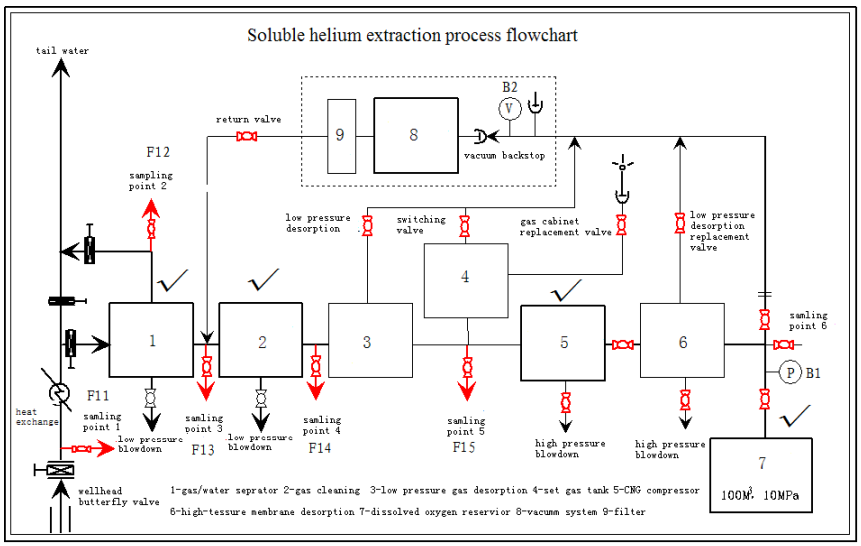

Fig 2 The Technological Process of Water soluble Helium Extraction

4.2 The Test Contest

According to the test process design requirements, the test system and test content set in each process unit include:

(1)gas-water separation process (QY1): gas flow, gas pressure, concentration of H2S, concentration of Helium and the whole composition analysis.

(2)purification dehumidifying process(QY2) : gas flow, concentration of H2S , gas dew point, concentration of Helium and the whole composition analysis

(3) gas holder buffer unit (QY3): concentration of O2, flow, pressure, concentration of CH4.

(4) high pressure dehumidifying (QY4) : dew point, pressure and flow rate

(5) gas collecting case (QY5) : dew point, concentration of H2S , concentration of Helium and the whole composition analysis

4.3 Field Test Instrument

(1)America Agilent 6890 GC

(2)Temperature thermocouple DT9206/7

(3) HT - 6292 dew point meter (guangzhou)

(4) Canada BW GAXT -H hydrogen sulfide tester

(5) CY – 12C oxygen meter (zhejiang)

(6) Germany GS - 10 combustible gas alarming device

5 HELIUM EXTRACTION

Membrane method was applied to extract helium in Sanpu # well in 2008 by Huabei branch of Sinopec(figure 3), which reduced a better result. The concentration of helium is increased by 20% and the recovery rate nearly reach to 100% under the same experimental conditions. Experiment demonstrated that the membrane method is an economic, convenient and efficient process method.

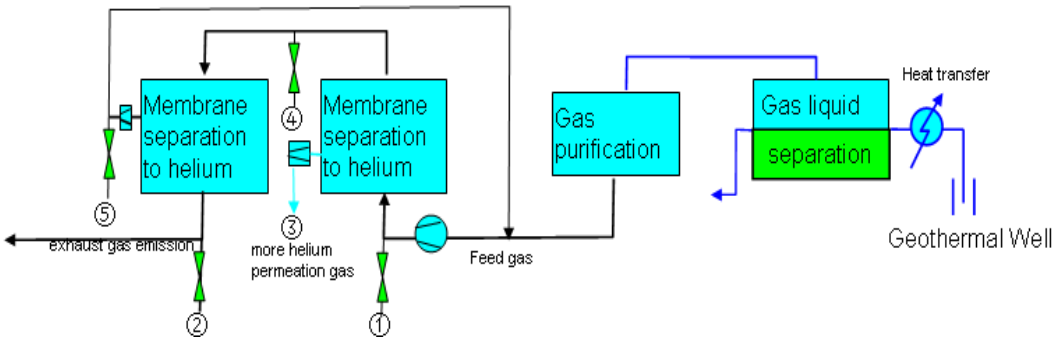

Fig 3 Technological Process of Helium Extraction in Geothermal Well

6 CONCLUSION

(1) Water soluble gas resources with rich helium in 3# test well.

(2) To set up wellhead resource evaluation system of water soluble gas with helium in single well station and to do the field test of water soluble gas extraction and storage technology.

(3) To develop the "gas purification", " dry gas collection ", "high pressure membrane dehumidification", "high pressure gas collection" and to obtain the resources reservoir of water soluble gas with helium and to lay the technological foundation for the development of water soluble gas with helium resource in geothermal area.

(4) The test in the first stage proved that the method of raw material gas and water separation, gas low to high pressure dehumidification to store helium is effective.

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