CONDITIONS OF CONSTRUCTING UNDERGROUND STORAGE IN SALT CAVERN IN JINTAN SALT MINE

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Abstract: The purpose of this paper is to introduce the condition of exploitation of salt mine and utilization of salt cavern in Jintan, as well as to analyze the advantages of constructing the underground gas storage with salt cavern in terms of geologic features, leak tightness and stability.

Keywords: gas storage, salt mine/mining, geology

INTRODUCTION

Our country is the importing country as well as the big consuming country of petroleum. With the rapid development of national economy, the conflict between supply and demand of petroleum and gas is aggravating gradually, and the risk of oil shortage disruption of national economy is also more and more increasing. Therefore, it is urgent to establish the Petroleum Reserve System. At the same time, the regional distribution of petroleum and gas resources in our country is very unbalanced, while they are usually used in different places, so it is imperative to carry out the safe storage and distribution project of long-distance pipes, namely the petroleum and gas storage cavern.

The way of storing petroleum and natural gas includes ground reserve tank, underground exhausted petroleum and gas field, underground aquifer, deserted mine and underground salt cavern, etc. Many countries have utilized underground salt cavern to store natural gas and petroleum since the last century. Especially after the developed countries went through the first petroleum crisis, all of them had made emergency strategic petroleum reserve plan. For instance, American petroleum production is less than 10% of the world total production, while petroleum consumption occupies 25% of the world total consumption. About 60% of petroleum consumption in USA comes from import. Therefore, more than 500 salt caverns were built for petroleum storage along the coastal area of the Mexican Gulf. German natural gas and petroleum mainly rely on importing, so about 250 salt caverns were established in Bremen and Hamburg, etc.

Our country's first underground gas storage of salt cavern is being constructed in Jintan Salt Mine, which is the accessory project of "West-East Gas Transmission Project". At present, six old wells have been transformed to the gas storage wells, which began to successfully store the natural gas in June 2007. Our country are very rich in the underground rock salt lick stone resources, which are distributed on various layers from Sinian, Ordovician, Permian, Triassic, Cretaceous to Paleogene stratums and many others. How to utilize the underground cavern

for mining rock salt to store petroleum and natural gas has great realistic meaning and economic value, and is also a topic that is worth researching.

The thesis provides a reference to people in the same profession about the conditions of Jintan Salt Mine to construct gas storage cavern, especially the geological conditions.

CONDITIONS FOR CONSTRUCTING THE CAVERN

1. Constructing underground salt cavern requires relatively good geographical conditions, reasonable site choices, which should be in accord with the construction of storage base and petroleum refinery base, and petroleum and gas pipe network. Transfer station should form the reservation and distribution system and be constructed at safe and reliable places with convenient transportation. For example, USA has constructed 21 large-scale refinery factories in the Mexico Gulf, as well as pipes and docks with convenient transportation.

Jintan Salt Mine is located at the South Jiangsu district with developed economy in the Yangtze Delta Region, about 30 kilometers north away from the main line of " West-East Gas Transmission Project, about 200 kilometers east from Shanghai, only about 210 kilometers from Zhejiang Province in the south direction, and less than 20 kilometers away from the Ningbo-Nanjing petroleum pipeline. All of these offer reasonable reverse and distribution system for the transportation piping network. So constructing underground gas storage cavern in this mine possesses abundant resources with the economical and geographical advantages.

Geological conditions for constructing the cavern

Both geographical conditions and geological conditions are required to construct salt cavern. For example, the tectogenesis in this region should be weak, rock salt aggradations regions have undeveloped faultages, and the rock salt bed is quite wide and thick, and has quite good sealing. Now the geological conditions for constructing underground salt cavern in Jintan are specified as follows:

Distribution area and thickness of rock salt layer

This rock salt mine is located at the fourth section of the Paleogene Funing Group with the area around 60 Km^2. The thickest part of the salt layer is 230m, while the thickness range is 150m-170m generally and 50m-80m at the edge of the salt basin. It is absolutely possible to construct a salt cavern with the height of 120-135m and diameter of 80-100m in the thick rock salt mine bed. (Bar chart 1 of the well)

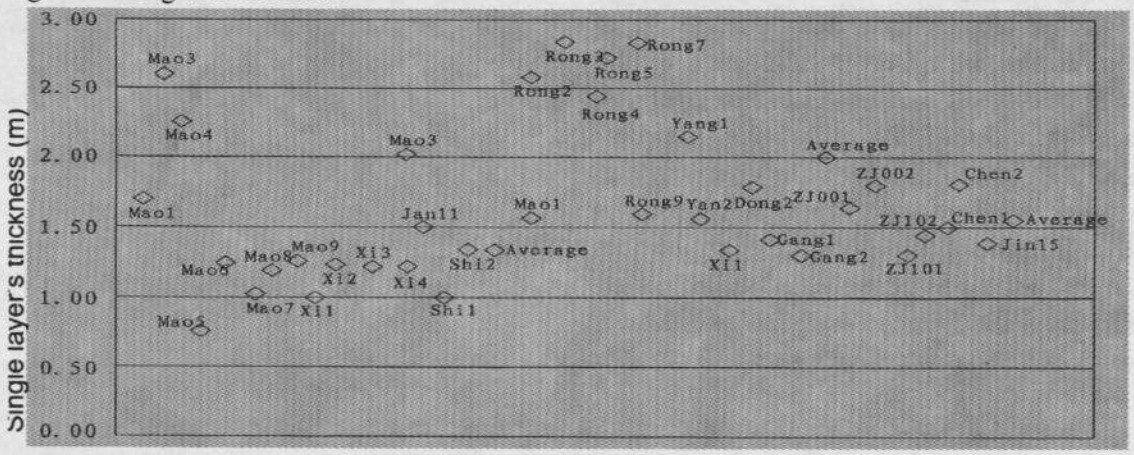
The high content of NaCl

The average content of NaCl is 80%. However, the amount is up to 85% on average in the south area, which belongs to high quality of rock salt mine bed, in which the soluble material such as Na_2SO_4 could account for 4.5%. Meanwhile, some insoluble materials with particle size changing from 0.1 to 5mm and average content about 9.23% will be taken to the ground during the process of brine mining. This content can not only meet the volume requirement of constructing single cavity for gas storage, but also the demand of group-scale for constructing group of salt cavern gas storage.

The interlayer of mudstone salt is very few, but contains a high rate of mine.

The accumulated thickness of mudstone in the salt layer is between 12m and 20m, with the average thickness 15m. There are about 10 to 15 layers mudstones. The thickness of single-layer mudstone is from 0.1m to 1m and the thickest part is around 4m. There are about 2 to 3 layers with the thickness larger more than 2m (see picture1, 2). The content of NaCl in the mudstone is generally around 7.45%-13.89%, and the lowest content is at 2.29%. In the water soluble mining, these interlayers of mudstone all fell into the bottom of the well. Some small granule mudstone

chippings will be brought to the surface of ground along with the brine.



Pt.1 Average single layer thickness of single well's interlayer

Suitable embedding depth

The imbedding depth mainly influences the economy and efficiency of the construction of cavern. If the cavern is embedded too deep, the drilling and construction investment fees will increase. Otherwise, if imbedded too shallow, it will limit the injection pressure, influence the gas storage quantity, and also increase the difficulty and safety of cavern construction. The layers of Jintan salt mine is embedded at the depth between 850-1200m. So the investment is low and it is relatively safe. As long as a petroleum and gas water-soluble mining technique is adopted, ground salt cavern with certain shapes and volume reaching 200,000 to 300,000 m^3 can be constructed. It can also ensure the safety of underground salt cavern and prevent surface subsidence caused by collapse of the cavity top layer.

Steady distribution of top layer and bottom layer as well as good sealing

Natural gas is stored in the cavities of rock salt underground storage, which must have a good sealing and stability and can not collapse so as to facilitate the normal operation of the gas cavern. Therefore, it is important that the roof and floor have good physical and mechanical properties, as well as steady distribution.

The lithology of top layer and bottom layer is mainly dolomite mudstone, calcareous mudstone, and sandy mudstone. The thickness of the top layer is 96150m, and the bottom one is not uncovered with low penetration rate being among 0.0085×10-3 to 0.707×10-3μm^2. Observed from the rock core of the drilling well, the rock core of the top and bottom layers is intact, with the cracks undeveloped fully and good seal property. The huge thick mud rock contains the salt layer, which makes the mud rock become a single large-scale mine. The rock salt itself has the features of sealing, plasticity, pressure-proof, and is not easy to react with petroleum and natural gas. At the same time, the rock salt layer is dense, with the low porosity low (generally about 1.4-4.05%) and low penetration rate. Therefore, the cavity in the salt layer has good sealing. For example, the exploited salt output of No.1 well in the north of the salt basin and No.1 well in the south are both over 250,000 tons. Being shut down for several months, the pressures of the two wells are very steady, respectively 4.3 MPa and 3.95 MPa. The different well pressure is mainly because of different mining depths. It means that the underground cavity has good sealing, and there is no phenomenon of leakage.

CONCLUSION

Constructing underground gas storage with salt cavern in Jintan Salt Mine not only has the economical and geographical advantages, but also has the superior geological conditions. As long as certain mining techniques are adapted to control the configuration of the cavity, protect the top layer, control well's distance and leave enough security jambs, the underground gas storage cavern could be built and run safely.

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