DOI: 10.21276/sjet.2016.4.10.2

Scholars Journal of Engineering and Technology (SJET) **ISSN 2321-435X (Online)**
Sch. J. Eng. Tech., 2016; 4(10):478-481 **ISSN 2347-9523 (Print)**

(An International Publisher for Academic and Scientific Resources)
www.saspublisher.com

Review Article

Study on 3D Geological Modeling of Shale Gas Reservoir---Take Sichuan Shale Gas Y Block as an Example

Shi Hao, Shao Bi-ying, Yin Yue-lei
Northeast Petroleum University, Heilongjiang Daqing 163318, China

***Corresponding author**
Shi Hao.
Email: 1418057666@qq.com

Abstract: Shale gas contains three kinds of flow mechanism, which are seepage, analytical attachment and spread, the situation is very complicated, so there is no substantial and breakthrough progress about 3D geological modeling of shale gas. The unique complex fracture system of shale gas is directly related to the result of numerical simulation, so the accurate representation of the complex fracture network system and the characteristics of the shale gas flow is the key to the simulation of the natural fracture and hydraulic fracturing. In this paper, combined with the exploration and development of Sichuan shale gas Y block, the preliminary study on the geological modeling of shale gas can provide useful reference for the numerical simulation of shale gas fine reservoir.
Keywords: Shale gas; Fracture; 3D geological modeling

OVERVIEW OF SHALE GAS

Shale gas concept

Shale gas is accumulation of natural gas, Main style of existence is free state or adsorbed state, it located in rich carbonaceous shale or organic matter dark mud shale mainly, and has the characteristics of low porosity and low permeability [1]. It is different from other conventional gas reservoirs, and the migration of the gas generated by the gas is in the interior. Shale gas is a "self-produced, self storage" system, the cover layer, the source rock and the reservoir are all included in it.

Characteristics of shale gas

Shale gas exists in two states in shale mainly, respectively the adsorption state and free state. When the state is the former, it is mainly distributed in the surface of organic matter and particles, and the state is the latter, it mainly distributed in the surface of the pore. In a few cases, when the shale gas is dissolved state exists in association with petroleum basins, it might exist in liquid hydrocarbons、formation water. Therefore, shale gas shows three state, each state of the main component will change accordingly. 20%-85% of Shale gas is adsorbed gas, and most of them are methane, in addition, there are a small amount of carbon dioxide, inert gases, carbon dioxide, nitrogen [2].

The adsorption mode of shale gas is physical adsorption, mainly through the surface of the molecule and the interaction of methane molecules, the formation of Fan Dehua force [3]. The desorption refers to the motion of molecules because of the changing external conditions, kinetic energy will be gradually increased to gravitational field and phase matching even higher, detached from the surface into the free state, resulting in desorption and adsorption in a reverse way.

Modeling characteristics of shale gas

Due to the characteristics of low porosity and low permeability of shale gas reservoirs, the production of high efficiency should be treated by artificial fracturing after completion. So through the artificial fracture treatment of the fracture and the formation of the original natural cracks together constitute a more complex fracture system. The reliability of the numerical simulation results is closely related to the accurate characterization of the fracture system. For the actual production, due to the crack is the main flow channel of shale gas and considering the characteristics of shale gas in a variety of different from conventional reservoirs, making shale gas reservoir 3D geological modeling is more complex than the other oil.

CURRENT SITUATION OF SHALE GAS DEVELOPMENT IN BOTH HERE AND ABOARD

Current situation of shale gas development in China

Since 2004, researchers have made great efforts in studying the nature of shale gas, and laid a theoretical foundation for the exploration and development of shale gas in China [4]. In 2010, the researchers were divided into 3 echelon to carry out researching shale gas areas. In 2011, the Ministry of land and resources combined with pre-survey research in Sichuan, Chongqing, Guizhou and Hubei Province to carry out the pilot tests on five projects, at the same time carrying out the five shale gas exploration and development technology research projects. During this period, the PetroChina Co Ltd selected 4 favorable blocks in the southern Sichuan, Guizhou and northern regions, Drilled 11 appraisal wells, which has 4 vertical wells in gas breakthrough; China Petrochemical in eastern Guizhou, South and East Sichuan area optimized two favorable blocks, drill 5 appraisal wells, of which there are 2 vertical wells gas breakthrough; too extend the oil in Yan'an after 3 shale gas wells drilling, the continental shale gas technology breakthrough; CNOOC, China United Coal began in Anhui and Zhejiang area, Qinshui Basin, Shanxi Province to carry out preliminary investigation. Through a series of investigations, the overall level of shale gas research in China has been rising, and gradually formed a combination of domestic and foreign understanding.

Current situation of shale gas development in foreign countries

Different from domestic, foreign shale gas is the main focus areas of large-scale commercial development. Take the United States as an example, the world's first shale gas wells drilled in 1821 in the United States, in 1981 first shale gas wells fracturing success in the United States, provides valuable information for the development of 5 shale gas [5].

At present, with the continuous development and progress of the horizontal well drilling and completion technology and large-scale subsection fracturing stimulation technology, the current development of shale gas in the United States and more than one country is not uncommon. 2010, the U.S. shale gas production up to 13.79 x 1010m3, compared with 2009, increased by 37.9%. In recent years, the United States shale gas production increased more than 20 times, and the continuous progress of the shale gas industry also makes the United States become the world's largest producer of natural gas. in 2001.

SHALE GAS GEOLOGICAL MODELING

Shale gas reservoir geological modeling is to provide accurate reservoir numerical model of shale gas. The conventional shale gas model is a statistical method for interpolation and solving the parameters, so the model can not be able to show the changes of geological bodies at random. Due to the random and structural characteristics of the geological variables in space, in recent years, the theory of variable and stochastic simulation of the field has provided a good foundation for the research of shale gas,in the process of modeling the actual process of continuous improvement, more accurate to the shale gas reservoir heterogeneity and crack system simulation [6].

The paper takes the Y shale gas block as an example, the area of the block is 41.5km^2, the structure is more complete, and there is no fault. We use petrel to complete petrel 3D visualization of the geological modeling. First is organizing the location coordinates, well stratified, porosity, permeability, water saturation, rock density, the abundance of free gas, adsorption gas abundance, micro seismic data according to the format of the corresponding format, input the software separately, and provide the foundation for the construction of the model and attribute model. The shale gas has not yet large-scale investment in the development, produce less experimental data, only has four production wells and 1 wells physical parameters at present, well number is relatively small, block does not has sedimentary facies data, therefore, it cannot be used phase control data. The stochastic modeling method and the average algorithm are used to assign the properties of the blocks, which have great uncertainty and error, which can not correctly reflect the geological structure and attribute characteristics of the block. Sequential Gauss algorithm is used to analyze the data. The model can make the properties of the whole shale block more in line with the actual situation [7].

Structural modeling is a very important part of 3D geological modeling. The purpose of structural modeling is to describe the spatial development characteristics of the strata and provide accurate stratigraphic framework for reservoir modeling. Modeling area 41.5km^2,so the plane grid unit uses 20m * 20m to improve the accuracy of modeling, in addition to considering the computer operation ability, In the subsequent coarsening process, the 40m * 40m plane mesh is used to improve the speed of numerical simulation.

Longitudinal, according to the well was drilled to meet layer depth, the well layers of vertical to the thickness, the elevation of the land, bushing high, well trajectory data and containing gas shale member of the five sub section thickness can be obtained five sub section of the well stratified data. According to the well layer to make each layer of the constraint surface,

establish 6 levels, a total of five zone. Subdivide each layer, the 11 sub segment is divided into 16 layers, the 12 sub segment is divided into 9 layers, the 2 segment is divided into 8 layers, the 31 sub segment is divided into 6 layers, the 32 sub segment is divided into 3 layers, and the 42 section is divided into layers, which makes the vertical precision accurate to 2m, Structural model is the basis of the three dimensional geological modeling of shale gas.

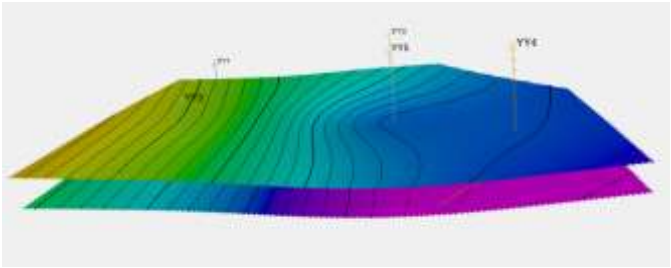

Fig-1: Three dimensional map of Y block structure model

Attribute modeling mainly refers to the establishment of the reservoir attribute parameter model, including porosity model, density model, permeability model and fluid saturation model and so on. The establishment of reservoir attribute parameter model is divided into three steps, namely, well logs Data, discrete data analysis and attribute model.

Known parameter wells are less, Well logging data is less, under the condition that the constraint condition is less, difference of model is large. Geological variables are different, the application of the simulation type also changes,we usually divide the stochastic simulation into two types: discrete and continuous.

Unlike other geological modeling, Shale gas geological model using dual porosity media model, dual porosity media model including matrix grid and fracture network. The model matrix grid describes the shale layer matrix, the matrix grid provides gas source, in the process of mining with the pressure drop, the gas is resolved from the matrix grid and then flows into the crack mesh. The model fracture grid describes the shale gas reservoir fracture, the shale gas flow in the cracks, and then flow into the production wells. Therefore, the PETREL modeling process of shale gas needs to establish the matrix and fracture model of the target block respectively [8].

Fracture model is divided into artificial fracture model and natural fracture model. Artificial crack model is artificial fracturing micro seismic data loaded into the petrel model, The data of each stage are dispersed into grid, and established micro seismic mesh model. The natural fracture model is established in the fracture model, including the dip angle, the trend, the opening and the permeability. According to the data of the study area, the measured maximum principal stress is 61.50MPa, the minimum principal stress is 52.39MPa, the maximum principal stress direction is north west direction, so the crack direction are arranged along the direction. With reference to the attribute model data and artificial fracture density, and because of the block is made of artificial fracture, the artificial fracture crack is combined with the natural fracture to form the airflow passage, so the crack opening is set to 2mm, and the fracture permeability is obtained through the ideal cube model [9]. Crack model is shown in Figure 2 and 3.

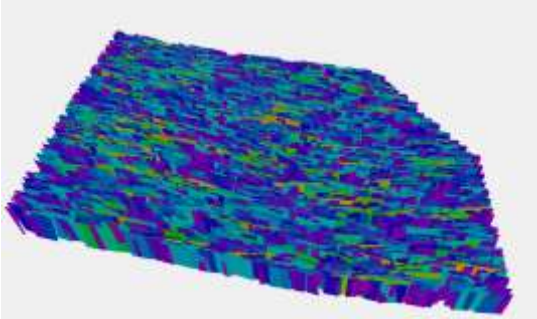

Fig-2: Natural fracture model

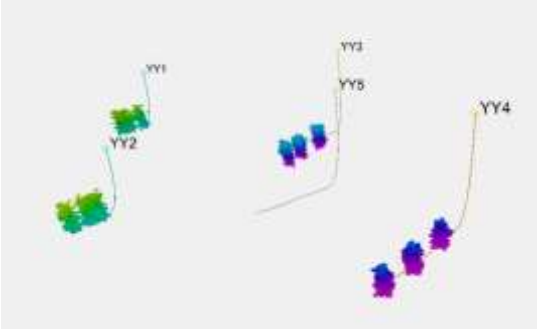

Fig-3: Artificial fracture model

CONCLUSIONS

1. Shale gas reservoir has the characteristics of low porosity and low permeability of natural fractures, and accompanied with the development of natural fractures, the general need for large-scale artificial fracturing can be efficiently mined.
2. Shale gas has great potential in China, growing shale gas industry requires a combination of advanced technology and the actual situation, combination of reservoir numerical simulation technology has been recognized, and domestic shale gas reservoirnumerical simulation technology and new progress of application in practice, the optimization of reservoir numerical simulation technology is realized in the end.
3. The natural fractures and fracture complicated fractures system for accurate modeling is ready for one of the keys in the shale gas reservoir numerical simulation, combined with the micro seismic monitoring data, natural fracture density data interpretation, hydraulic fracturing data, geological mechanical properties data to better realize geological modeling.

REFERENCES

1. Jinchuan Z, Zhijun J, Mingsheng Y. Reservoiring mechanism of shale gas and its distribution. Natural Gas Industry. 2004;24:15-8.
2. Yuqiang J, Dazhong D, Lin Q, Yanfei S, Chan J, Fuwei H. Basic features and evaluation of shale gas reservoirs. Natural Gas Industry. 2010;30(10):7-12.
3. Huaiyou J, Xinmin S, Xiaoxuan A. The exploration and development of shale gas resources status and Prospect of J. Petroleum geology and development in Daqing. 2008;27(6):10-14.
4. Shangbin C, Yanming Z, Hongyan W. Research status and development trend of shale gas in China. Petroleum journal. 2010;31(4): 689-694.
5. Pengfei Z, Jie Y, Lei Y. Shale gas reserves evaluation method J. Marine geology frontier. 2011;27(7): 57-62.
6. Baoyi J, Zhiping L, Xiang P, Gang L, Jianning W, Hua GH. Evaluation method and model of shale gas production capacity. science and technology and engineering. 2014;25:58-62.
7. Jie L. Shale gas production in Changning Sichuan area of Southwest Oil and gas field is over 6000 * 10~4m~3[J]. natural gas and oil. 2014;05:40.
8. Jun Y, Hai S, Dongyan F, Huang ZQ, Zhixue S, Guohao Z. Journal of shale gas reservoir migration mechanism and numerical simulation. China University of Petroleum. Natural science edition. 2013;01:91-98.
9. Xiaotao ZH, Jianfa WU, Xi FE, Hui D, Jiyuan Y. Numerical simulation of seepage flow characteristics of multi-stage fracturing (MSF) in horizontal shale gas wells. Natural Gas Industry. 2013;33(3):47-52.