International Journal of Engineering Research and Development
e-ISSN: 2278-067X, p-ISSN: 2278-800X, www.ijerd.com
Volume 8, Issue 8 (September 2013), PP. 62-65

The World's Present Research Situation of Shale Gas

Chen Can, Dong Chenghe, Lu Guang*
(Liaoning Shihua University, Fushun, Liaoning, China 113001)

Abstract:- Shale gas, an unconventional natural gas with considerable reserve, distributes worldwide and the proportion accounting for the natural gas production is increasing in recent years. However, the structure of shale gas reservoir is complex, most of which is of low porosity and low permeability, mainly showing that the production is low in the conventional well test in the development process. Just as the shale gas has special geological characteristic, the development technology on the conventional reservoir is obviously unable to suit the efficient development. The research and development of shale gas in our country is in the exploratory stage. Many basins in China have geological conditions of shale gas accumulation, which has good exploration and development prospects. This paper summarizes the distribution of shale gas resources, shale gas accumulation and the basic characteristics of the reservoir and advanced technology and successful experience in shale gas at home and abroad. The exploration and development technology of shale gas at home and abroad were introduced in detail, mainly including reservoir evaluation technology (logging and coring), horizontal well stimulation and fracturing stimulation technology. At last, aiming at China's actual conditions, this paper analyzes the main problems existing in the research and development of the shale gas in China, makes suggestions to the development of shale gas and points out the current trend of shale gas development technology.

Keywords:- shale gas; reservoir evaluation; horizontal well technology; hydraulic fracturing technology.

I. INTRODUCTION

Currently As natural gas, shale gas is mined from shale or clay formations. Some is stored as free gas in natural fractures, pores and other reservoir space, some as gas sorbed onto kerogen and clay- particle surfaces (20% ~ 85%) and a very small amount as gas dissolved in kerogen, bitumen and petroleum. Under the conditions of the current economic and technological industrialization, shale gas is an important exploration area and objective. U.S. shale gas exploration and development walks in the forefront of the world and is the only country succeeded in large-scale commercial development of shale gas. In recent years, Canada also carried out shale gas exploration and experimental research. Shale is widely distributed in China with great potential for development.

The research and exploration and development of shale gas first began in the United States. In 1821, the first shale gas well started drilling in the eastern United States, the large-scale production started in the 1920s, and shale gas exploration and development expanded to the United States Midwest in the 1970s. In the 1990s, driven by policy, price and technological progress and development, shale gas became an important objective and field in oil and gas industry exploration and development. It is predicted that the U.S. shale gas resources is more than 28 × 1012m3. The U.S. and Canada are two major countries developing shale gas. In 2009, shale gas production of U.S. is close to 1000 × l08m3, more than the annual output of China's conventional natural gas [1]. U.S. shale gas development has entered a stage of rapid development. Currently, shale gas exploration technologies are mainly horizontal wells + multi-stage fracturing technology, water fracturing technology and the recent emergence of the latest fracturing technology - synchronous fracturing technology, innovative horizontal drilling and completion technique is key to ensure production success . Using hydraulic fracturing and horizontal well technology, micro-seismic fracture imaging technology can directly monitor hydraulic fracture network expansion dynamics, which can greatly improve the shale gas reservoir exploitation. After the study and practice, horizontal drilling technology and low viscosity hydraulic fracturing technology open the huge treasure trove of shale gas resources previously considered with no value of commercial development. Meanwhile, shale gas well cementing techniques used are mainly foam cementing, completions with perforated well casing cementing after the main. It is the development acceleration and successful application of these advanced technologies that promotes the rapid development of shale gas development in the United States

China has great potential of shale gas resources, but exploration and development is in the "blank" state. Shale gas geological condition in China is superior, from the available information, in addition to distributed in Sichuan, Ordos, Bohai Bay, Songliao, Jianghan, Tuha, Tarim and Junggar basins contained oil and gas, marine shale formations, it also distributes in land and sea interlinked continental shale formations and

coal-bearing strata. According to estimates, China's recoverable shale gas resources is about (15 ~ 30) × 1012m3, equivalent to the United States roughly. Southern Sichuan, eastern Sichuan, Chongqing southeast, Guizhou, Hubei Province and other upper Yangtze region are the main prospect areas of shale gas. Take Sichuan Basin for example, only in the Cambrian and Silurian two shales, shale gas resources is 1.5 to 2.5 times equivalent to conventional natural gas resources. Inspired by successful examples abroad, in order to meet the needs of safety, environmental protection and energy alternate, China started to enter the field of shale gas development in 90 years. However, due to the limitations of geological conditions and the development of technical, a large-scale development has not formed [2]. Shale gas exploration and development in China is only in its infancy, there are many technical and policy issues are needed to be explored. The analysis of experimental technology aiming at shale gas exploration and development is not perfect, shale gas accumulation mechanism and enrichment features understanding is unclear and favorable zones for shale gas and shale gas producing areas of the selection and evaluation of construction, shale gas reservoir description, production forecasting, well placement and well network optimization techniques and gas reservoir engineering geological theory shale gas development in China are still in the blank. China's existing horizontal well drilling and completion technology cannot fully meet the horizontal shale gas well drilling and completion requirements, multi-stage horizontal well fracturing technology and supporting tools are still needed introducing, developing, testing and evaluating. Shale gas fracture extension rules, fracturing preferred size, production forecasts and other aspects need to be improved, the use of micro-seismic monitoring fracturing effect testing equipment, construction techniques and evaluation methods in China are still in the blanks.

Although the development levels of U.S. and China are different, some similar characteristics in the development process are showed and some common problems are faced. The U.S. and China are the largest economic countries with economic aggregate ranking in the front, while carbon emissions are substantial facing economic restructuring through lower carbon emissions and take a low-carbon economy development road. The two countries are both major energy consumer, energy with a high dependence on foreign demand, diversification of energy supply through the realization of energy security is a common choice for the two countries. Meanwhile, the two countries are the largest producer of oil and gas, so shale gas resources are relatively abundant.

As the development process shows some similarities, so learning from the U.S. experience in promoting China's shale gas exploration and development should be realistic, necessary and possible.

II. RESEARCH SITUATION OF SHALE GAS

Today's rising energy demand and huge pressure on resources, the increase of natural gas price, and the development of technology and people's increasing dependence on gas make shale gas exploration become an important field and goal of natural gas industrialization. According to the U.S. National Petroleum Council (NPC) statistics, by the end of 2007, the global shale gas resources had been about 456 trillion cubic meters. Shale gas is mainly distributed in North America (23.8%), Central Asia and China (21.9%), the Middle East and North America (15.8%), Latin America (13.1%) and other countries and regions [3].

A. Status of U.S. shale gas exploitation

U.S. is the earliest and most successful country in shale gas development. Early in 1627 ~ 1669, the French surveyors and missionaries have described organic-rich black shale in the Appalachian Basin and the oil and natural gas they mentioned are considered from mud Devonian shale in western New York. In 1821, the first shale gas well was completed in Devonian shale of New York Chautauga County Dunkirk. It was located above the gas seedlings, the gas for local use was produced from fractures about 8m deep and the well was later drilled to a depth of 21m. Thw discovery of shale gas opened the prelude to the development of U.S. natural gas industry. In 1981, the first shale gas well was fractured successfully, realizing the breakthrough of shale gas development. In this century, with the large-scale horizontal well fracturing successful application, shale gas in the United States developed rapidly. In 2000, U.S. shale gas production was 12.2 billion cubic meters, 19.6 billion cubic meters in 2005 with an average annual increase of 9.9%.In 2010, shale gas production was 137.8 billion cubic meters, seven times more than that in 2005 with an average annual increase of 47.7%. It was predicted that U.S. shale gas production will reach 200 billion cubic meters or so in 2015 [4], close to 2 times of the production in 2010. Major U.S.

B. Status of Canada shale gas exploitation

Canada is the second country to achieve commercial exploitation of shale gas, the production in 2008 was only 10 billion cubic meters while the production in 2009 was amounted to 7.2 billion cubic meters. Successful development of shale gas in the United States triggered a global boom in shale gas development and the successful exploration experience of U.S. shale gas, rich shale gas resources and rising energy demand are the main driving forces to promote Canadian shale gas. Currently, more than 30 countries around the world have actively carried out shale gas exploration and development work.

Canadian shale gas exploration and research projects are mainly in the Western Canadian Sedimentary Basin. In addition, Willislon basin is also a potential source of gas basin, Upper Cretaceous, Jurassic, Triassic and Devonian shale are identified as potential source layers. The evaluation of Western Canada Sedimentary Basin (British Columbia and Alberta eastern region) of the Upper Cretaceous strata Wilrich groups and their contemporaries, Jurassic Nordegg / Fernie group, Exshaw / Bakken combination Devonian Ireton / Duvernay shale gas exploration potential group predicted the area of shale gas resources was about 24 × 1012m3 [6]. Canadian Unconventional Gas Association believes (CSUG) that the western (including the Bowser Basin, northern British Columbia) Colorado shale, Jurassic and Paleozoic shale and southeastern Devonian shale have development potential. By the end of 2006, the Cretaceous and Devonian shale gas test blocks approved by the Commission are 22 [7].

C. Status of Europe shale gas exploitation

European shale gas is mainly concentrated in the UK Weald Basin, Poland, Baltic basin, basin, Lower Saxony, Germany, Hungary, Mako Canyon, East Paris Basin, France, Austria Vienna Basin and the Swedish Cambrian Alum basin [8] and so on. The UK shale gas resources is up to 5.7 trillion cubic meters, Bo Landa 5.3 trillion cubic meters, both of which are Europe's countries with best shale gas prospects.

In order to get rid of dependence on Russian gas, Europe has begun to actively develop shale gas resources. Exxon Mobil, ConocoPhillips, OMV and Shell and other international oil companies have begun substantive work in Germany, Poland, Austria and Sweden. Europe is expected to replicate the success of U.S. shale gas. However, there are still some obstacles in the European shale gas, for example, the policy of shale gas development in most countries is not clear, shale gas development may cause pollution of local water resources, development sites and the relocation of residents in the economic development issues and so on.

D. Status of China shale gas exploitation

According to geological history and its change characteristics, China's shale gas developmental area can be divided into sections corresponding roughly four regions, namely North - Northeast, South, Northwest and Tibet and other four regions [9]. The marine, terrestrial shales in different geological history are widely distributed. Proterozoic and Paleozoic shale, with high maturity, high TOC and shale gas reservoir geological conditions, distributed over an area of 100 × 104km2. Compared to other types of unconventional gas reservoirs, the shale gas exploration cost in high abundance region is not high and the economic value is huge [10]. On November 28, 2009, the first domestic shale gas exploration well was started in Chongqing Pengshui Miao and Tujia Autonomous County town, shale gas resources in our country has a good development prospect. In international cooperation, China's three national oil companies take a variety of active ways with foreign oil and gas companies in the shale gas exploration and development to seek cooperation, of which China Petroleum also conducted joint research with ConocoPhillips, Shell, Exxon Mobil, the Norwegian oil and other transnational oil companies, seeking for exploration of shale gas development in international cooperation. Sinopec also actively cooperates with foreign companies, such as BP, Chevron, Newfield, etc. to expand exchanges and cooperation. In October 2010, CNOOC announced the purchase of Eagle Beach, Chesapeake Shale oil and gas projects with 33.3% interest. All of these indicate shale gas exploration and development will flourish in our country.

At present, China's shale gas research and exploration and development are still in the exploratory stage. In recent years, many researchers have gradually noticed the "shale gas" in the accumulation mechanism and its distribution particularity, Shide Guan [11], Jinxing Dai [12] conclude the shale gas reservoirs basic geological features as follows: self-contained shale reservoir-cap system, with shale gas reservoirs more pressure abnormalities, and a variety of reservoir space in order to crack the main non-anticlinal trap type and lithology-based, and reserves of shale oil and gas reservoir single small, low production per well. Jinchuan Zhang [13] etc. believe shale gas is between root-like gas (typically adsorbed gas, such as coalbed methane reservoir), the root edge gas (typical piston accumulation of free gas, such as narrow deep basin gas trap) and Root Far gas (typically substitutional accumulation of free gas, such as a conventional gas reservoir anticlinal traps). As shale gas represents as sorbed or free gas in the main manifestations, only a very short distance migration is in the accumulation process. So in a sense, a shale gas reservoir has dual mechanism of typical coalbed methane gas and typical root edge gas. Shale gas accumulation and evolution can be divided into three main action process: itself constitute gathered from the generation and absorption, making the expansion gap enrichment to the piston propulsion, substitutional migration mechanism sequence. Domestic scholars generally believe that shale gas is natural gas gathering with an extremely rich exploration potential and prospects, but related study on systematic mechanism has not carried out.

III. CONCLUSION

Shale gas is an emerging energy resource and global shale gas development is still in its early stages. The United States has built a large-scale shale gas production capacity, becoming an important source of natural gas supply in the country. Shale gas development in China has not yet started, but the high resource potential

and good prospects for development have real strategic significance in improving the ability of domestic oil and gas supply capacity and enhancing national energy security.

REFERENCES

[1]. Li Wuguang, Yang Shenglai, Yin Dandan. Shale gas development technology and strategy review [J]. Natural Gas and Oil,, 2011, 29(1) : 34~37

[2]. Zhang Jinchuan, Jin Zhijun, Yuan Mingsheng. Shale gas accumulation mechanism and distribution [J]. Natural Gas Industry, 2004, 24(7) : 15~18

[3]. Cui Qing, Gao Jinlong. World's shale gas exploration and development technology and exploration prospects [J]. Inner Mongolia Petrochemical Industry,, 2011(17) : 122~124.

[4]. Pat Roche. Most Shale Gas Growth To 2015 Will Come From U.S. And Canada : Report. Daily Oil Bulletin. 2011-02-14.

[5]. C.D. Rokosh, J. G. Pawlowicz, H. Berhane, S. D. A. Anderson and A. P. Beaton. What is ShaleGas？An Introduction to Shale-Gas Geology in Alberta. ERCB/AGS Open File Report : 2008-08.

[6]. Jiang Huaiyou, Song Xinmin, An Xiaoxuan, etc.. Overview of world's exploration and development of shale gas resources and technical [J]. Natural Gas Technology, 2008, 2(6) : 26~30.

[7]. Li Xinjing, Hu Suyun, Cheng Keming. Inspiration of fractured shale gas exploration and development in North America [J]. Petroleum Exploration and Development, 2007, 34(4) : 392~400

[8]. James Watson, Herbert Smith. Unconventional gas : Opportunities in Europe. Number 39, January 2011.

[9]. Zhang Jinchuan, Xu Bo, Nie Haikuan, etc.. Two important areas for natural gas exploration in China [J]. Natural Gas Industry, 2007, 27(11) : 1~6

[10]. Liu Honglin, Wang Li, Wang Hongyan, etc.. Discussion of China shale gas exploration and development of appropriate technologies [J]. Well Testing, 2009, 18(4) : 68~78.

[11]. Guan Shide, Niu Jiayu, Guo Lina, etc.. Chinese unconventional oil and gas geology [M]. BEI JING : Petroleum Industry Press, 1995 : 116~120.

[12]. Dai Jinxing, Pei Xigu, Qi Houfa. China Natural Gas Geology (Volume II) [M]. BEI JING : Petroleum Industry Press, 1996 : 76~79.

[13]. Zhang Jinchuan, Xue Hui, Zhang Deming, etc.. Shale gas and its accumulation mechanism [J]. Geoscience, 2003, (4) : 466.