

## A Review on Development of CBM Industry in China

**Qin Yong<sup>1</sup> and Ye Jianping<sup>2</sup>**

<sup>1</sup>China University of Mining and Technology, Xuzhou, Jiangsu 221116, China

<sup>2</sup>China United CBM Co., Ltd., Dongcheng District, Beijing 1000713, China

### **Abstract**

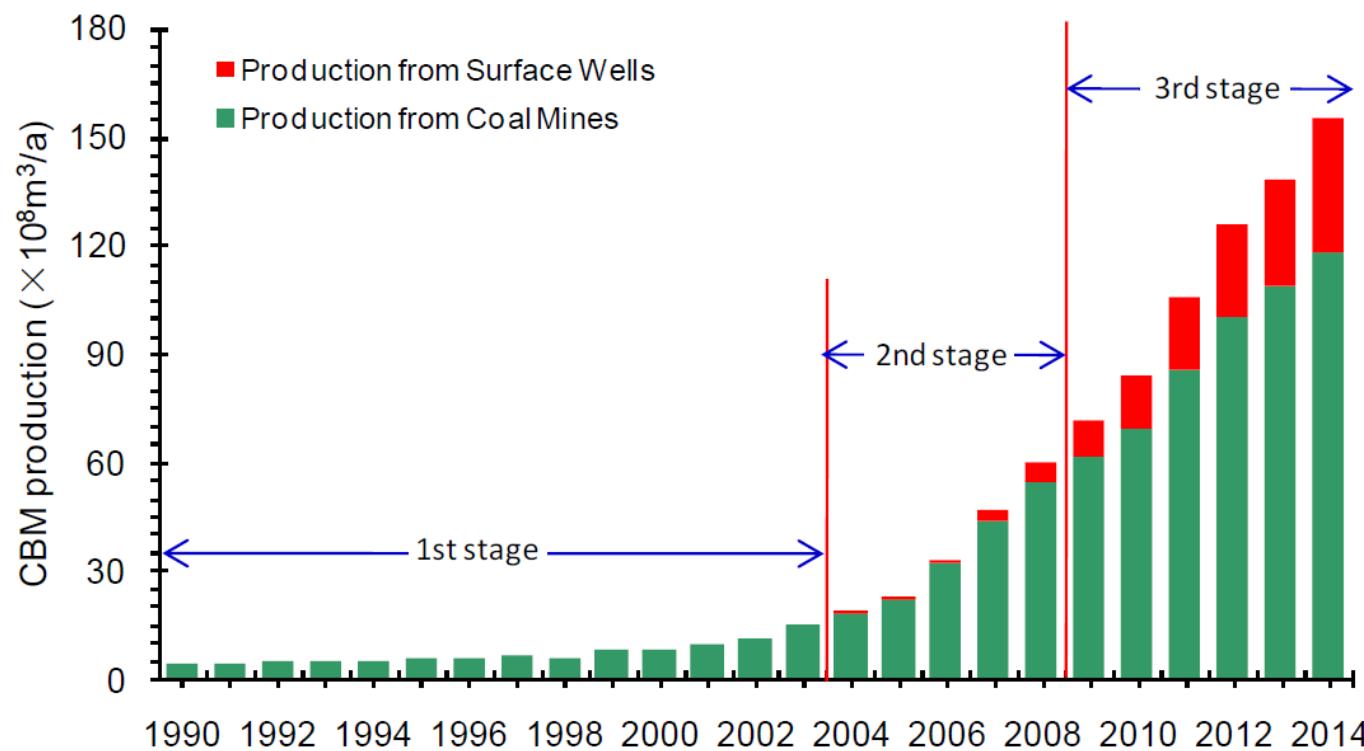
#### 1. CBM Resources and Exploration & Development History of China

Total CBM Resources of 38.61 trillion cubic meters, in which:

- 31%, 28% and 28% in the eastern, central and western, only 13% in the southern
- 85% occur in nine basins including Erdos, Jungar, Qinshui and so on

Three Stages of CBM Development (Fig. 1):

- Geological constituency and production test from 1989 to 2002, in which hardly any CBM was commercially produced from ground wells.
- Small scale of commercial production from 2003 to 2008 in the Qinshui and Tiefa basins. Annual CBM output from the ground wells reached 5 billion cubic meters in 2008.
- Substantial scale of production concentrated in the Qinshui and Erdos basins since 2009, reaching an annual CBM output of 155.3 billion cubic meters, in which the 36.9 billion cubic meters was produced from the ground wells.



**Fig. 1. CBM output and industrial development stages of China over the years**

CBM production of the Whole Country in 2014:

- Total CBM production is 155.3 billion cubic meters, including 36.9 billion cubic meters from the ground wells and 118.4 billion cubic meters from coal mines.
- By the end of 2014, China has about 14500 ground wells mainly located in the Qinshui and Erdos basins, in which about 9300 wells are operating with the average daily production per well of 1087 cubic meters per day.

## 2. Activities of CBM Research in China over the Past Ten Years

3267 CBM papers were published by 245 Chinese journals from 2003 to 2013.

Research Hotspots:

- In the field of geology and exploration, the interest was focused on the CBM resources and geologic controls, geophysical logging, the physical properties of coal reservoirs, CBM accumulation, and the paragenetic sequence and co-mining of coal measure gas (CMG) including CBM, shale gas and tight sandstone gas are concerned recently.
- In the field of CBM extraction and enhanced production technology, the focus were on the drilling fluid, well pattern optimization, hydraulic fracturing, fracturing fluid, foam fracturing, CO<sub>2</sub> injection, drainage system optimization etc.
- In the field of CBM utilization and environmental protection, the technologies of the CBM power generation, CBM purification and concentration, CBM transportation and storage are more discussed, and industrial policy and the clean development mechanism (CDM) are involved.

#### Interest Conversion:

- In the field of geology and exploration, the research findings of the CBM recoverability were concentrated in 2006, and paragenetic sequence and co-mining technology of CMG has come into the study view since 2008.
- Researches on CBM development technology growth significantly in the past ten years, and research hotspots are most concentrated. Concern for CBM well type is expanded from multi-branch horizontal wells (2005), cluster wells (2008) into U-pattern well (2010), and the interest for the technology of CBM reservoir stimulation develops from hydraulic fracturing (2003), CO<sub>2</sub>-ECBM (2006), VES fracturing fluid (2009) into HRS fracturing and nitrogen foam fracturing (2012). Recently, the research results on the pulse shock wave technology for increasing the coal reservoir permeability have been reported.
- In the field of comprehensive CBM utilization, concern only focus on fuel before 2004, on concentration, purification, liquefaction, hydrate of CBM during 2005 to 2006, on the clean CBM conversion since 2007, on the synthesis gas since 2010, and on the pressurized gathering, network and storage since 2012.
- The evolution of research hotspots shows clearly the fronting trends of the CBM research in China, and indicates the major problems of science and technology for the development of CBM industry in China.

#### Interested Areas:

- Research was carried out mainly in the Qinshui, Erdos, western Henan, western Guizhou, eastern Yunnan and Liaohe, accounting for the 18% of published papers over the past ten years. Then, the Turpan-Hami, Junggar, Liang Huai and Sichuan also obtained attention, and the Ningwu, Hailar, Erlian and Santanghu were also involved.
- For the literature on the Erdos and Qinshui basins, those of geological research, exploration and drainage test is accounted for more than 96%, indicating that the main concern of CBM research in China is paid on these two basins in recent years. In fact, the more than 90% of the ground-well CBM production in China was derived from the two major basins over the past ten years.

Since 2008, Chinese government has launched major CBM National Science and technology Projects, and the investment funded by the government and related CBM enterprises has exceeded 100 billion US dollars so far. The project is divided into two categories. CBM research

and development includes the 10 projects, covering each technical link of the whole process from the CBM resource evaluation to the development. Technical demonstration is composed of the 6 projects, including the CBM drainage technology with the surface wells and coal mine, and 4 of them are implemented in the Qinshui and Ordos basins.

### 3. Progress of CBM Exploration and Development Technology in China

China is the biggest coal producing country in the world, so that the CBM development had to be taken to the strategy of the ground wells jointly with coal mine drainage. The purpose is to make full use of CBM resources, reduce the disaster risk from coal mine gas and coal mine methane emissions to the atmosphere. Six series of Technology have been formed:

- Development technology of the CBM from high-rank coal reservoir in Qinshui basin with ground wells.
- Development technology of the CBM from middle-rank coal reservoir in Qinshui and other basins with ground wells.
- Drilling and CBM development technology of directional wells, including the horizontal multi-branch, horizontal comb-pattern, horizontal multi-seam, U-type and cluster wells.
- CBM development supporting tools and equipment such as the long needle threading tool, electromagnetic wave geosteering tool, complete sets of continuous tube equipment, rotary abrasive jet equipment for deep penetration, and micro seismic equipment of well jointly with surface for monitoring the fracturing.
- CBM drainage technology suitable to China's coal reservoirs, such as the area step-down method with double control step by step, drainage control with five stage and three pressure points and recovery with fine stability control.
- Efficient extraction technology of coal mine gas represented by the Huainan model and Jincheng model.

These technologies are supporting the development CBM and coal industry of China:

- Has built up the surface CBM development bases with the production capacity of 110 billion cubic meters, bring about the gas production of 120 billion cubic meters in underground coal mines, and the CBM industry of China has been initially formed.
- Continuously to improve the coal mine safety in China. Since 2006, the coal output of China grew at an average annual rate of 2.3 tons, and the mortality per million tons coal decreased from 2.81 in 2005 to 0.293 in 2013, significantly reducing gas accidents.
- Total proven CBM reserves of 8454 billion cubic meters, find the two CBM field respectively with the reserves of more than one hundred billion cubic meters, and provides the basis for the sustainable development of national CBM industry.

### 4. Problems and development trends of China's CBM industry

After more than 30 years of unremitting efforts, China's CBM industry has made significant progress on the background of complex coal reservoirs, but still faces many problems to be solved. The government will continue to support the industry in the R&D investment and policy and the related large CBM enterprises are also looking for ways to solve the key technical problems in constant.

Major problems:

- The lower single well production on the whole affects the CBM development benefit and investor confidence.
- Exploration and geological evaluation technology of the "sweet spot" within a block still under development.
- Development technology suitable to various coal reservoirs needs to be improved.
- Drainage production needs more support of the technology, such as coal power suppression.
- Industry strategic alternative bases are still to be formed.

Measures that have been taken or will be taken:

- The Chinese government promulgated the "Coalbed Methane Industry Policy" in 2013 March, has been clear about the industrial development objectives, market access, industrial layout, technology policy, safeguard measures and so on.
- The government will continue to carry out Major CBM National Science and Technology Project, support the CBM research and technical demonstration projects.
- More attention will be paid to the R&D of enhanced production technology for single well of two existing industrial base, including the new technology principle.
- More attention will be paid to the R&D of integrated exploration and development technology for the CBM, shale gas and tight sandstone gas in coal measure.
- More attention will be paid to the technology and demonstration of low-rank CBM resources, accounting for total CBM resources of 47% in China.

The latest progress in CBM exploration and development:

- Low-rank CBM production of single well has realized industrial gas flow breakthrough in some areas such as Fukang, Yilan, Hui Chun, Huolinhe etc.. Among them, one wells Fukang, Xinjiang, yields the stable gas flow of 12000 cubic meters per day.
- Production of single well in some blocks of the existing two bases is significantly increase on the whole, such as nearly 3000 wells in Hancheng block, Erdos basin.
- Co-drainage tests of coal measure gas have achieved a major breakthrough. For example, gas productions of the single wells in Lin Xing block, Erdos bas and in western Shilou block, have reached several ten thousands of cubic meters.
- CBM exploration in some other areas has produced industrial gas flow of single wells, such as the western Guizhou, southern Sichuan and eastern Heilongjiang.