



CHINESE NATIONAL COMMITTEE
WORLD PETROLEUM COUNCIL

LOW-COST DEVELOPMENT OF UNCONVENTIONALS

WPC EXPERT WORKSHOP · BEIJING

6 SEPTEMBER, 2016

TECHNICAL PROGRAM

Host Organization



China National Petroleum Corporation



INTRODUCTION



As an important event in the middle of the triennial WPC (World Petroleum Congress), WPC Expert Workshop aims to focus on the latest challenges/ hot topics/ difficulties/ special issues facing the petroleum industry and is organized by WPC member country committees. The discussions and deliverables of the Workshop will be officially presented during the following WPC.

At present, unconventional have played a considerable part in oil and gas output with even more important future contributions. Major breakthroughs and technical development of shale gas and tight oil & gas in North America have made the E&P of unconventional oil and gas a very promising prospect. However, with the decline of oil price, the extensively focused E&P of unconventional has to encounter new challenges under a new situation and shall be carried out in some new ways against the changing background. Therefore, a path of cost reduction through technical innovations has become an imperative choice.

Against such a background and proposed by Chinese National Committee for WPC, WPC Expert Workshop themed with " Low-Cost Development of Unconventionals" will be held on September 6, 2016 (Tuesday) at Research Institute of Petroleum Exploration and Development (RIPED), PetroChina (No.20 Xueyuan Road, Haidian District, Beijing, China). From the aspect of technological and managerial innovation, the Workshop aims to explore the solutions and best practices of cost reduction and efficiency improvement for E&P of unconventional with in-depth interaction and sharing of insightful views and successful experience.



Steering Committee

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	WANG Zhongcai	Senior VP, CNODC
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	LIANG Jianshe	Director, New Energy Research Center, CNOOC Research Institute
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	WU Zhenmin	Deputy Chief Security Officer, RIPED, CNPC
	WANG Jianqiang	Director, Office of Administration, RIPED, CNPC
	LI Jianzhong	Director, Department of Petroleum Geology, RIPED, CNPC
	PEI Xiaohan	Director, Department of Petroleum Equipment, RIPED, CNPC
	WU Shuhong	Deputy Director, Software Research Center of Oil & Gas Development, RIPED, CNPC
	ZHANG Zhaohui	Deputy Director, International Affairs Department, RIPED, CNPC

TECHNICAL PROGRAM

Tuesday, 6 September 2016



Opening Session 09:00-10:00

Host: LIU Zhenwu, CPC Member, WPC

TIME	ITEM
09:00-09:30	Opening Remarks -- ZHOU Jiping , VP Marketing, WPC Vice Chairman, Chinese National Committee for WPC -- Jozsef TOTH , President, WPC -- LI Luguang , Assistant President, CNPC -- Pierce RIEMER , Secretary General, WPC
09:30-10:00	Keynote Speech: Progress, Challenges and Opportunities of Unconventional Oil & Gas Development in China ZOU Caineng , Vice President, RIPED, CNPC / President, RIPED-Langfang
10:00-10:20	Coffee Break

Session 1 10:20-12:00

Moderator: LIU Yuzhang, Director, Office of Senior Consultants, RIPED, CNPC

TIME	ITEM
10:20-10:40	PetroChina Southwest Shale Gas E&D Status CHEN Gengsheng , Chief Shale Gas E&D Expert, PetroChina Southwest Oil & Gas field Company
10:40-11:00	Unconventional Resource Development in ExxonMobil Rick POWELL , President, ExxonMobil China Upstream Limited
11:00-11:20	The Progress of Fuling Shale Gas Exploration and Development, SINOPEC CAI Xunyu , Deputy Director, Oilfield Exploration & Production Department, Sinopec
11:20-11:40	The Current State of Unconventional Oil & Gas from International and Cost Perspectives Robert LIOU , Associate Director, Upstream Research, IHS Energy
11:40-12:00	Q & A
12:00-13:00	Luncheon



Session 2 13:00-14:40

**Moderator: LI Qun, Director, S&T Cooperation,
R&D Department, CNPC**

TIME	ITEM
13:00-13:20	In-situ Upgrading Process (IUP) and In-situ Conversion Process (ICP) Technology John KARANIKAS , Chief Scientist for Reservoir Engineering, Shell
13:20-13:40	Practice and Development of Innovation to Drive Cost-saving and Profit-Increasing LI Guoshun , Vice President, CNPC Technical Service Company
13:40-14:00	Lowering Total Cost Through Geo-engineering Axel DESTREMAU , CHG Geomarket Manager, Schlumberger
14:00-14:20	Technical Challenges and Solutions for China's Tight Oil LIU He , Deputy Chief Engineer, RIPED, CNPC
14:20-14:40	Q & A
14:40-15:00	Coffee Break

Session 3 15:00-16:50

Moderator: LIU He, Deputy Chief Engineer, RIPED, CNPC

TIME	ITEM
15:00-15:20	The Best Practice of Intensive Production for Unconventional Reservoirs in Jilin Oilfield-Case Study WANG Feng , Vice President, Jilin Oilfield Company, PetroChina
15:20-15:40	Progress in Coalbed Methane Exploration & Development Techniques and Geological Research in China SONG Yan , Dean, Unconventional Gas Research Institute, China University of Petroleum- Beijing
15:40-16:00	The Future of Oil Sands Producers: A Road to Low Cost and Green Development NIE Changmou , Operations Director, Brion Energy Corporation /PetroChina
16:00-16:20	Development Practices of Tight Oil and Gas Reservoirs in Ordos Basin HAN Xinggang , Deputy Director, Research Center of Sulige Gas Field, Changqing Oil & Gas Field Company, PetroChina
16:20-16:40	Q & A
16:40-16:50	Summary LIU Zhenwu , CPC Member, WPC
17:00	Closure

ABSTRACT

Progress, Challenges and Opportunities of Unconventional Oil & Gas Development in China

ZOU Caineng

Two major unconventional oil & gas breakthrough regions, namely the United States in the Western Hemisphere and China in the Eastern Hemisphere, are being established worldwide. After three decades exploration and research, the unconventional oil & gas such as shale gas and tight oil in the United States has gained “revolutionary development”, which has made its dependence on foreign oil & gas dropped significantly and will continue to promote its implementation of the “energy independence” strategy. Self-sufficiency of natural gas has basically been achieved, and the external dependence on oil has already dropped to 33% in the US. After 10 years’ research and innovation on unconventional oil and gas in China, the tight oil & gas and shale gas have achieved a “strategic breakthrough”. In 2015, its tight gas production was $360 \times 10^8 \text{ m}^3$ and two giant tight gas area with two trillion m^3 scale have been discovered in Sulige Formation, Ordos Basin and Xujiahe Formation, Sichuan basin respectively; the proven shale gas reserves reported reach $5441 \times 10^8 \text{ m}^3$ and three large marine phase shale gas fields with one hundred billion m^3 scale named Beiling, Changning and Weiyuan have been discovered, the total production of shale gas reached $45 \times 10^8 \text{ m}^3$ in 2015; the tight oil has been included into the reserve sequence and three large tight oilfields of 100 million ton scale have been identified, namely Xinanbian in Eros basin, Fuyu in Songliao basin and Jimusaar in Junggar basin. The annual production of tight oil in 2015 is $150 \times 10^4 \text{ t}$; Commercial CBM development has achieved initial success, forming Qinshui and Ordos production bases. In 2015, the CBM production was $44 \times 10^8 \text{ m}^3$. Industrialized development of unconventional oil & gas has been initially achieved in China.

During the last decade, great theory and technology progress has been made in China's unconventional oil & gas resources concerning the following four areas: fine-grained sediments, unconventional reservoirs geology, unconventional oil and gas geology, exploration and development technologies. ① New progress in regards to fine-grained sediments studies has been achieved in the sand bodies of continental facies uncontrolled flow lacustrine basin large shallow-water deltas, lake center sandy debris flow deposits, continental and marine phase organic-rich fine-grained sedimentary shale, which offered theoretical basis for basin-centered accumulation and distribution study. ② Major progress in the geology of unconventional reservoirs has been made in the fields of research methods & techniques, multi-scale data fusion and reservoir condition physical simulation. Micro-and nanometer pore system has been discovered in the tight sandstone and shale reservoir. Overall characterization of unconventional reservoir by using the multiple methods and multi-scales has become a hotspot of studies. ③ The continuous oil & gas accumulation mechanism has been revealed and the accumulation characterization has been defined, which laid the theoretical basis for unconventional oil & gas geology.



ABSTRACT

④Rapid progress has been made in unconventional oil & gas exploration & development technologies and methods, for example, the key evaluation methods such as the "sweet spots" geological and engineering comprehensive evaluation method, and core engineering ideas and key technologies such as micro-seismic monitoring, horizontal well drilling and completion, "factory-like" production and "artificial reservoir", which promoting "strategic breakthrough" of China's unconventional oil & gas.

Large scale exploitation of China's unconventional oil & gas resources has been achieved, but we are still facing geological, geophysical, development & stimulation and many other challenges. China's geological settings have the characteristics of multiple tectonic evolutionary cycles, mainly in continental strata with large facies changes. The unconventional oil & gas accumulation has particularities in geodynamics, depositional environments, hydrocarbon source rock distribution, reservoir heterogeneity, oil-gas-water relationship and formation energy, and other aspects, and the unconventional oil & gas theories & technologies with Chinese features need to be innovated. Tight gas is facing adverse factors such as strong reservoir heterogeneity, difficulties in "sweet spots" characterization, ungovernable horizontal well trajectory, difficulties in identifying hydrocarbon reservoir logs, and difficulties in deep layer tight reservoir stimulation; For shale gas, many challenges such as complex surface conditions, large burial depth, incomplete pipe network facilities, lack of engineering technology for drilling wells with depth more than 3500m, high thermal evolutionary degree of Cambrian shale and zero breakthrough in continental - transitional facies shale gas; For CBM, it is facing many problems such as complex gas & water distribution, unclear enrichment rules, lack of development technology for wells with a depth larger than 800m, large difficulties in reservoir stimulation; shale oil is facing many difficult problems such as strong heterogeneity of mud & shale, high clay mineral contents, low maturity of organic matters, poor crude oil mobility and inadaptability of horizontal well fracturing technology.

In the future, China's unconventional oil & gas is facing a strategic development opportunity period. ① China has got abundant unconventional oil and gas resources. According to a preliminary evaluation, China's unconventional oil resources reach $(223\sim 263)\times 10^8\text{t}$ and natural gas sources reach $(890\sim 1260)\times 10^{12}\text{m}^3$. ② Rapid progress has been made in the research & development of key technologies as to China's unconventional resources. Key technological such as tight gas horizontal well volumetric fracturing + large platform "factory-like" exploitation, large platform "factory-like" development for shale gas with burial depth shallower than 3500m, multiple well type development for CBM with burial depth shallower than 800m and industrial testing for reservoir volume fracturing in tight oil horizontal wells, have been mature and improved. ③Industrialized development of tight oil & gas, shale gas and CBM has been basically achieved in China, and the large scale development of China's unconventional resources can be expected. The production of unconventional gas has accounted for 30% for the whole gas production and unconventional resources will become important replacement of China's oil & gas.

SPEAKER PROFILE

ZOU Caineng

**Vice President of Research Institute of
Petroleum Exploration & Development, CNPC
President, RIPED-Langfang**



Dr. ZOU is Vice President of Research Institute of Petroleum Exploration & Development(RIPED), President of RIPED-Langfang, Director of National Energy Tight Oil& Gas R&D center and Chief Scientist of National Tight Oil (Shale Oil) Program 973.

He is a principal engineer and holds a Doctor's degree in Mineral Prospecting and Exploration.

He served as Vice President and Chief Geologist of RIPED since April 2007 and has been the Vice President of RIPED and President of RIPED-Langfang since October 2014.

He has long been engaged in the research and practice of geological theories and technical methods such as geology of unconventional oil& gas, lithological hydrocarbon reservoirs and major oil& gas provinces. He has published more than 100 technical papers in journals such as " Earth-Science Reviews " and " Scientific Reports " etc, 6 monographs such as "Unconventional Hydrocarbon Geology" and "Hydrocarbon Geology of Volcanic Rocks "in both English and Chinese. He has won one 1st prize of National Science and Technology Progress and a dozen more with provincial level.



ABSTRACT

PetroChina Southwest Shale Gas E&D Status

CHEN Gengsheng

Sichuan Basin abounds in shale gas, with expansive Silurian Longmaxi formation and Cambrian Qiongzhusi formation, both marine phase and of consistent depths. The Longmaxi formation features favorable shale qualities promising development potentials, and southern part of the basin boasts a favorable development area.

Shale gas exploration development in Sichuan Basin has had to start from a scratch, facing a series of challenges, including complex preservation conditions, high evolution degree, huge burial depth, hilly and mountainous terrains, environmental sensitivity and etc.

In 2007, the company initiated shale gas resource evaluation activities. In 2009, Wei201, the first shale gas appraisal well in China, was drilled. PCSW has since made many achievements: it drew on years of experiences, defined the volume in place, and identified 3 shale gas-rich areas, i.e. Changning, Weiyuan and Fushun-Yongchuan; Targets for Wells Ning201, Wei202 and Wei204 to be put into production have been set; Six methods and technologies for shale gas development and boosting production rates through geology and engineering measures integration have been successfully developed; A pattern encompassing well pad deployment, workshop drilling, surface construction using skids, outsourced engineering services and digital production management has been established for efficient exploration and development; An innovative mechanism for joint development and a safe and environmental development operation system have been developed. All these achievements have promoted the shale gas E&D in Sichuan Basin. So far 145 wells have been drilled, and 91 wells fractured. Export pipelines for Changning and Weiyuan blocks and supporting facilities for an annual production of 2 bcm have been put into place. Cumulatively PCSW has produced 2.233 bcm of shale gas, marking the preliminary realization of scale and efficient shale gas development, and successful accomplishment of the construction tasks of the Changning-Weiyuan State-level Shale Gas Pilot Area.

Looking ahead, PCSW will target its development activities at the shale gas zones less than 3,500m deep in Longmaxi formation, and meantime use its reasonable endeavor to develop supporting technologies to make possible the development of shale gas zones more than 3,500m deep, to ensure steady and consistent shale gas development.

SPEAKER PROFILE



CHEN Gengsheng

Chief Shale Gas E&D Expert

PetroChina Southwest Oil & Gas Field Company



Deputy Chief Geologist and Chief Shale Gas E&D Expert of PetroChina Southwest Oil & Gas Field Company from 2007, principally involved in shale gas E&D and international cooperation management.

Professorate Senior Engineer, B.S. from the Department of Geology, Southwest Petroleum University in 1983; Ph. D. from the Department of Mineral Prospecting and Exploration, Southwest Petroleum University in 2005.

Former Chief Geologist of Exploration Company, Sichuan Petroleum Administration;
Former Venture Exploration Manager in KumuxBasin and southern margin of JunggarBasin;
From 1998, Deputy Chief Geologist and Director of Exploration Department of Southwest Oil and GasfieldCompany, responsible forexploration activities in Sichuan Basin and venture exploration, joint evaluation and study, and international cooperation management in several other basins (blocks).

Currently mainly engaged in the shale gas E&D technology management and research.



ABSTRACT

Unconventional Resource Development in ExxonMobil

Rick POWELL, Tim TYRRELL

ExxonMobil is active in the major unconventional resource plays in United States through its 100% owned affiliate, XTO Energy Inc. This large scale activity, covering all unconventional resource types, has made ExxonMobil the largest unconventional producer in the USA.

A major contributing factor to this success is the relentless pursuit of both cost reduction and well productivity improvements. When measured over a recent 5 year period, the result has generally been a >50% reduction in drilling days, a 50% increase in oil well productivity, and > 50% reduction in oil development cost per OEB. In particular, this has also yielded a tripling of the onshore liquids production from the Bakken, Permian, and Ardmore plays in the last 5 years.

Key drivers of XTO's success are: an organization focused on learning how to achieve optimized drilling, completions, and pad development; a rapid, flexible response to the changing cost/price environment; the utilization of proprietary technology; and an agile organization with the ability to act quickly and responsibly while maintaining the focus on results.

SPEAKER PROFILE

Rick POWELL

**President
ExxonMobil China Upstream Limited**



Mr. Powell has been an employee of ExxonMobil for over 35 years and is currently President of ExxonMobil China Upstream Limited. Throughout his career, he has held a variety of managerial positions in exploration, production, development, and operations. Initial assignments in exploration, development, and production geoscience focused on the onshore and offshore United States.

In 1991, Mr. Powell began a series of international leadership assignments for ExxonMobil, including management of exploration activities in the North Sea, the Far East (including China in the 1990s), and global new opportunities after the ExxonMobil merger. In 2003, he became Project Manager for Russia / Caspian / Middle East development, which included major field development projects in Russia (Sakhalin 1), the North and South Caspian, and Qatar. Mr. Powell returned to exploration in 2007 as Arctic Project Manager and became ExxonMobil Unconventional Resources Project Manager in 2009. In late 2010, Mr. Powell moved to Beijing where he remained until early 2015.

Born in 1957 in the United States, Mr. Powell received a Master of Science in Geology from the University of North Carolina at Chapel Hill in 1981.



ABSTRACT

The Progress of Fuling Shale Gas Exploration and Development, SINOPEC

CAI Xunyu , ZHOU Dehua

SINOPEC launched its extensive shale gas exploration in 2009. The key exploration area was transferred from marine facies in south China to Sichuan Basin and its peripheral areas. In 2012, southeast of Sichuan Basin saw a great breakthrough in the lower Silurian shale, and the first large-scale shale gas field, Fuling shale gas field, was successfully discovered. Fuling shale gas development tests began in 2013, after three years construction, Chongqing Fuling National Shale Gas Demonstration Reservoir achieved an annual shale gas production up to 5 billion m³, which marks Fuling shale gas field has realized its commercial production.

Success obtained in Fuling shale gas field has greatly promoted the theory and technology development of marine shale gas exploration and production. Key issues achieved also include: establishing a replicable and propagable “Well Factory” shale gas development model, creating a proper industrialized mode for shale gas effective development and construction, achieving the domestication of critical technology and equipment, and realizing a safe and green shale gas development. Furthermore, SINOPEC has been taking an active role in fulfilling its social responsibility, and a win-win model was created in order to better cooperate with local government and serve for local people. Fuling shale gas development has wide-ranging impacts on adjusting and optimizing China’s energy structure, its social benefits is emerging gradually.

Construction of second annual 5 billion m³ shale gas production in Fuling is underway. SINOPEC will well-manage the first stage, well-construct the second stage and prepare for the third stage, follow the “deploy as a whole, implement by steps, integrate evaluation and construction, optimize and adjust” principle and “high level, high speed, high quality and high efficiency” standard, aiming to build a green, profitable, exemplary, harmony and humane shale gas field.

SPEAKER PROFILE

CAI Xunyu

Deputy Director

Oilfield Exploration & Development Dept., Sinopec



Cai Xunyu is Deputy Director of Oilfield Exploration & Development Department, and mainly responsible for oil and gas resource exploration, Sinopec. He was appointed to the position in June, 2016.

He has a professor level senior engineer. He graduated from Chengdu University of Technology with a major in petroleum geology in 1985, and holded a Doctor' degree from Chengdu University of Technology in 2005.

Prior to his current role, Cai Xunyu served as Director of Exploration Division in Oilfield Exploration & Production Department, and responsible for Conventional oil and gas resource exploration. Before that he was mainly engaging in oil and gas exploration research in Southern exploration company of Sinopec.

He mainly engaged in hydrocarbon exploration research and management.



ABSTRACT



The Current State of Unconventional Oil & Gas from International and Cost Perspectives

Robert LIOU

What is the current status of the unconventional plays throughout the United States and the rest of the world? What kind of economic returns do they provide? Broadly, what does the future of unconventional resources look like from a cost perspective?

SPEAKER PROFILE

Robert LIOU

Associate Director

Upstream Research, IHS Energy



Robert Liou, Associate Director for China Upstream, is a member of the IHS Energy team in Beijing and focuses on the equipment and services markets for China upstream oilfield services. He is the lead researcher for Pumping IQ China (now China IQ), which is the premier research report monitoring hydraulic fracturing, drilling, and completion trends in the China market. Mr. Liou was previously the China Country Manager at PacWest Consulting Partners, which was acquired by IHS in late 2014. Before joining PacWest, he was the Chief Financial Officer of Shengli Oilfield Victory Software, a former subdivision of Sinopec, Shandong province. Prior to that, Mr. Liou served as a Certified Public Accountant with Deloitte and Touche for a number of years and later the Head of Internal Audit with the Asia Foundation. Mr. Liou holds a bachelor's degree from the University of California, Los Angeles, and an MBA from the University of Michigan, where he focused on energy studies.



ABSTRACT

In-situ Upgrading Process (IUP) and In-situ Conversion Process (ICP) Technology

J. M. KARANIKAS , Weijian MO

Massive concentrations of hydrocarbons exist in the form of oil shales, heavier oils and liquids-rich shales. Commercial development of these unconventional resources is hindered by two fundamental technical barriers that limit production rates and ultimate recovery: lack of mobility due to either the high viscosity of the oil in place or the tight permeability of the rock and insufficient reservoir drive, often due to low content of dissolved gas.

Shell has developed technologies to boost the recovery factor from unconventional resources by injecting heat in the subsurface to thermally crack molecules of heavy oil – In-situ Upgrading Process (IUP) technology – and to accelerate the maturation of kerogen – In-situ Conversion Process (ICP) technology. Raising the temperature of the entire reservoir to the oil pyrolysis temperatures increases the reservoir drive due to the generation of pressure by pyrolysis products, especially gas. Moreover, IUP and ICP are less sensitive to reservoir heterogeneities such as fractures and thin, shaley barriers to flow.

ICP is particularly suitable for tight-oil sands underlain by kerogen-rich shales that are been produced by hydraulic fracturing as is the case in the Ordos basin in China. ICP can significantly increase oil recovery by sweeping the sand layer with ICP gas generated in the underlying shale while making use of the existing infrastructure in order to reduce the cost of the development.

The IUP/ICP technologies have been tested in field experiments and pilots in the USA and Canada where they have achieved recovery factors of close to 70%, while raising the API gravity of the produced oil to >30°API from the 6-8°API of the oil initially in place. Results from the pilot conducted in the heavy-oil formation of Peace River (Alberta, Canada) will be presented.

SPEAKER PROFILE



John. M. KARANIKAS

**Chief Scientist for Reservoir Engineering
Royal Dutch Shell**



J. M. KARANIKAS is Chief Scientist for Reservoir Engineering at Royal Dutch Shell. He has been with the company for more than 25 years. His interests center on the development of advanced thermal recovery methods for unconventional resources, including the development of models for reservoir performance and geomechanics. He holds a Ph.D. degree in physics from The Ohio State University as well as over 80 patents.



ABSTRACT

Practice and Development of Innovation to Drive Cost-saving and Profit-Increasing

LI Guoshun

CNPC Technical Service Company is a state-owned oilfield service company integrated engineering and technical service. Business scope includes geophysical prospecting, drilling, mud logging, wireline logging and downhole service, etc. CNPC Technical Service Company always focuses on cost-saving and profit-increasing, and provides high quality service to CNPC Exploration and Production section and other domestic and overseas oil & gas company. CNPC Technical Service Company and its subsidiary company gain operation experience of unconventional oil & gas such as shale gas, CBM, tight gas etc. In low price, Oilfield Service Company should enhance cooperation with Oil Company, and carry out cost-saving and profit-increasing further and improve development efficiency of unconventional oil & gas by management innovation and technology innovation

Challenges:

1. Current equipment and instrument of CNPC technical service company are suitable for exploration and production of conventional oil and gas. In order to make current equipment and instrument to meet the requirement of conventional oil & gas, further abundant modification need to be done to low the operation cost and improve Efficiency.
 2. Horizontal drilling + massive fracturing are general technology to develop unconventional oil & gas. CNPC technical Service Company has done many cases and summary a complete set of technologies, some of these technologies need be optimized, some key tools need manufactured domestically to low the cost.
 3. General speaking, the workload of unconventional oil & gas development should be carried out by batch or as a whole. CNPC Technical Service Company discover an execution pattern of factory drilling and fracturing which need further improvement.
- CNPC Technical Service Company continue doing management innovation and technology innovation, promote EPC and cooperative development in business pattern, factory drilling and fracturing in execution pattern, integration of geology and drilling in technology pattern, earn valuable experience and series of achievement.

ABSTRACT

Implement management innovation, take the advantage of complete technical service chain, rich experience in operation management of well production construction and execution, and expand production construction EPC model, area EPC model, block EPC model and lump sum model.

Take Block Chang 7 as an example, Chuanqing Drilling Company introduce suitable and matured technology by mean of EPC, allocating resource optimally, taking advantage of integrated management. Achieve decreasing the production construction period, making oilfield produce early, improving contribution rate and decreasing construction cost.

Use the advantage of integration and profession, choose and optimize suitable technology, keep on simplifying well structure and improving drilling speed, operate horizontal well, snubbing service, improve construction speed and single well production volume, decrease the material consumption and waste discharge during well construction, to achieve cost-saving and profit-increasing. Bohai Drilling Company introduce aerated UBD and reaming operation in horizontal section to improve production. Chuanqing Drilling Company introduce High-Performance WBM, Big Diameter Bridge Plug + dissolvable ball stage fracturing technology etc. to decrease the difficulty of waste treatment, improve operation efficiency, low the cost.

Implement cooperative EPC model in low quality oilfield, for example, Chuanqing Drilling Company and Greatwall Drilling Company are operating in Chuanyu region and Sulige gas field. Expand engineering chain in exploration and production, use advanced technology and optimal production technology to find out a new model to develop low quality, difficult-to-produce unconventional oil & gas reservoir, share production risk with oil company and earn extra profit by production sharing, by using above mentioned method, decrease the investment risk of oil company, and increase technology capability of service company.

CNPC Technical Service Company will follow the strategy positioning of “management & technology type enterprise”, implement “6 realizations and measures”, and conduct management innovation, technology innovation. CNPC Technical Service Company will face the challenge the impact of low oil price to realize the profit-increasing and make ongoing progress.



SPEAKER PROFILE

LI Guoshun
Vice President
CNPC Technical Service Company



Mr. Li Guoshun is responsible for technology support of oilfield service, HSE, well control, and operation management since He was appointed as Vice President of Technical Service Company of CNPC in December, 2015.

Prior to his current role, Mr. Li Guoshun was Vice Chief Engineer&Director of Drilling Engineering Dept. of Technical Service Company. He previously held several key position in Technology & Marketing Department of CNPC and Technical Service Company of CNPC, such as head of Well Control Dept. and Drilling Engineering Dept.

Mr. Li Guoshun earned a Bachelor of Drilling Engineering in University of Petroleum China in 1983 and an MBA in University of South Alabama in 2006.

ABSTRACT

Lowering Total Cost Through Geo-engineering

Axel DESTREMAU

Geo-engineering is a Schlumberger integrated workflow that link rock & fluid characterization at the centre of the system with drilling systems, completion systems and production systems. All of the building blocks are interlinked and constantly refined in realtime through iterative process to achieve optimized systems.

It begins with the understanding of rock & fluid properties such as matrix permeability, natural fractures, pore pressure, Total Organic Content (TOC), and geomechanics attributes. The knowledge is used to engineer the well by selecting the best well location, developing optimize well path and staying within the sweet spots. During drilling execution, most efficient drilling system is selected to reduce total drilling time hence drilling cost. In addition, data acquired in realtime is compared with the pre-drill knowledge and used to adjust well path for best reservoir contact. Post-drilling logging information is used to further optimize the completion system, which has the attributes of effective design and simple stimulation operation. Effective stimulation design followed by an optimized flowback process will ensure best production is achieved.

Geo-engineering workflow is created to reduce the total cost per barrel equivalent (BOE) by integrated the workflow outlined above with fit purpose technologies such as Archer Rotary Steerable System for effective well trajectory, near bit GR or GVR for best well placement, thru-bit logging tools for post-drilling petrophysical evaluation, full bore dissolvable Infinity for efficient completion system and Broadband Sequence for optimized hydraulic fracturing. On average, the implementation bring cost saving in the order of 15-20 % and production increase in excess of 20% when compared to neighboring pads drilled and completed conventionally. Use of this workflow is now widely implemented in US land, Argentina, Saudi and recently in China.

Recently, a Geo-engineered project was implemented in a CBM field in central China using some of the key technologies mentioned above, which was Broadband Sequence hydraulic fracturing and Infinity completion system.



SPEAKER PROFILE

Axel DESTREMAU
CHG Geomarket Manager
Schlumberger



Mr. Destremau is Geomarket Manager of Schlumberger North Asia, responsible for China, Japan, Korea and Taiwan business units. He was appointed to the position in January, 2015.

Prior to his current role, Axel served as Vice President of Completions in Dubai, UAE covering the Middle East operations and in Rio de Janeiro, Brazil covering the Latin America operations. Before that he was Vice president for Sand Management Services and Marketing Manager for Completions in Houston, TX, covering worldwide operations. Previously, he was operations manager for Completions, Testing and Artificial Lift services in Nigeria and Angola.

Before joining Schlumberger in 2001, he worked for TOTAL as a reservoir engineer and later as completion and well performance engineer in France, UAE and Venezuela.

He holds a Masters' degree in Mechanical Engineering from Oregon State University in US and a Masters' degree in Aerospace Engineering from Ecole Nationale Supérieure de Mécanique et d'Aéronautique in France.

ABSTRACT

Technical Challenges and Solutions for China's Tight Oil

LIU he

In recent years, tight oil has attracted people's great attention and has become a new favorite in the unconventional oil and gas industry after shale gas. The appearance of tight oil changed the mind of oil exploration, and brought new hopes to the global oil industry. The geological conditions of tight oil in China are quite different from that in North America in terms of pressure coefficient, oil-bearing ability, and natural micro fractures. The mature engineering technology is not fully applicable to the development of tight oil in China so far. At present, we mainly faces five major challenges, including horizontal well drilling and completion, horizontal well reconstruction, 'Factory' operation, enhancing oil recovery of tight oil horizontal wells, and engineering technology management mode.

This manuscript systematically explains the key to solving the challenges of tight oil engineering technology, proposes to solve problems by adhering to the optimization concept of integrating geological reservoir and engineering in China. In the aspect of engineering management, the oil-gas field development working process has been designed as a continuous and complete life cycle from earthquake to drilling, reservoir engineering, production engineering, and ground engineering. In the aspect of technological development, the bottleneck of engineering technology has been broken by taking 'efficient, safe, green' as the core concept. In recent years, the China petroleum industry has created a series of design methods and management models for the development of tight oil, based on intensive integrated optimization platform for construction of reservoir and engineering, intensive high efficiency drilling and completion engineering technology, technology of integral oil reservoir reconstruction to increasing production and oil recovery of single well, technology of energy supplement and technology of high efficiency lifting and gathering injection process, then created a multi-disciplinary, cross-department, seamless integration-cooperation innovative environment, which have achieved multiplied effects and continuous integration of innovation. This manuscript also puts forward suggestions on the development of tight oil engineering in the aspects of management mode, technology innovation direction and so on.



SPEAKER PROFILE

LIU He

**Deputy Chief Engineer, Research
Institute of Petroleum Exploration and
Development, CNPC**



Dr. Liu has worked in petroleum industry for 35 years. Now he is the Deputy Chief Engineer, Professorate Senior Engineer at Research Institute of Petroleum Exploration & Development, CNPC. He has spent most of his career in research on oil and gas exploration and production engineering. He has made significant contributions to several areas, such as layered water injection and wellbore control technique, casing damage prevention and repair technique, stimulation and modification technique in low permeability reservoir. As an inventor, he has been granted 25 invention patents. He received Regional Awards with Distinguished Service Award in 2005, Production Engineering Award in 2007 and Distinguished Member Award in 2012 from Society of Petroleum Engineers.

ABSTRACT

The Best Practice of Intensive Production for Unconventional Reservoirs in Jilin Oilfield-Case Study

WANG Feng

At present, the poor quality has become the common problem in China's petroleum development. The subject of exploration and development has moved from conventional low-permeability reservoirs to extra low-permeability and tight reservoirs. This problem is particularly prominent in Jilin Oilfield and more than 80% of unused reserves are extra low-permeability oil reservoirs. In recent years, under the pressure of low oil price and low resource quality, conventional deliverability construction mode is not effective any more to achieve the goal of reducing investment and operation cost. It is more difficult to realize the benefits of production and construction. The fact that production capacity dropped dramatically seriously influences the oil field development. To face the challenges of achieving effective and intensive production of oil and gas resources with low quality, based on the successful experience of unconventional concepts and technologies in the development of tight oil and gas in North America, we proposed the strategy of "raise production and recovery rate, reduce investment and costs". Based on paramilitary field tests of conventional low-permeability reservoir in Block III in Jilin Oilfield, we have formed and realized a series of unconventional technologies, such as the mode of production well clusters, integrated optimization of geology and engineering, volume reconstruction of reservoirs, unconventional energy supplement, factory operations, etc. Compared with the conventional construction mode of production, new technologies has achieved remarkable results and realized the goal of high yield. In addition to the success of the conventional low-permeability reservoirs, the new construction mode is proposed and applied in the development of tight oil reservoir in Jilin Oilfield, such as Block Rang29 and Block Qian246. Practices show that based on the understanding of low-permeability reservoir potential and technology system, unconventional approaches and techniques including implementation of intensive construction of wells and geological engineering integration are necessary choice to realize large scale and efficient production at present and in the future.



SPEAKER PROFILE

WANG Feng

Vice President

Jilin Oilfield Company, PetroChina



WANG Feng was graduated from Southwest Petroleum Institute in July 1989. He is the professorate senior engineer, deputy chief manager of Jilin Oilfield Company, one of CNPC's first senior technical experts.

He has been engaged in low-permeability reservoir fracturing, CO₂ oil displacement and other key technologies and applications. He won 10 awards on provincial and ministerial level, was awarded by the State Council Special Government Subsidies and won the award of Sun Yueqi Youth Science and Technology. He owns 9 national patents and published 15 papers and one monograph.

ABSTRACT

Progress in Coalbed Methane Exploration & Development Techniques and Geological Research in China

SONG Yan

The exploration of Coalbed methane (CBM) in China began in early 1990s. Based on the succeed experiences of the CBM development in the US, petroleum, mining and coal companies in China initiate the exploration and development test of CBM. Two CBM industrial development zone have been completed in the southern QinshuiBasin and the eastern OrdosBasin. By 2014, the proven reserves of CBM are of 626.6 billion cubic meters, the wells are more than 15000, including 11131 production wells. A yield construction of 4.5 billion cubic meters has been completed. A yield construction of 6 billion cubic meters are ongoing, finally, a commercial yield of 3.7 billion cubic meters has been achieved.

With the supports of the national 973 projects, the national major projects and energy companies, great progress in the CBM geological research in China has been made in recent years. Major findings about high rank CBM, such as CBM occurrence (absorbed gas or free gas) evolution with burial history, three major controls on CBM accumulation and geological models of high yield CBM, have been discovered.

The suitable processes and techniques for CBM development in China are continuous improved. such as: CBM well type, well pattern optimization technique, the well completion and phase pressure control, etc.

The challenges of CBM industry in China include complex geological conditions, difficult development geological backgrounds and low single well production. The future development directions are: firstly, improve techniques to increase single well production of high rank CBM; Secondly, enhance low-middle rank CBM development to found substitute fields; Thirdly, perform spatial exploration and development of CBM to improve efficiency.



SPEAKER PROFILE

SONG Yan

**Dean of Unconventional Gas Research Institute
China University of Petroleum-Beijing**



Dr. Song is Dean of the unconventional gas research institute, China university of petroleum, Beijing. She is conducting unconventional oil and gas exploration and development research. She was appointed to the position in January, 2013.

Prior to her current position, She has 30 years of work experiences in research institute of petroleum exploration and development and is the senior professor of CNPC. She is the chief scientist of two coal-bed methane projects of Major State Basic Research Development Program of China (973 Program), the subject expert in resource and environment field of National High Technology Research and Development Program of China (863 Program), the principal organizer and project leader of Natural Gas National Key Technologies Research and the 8th, 9th, 10th national key projects of natural gas. She has dedicated to natural gas geology and oil and gas accumulation research and has achieved systematic and innovate products in the aspects of Coal-bed methane accumulation, natural gas accumulation and hydrocarbon accumulation theory in foreland Basin.

She received her bachelor' Degree in China university of petroleum, Qingdao, and received her PhD degree in Guiyang geochemistry institute of Chinese Academy of Sciences.



The Future of Oil Sands Producers: A Road to Low Cost and Green Development

NIE Changmou , Brad KEARL, CHANG Guangfa , Jordan WIESS

In the past 20 years, the oil sands have been developing, supported by high crude prices and have emerged as a significant global hydrocarbon resource. In 2015, bitumen production rate accounted for 60% of total crude production in Canada. The drop in oil prices, from over \$110 in 2014 to below \$30 in 2016, places acute pressure on Canada's oil sands. The oil sands producers are facing unprecedented survival crisis.

The current challenges for oil sands industry are lower and longer crude price, high cost, high GHG emission, strong social license resistance, strict government legislations, new emerging competition of light tight oil and pipelines constraint. The supply cost is around C\$60/bbl for a SAGD project; reducing costs and devising more environmentally friendly means of development is only option for sustainable development of oil sands in Canada.

New investments in oil sands mining projects have been constrained by the current oil price. In Situ recovery technologies such as SAGD, which commenced its first commercial production in 2002, will be the main recovery method for continued oil sands recovery for many years into the future as the most recent operating costs of Christina Lake, Tucker and some other projects are lower than C\$10/bbl. Lowering costs will depend on the continuous improvement and breakthrough of the SAGD technology. There has been unceasing research and development into new methods and technologies such as Infill development, Non-condensable Gas Co-injection and Steam with Solvent Co-Injection which have all achieved enhanced commercial production for Suncor, ConocoPhillips and many others. In-situ Upgrading Process (IUP), ESEIEH and NSOLV are newer developments that have been trialed on pilot projects of Shell, Suncor and a few other companies and have proven encouraging results. All these new technologies are targeting lower cost and lower GHG emissions.

Since 2010 PetroChina in Canada, Brion Energy, has acquired substantial oil sands resources, approximately 5 billion barrels in place with bitumen production potential of over 400,000 bbl/day of commercial plans approved by the government; startup with first steam will take place in MacKay River Phase 1 SAGD project in Dec. 2016. Brion Energy Corporation is developing new technologies and striving to become a responsible and sustainable oil sands producer.



SPEAKER PROFILE

NIE Changmou
Operations Director
Brion Energy Corp./PetroChina



Mr. Nie is the Operations Director of Brion Energy Corp., responsible for operations of oil sands assets, unconventional gas and oil assets of CNPC in Canada. He was appointed to the position in Dec., 2014.

Prior to his current role, Changmou served as the Deputy Director of Development at CNODC, mainly managing the operation and production of overseas oil and gas projects of CNPC. He has been employed by CNPC/CNODC since November of 2002 and has worked on various onshore and offshore projects in Africa, Middle East and North America.

Before joining CNODC, he worked for Sinopec as a geologist and later as the Director of Oilfield Development in Zhongyuan Oilfield, China.

He holds a Masters' degree and a PhD. in Geoscience from China University of Geoscience in Beijing.

ABSTRACT

Development Practices of Tight Oil and Gas Reservoirs in Ordos Basin

HAN Xinggang

The Ordos Basin, located in northern China, is rich in oil and gas resources. The latest resource investigation reveals that approximately 12.85 billion tons oil and 15.16 trillion cubic meters natural gas have been stored in Ordos Basin. About 80% and 60% of total resource comes from tight oil and gas sandstone reservoirs respectively. The effective development method for tight oil and gas reservoirs provides great support for achieving annual productivity of 50 million tons oil equivalent in Changqing Oilfield Company.

The tight reservoir in Ordos Basin has the characteristics of low formation permeability, low pressure, low abundance and high heterogeneity. The average permeability is merely 0.01-0.1mD and pressure coefficient is 0.7-0.98. Geological studies show the effective reservoir has poor continuity and connectivity. Average 2-3 pay zones can be drilled through in single well. Thickness of each pay zone is about 5 -20m. The reservoir has low abundance which is as little as $1.1-1.4 \times 10^8 \text{m}^3/\text{km}^2$ and $15-45 \times 10^4 \text{t}/\text{km}^2$ in gas and oil reservoir respectively. Low per-well productivity, low estimated ultimate recovery (EUR), making it more challenging to develop those tight reservoirs in the Ordos basin.

A series of assembly researches and field trials have been carried out in view of its low productivity, sharp decline of formation pressure and high development cost. In order to increase per-well productivity, several stimulation techniques have been developed, such as hydra-jetting fracturing for horizontal wells. In order to enhance tight oil and gas recovery, advanced water injection technique and well pattern optimization technique have been applied. Furthermore, the digitization management platform and well factory approach have been widely used to cut down development cost.

The Sulige Gas Field is a typical tight sandstone gas reservoir in Ordos Basin. Twelve main technologies have been developed which improves the annual gas production from 1.8 billion cubic meters in 2007 to 23.7 billion cubic meters in 2015.

Four major categories with 30 matching technologies have been applied to develop the typical tight oil reservoir Chang-6 reservoir in Huaqing oilfield in Ordos Basin. The tight oil production have been increased from 10 thousand tons in 2005 to 780 thousand tons in 2015.

While the collapse in oil price, an emphasis on technology innovation to further increase EOR and extend well production life will be crucial to the sustainable development of tight reservoir.



SPEAKER PROFILE

HAN Xinggang

Deputy Director

**Research Center of Sulige Gas Field,
Changqing Oil & Gas Field Company, PetroChina**



Mr. Han Xinggang was appointed Deputy Director of Sulige Gas Field Research Center, one of research organizations in PetroChina Changqing Oilfield Company, in 2008. He holds responsibility for the gas field development planning.

Han Xinggang is senior engineer. He got his BS degree in Reservoir Engineering from Southwest Petroleum Institute, and an MA degree in Oil & Gas Field Development Engineering from Xi'an Petroleum University.

Han Xinggang joined PetroChina Changqing Oilfield Company in 1992. He undertook a series of positions in Changqing Oilfield Company. From 1992 to 2005, he worked as a reservoir engineer in Exploration and Development Research Institute, and later as Section Chief of Gas Field Development Department. Prior to his current role, he served as Assistant Production Manager in the Third Natural Gas Plant.

During his 25 years at the firm he has focused on reservoir engineering, and has worked in tight gas production technology.



LOW-COST DEVELOPMENT OF UNCONVENTIONALS
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