Highlights of G3DEM CBM Enhance Production Technology

(Peter (Yongpei) Wei, PhD, P.Geol.) - Sep 21, 2013

- Overview CBM Production
- Geology & Reservoir Engineering
- Design
- Drilling and completion
- Dewater
- Economic Evaluation
- Management
Overview CBM Production

Even under the similar geological condition at the same sedimentary basin, CBM production varied greatly from well to well or from location to location. Some wells have good production, while others even did not have the production. G3DEM Technology can give the right answer regarding such issue.

- Excellent Production
- Good Production
- Fair Production
- No Production

Why?
Overview CBM Production

Compare two unique countries

• Canada
• China

Canada: Dry coal seam. Do not need to dewater after the completion of drilling. Gas flow automatically as soon the completion of drilling.

China: Wet coal seam. It would take a long time to dewater after the completion of drilling no matter what kinds of well drilled

Big difference!
Overview CBM Production

CBM situation in China

History
- Some international companies gave up CBM projects due to no commercial production at the very beginning
- Upside and downside several times

Current situation
- Good result for some operators
- Development Technology tend to be mature
- Problems still existing for production and economical value for wells drilled
- Exploration and Production Technology need to be organized to maximum the production
- Standard method need to be authorized
Geology & Reservoir Engineering

- Thickness
- Depth
- Structure
- Dip Angle
- Coal Rank
- Reservoir pressure
- Gas Saturation or Gas Contents
- Water Saturation
- Porosity
- Permeability
Design

Well Types
- Vertical Wells
- Deviated wells
- Horizontal wells

Well Space
- The distance in one pilot wells between each vertical wells
- The distance between each laterals for horizontal wells

Minimum wells need to be drilled in each pilot wells
- Vertical wells
- Horizontal wells

Horizontal wells
- Single Laterals(Up dip or down dip)
- Multi laterals (up dip or down dip)
- Whether need to intersect between two wells
- Whether liners needed
- What kinds of liners needed(steel or polymer)
- Advantage and disadvantage of steel and polymer liner

G3DEM-CBM Enhance Production Technology
Different Well Types

Single V-test well
Three Pilot V-wells
Five Pilot V-wells
Nine Pilot V-wells
Thirteen Pilot V-wells (Block location is observation wells)

Multi Laterals
Single Lateral
Single to Triple lateral to intersect with V-Well

H-Well
V-Well

Updip
Lateral
Horizontal or downdip

How much教导 - Steel or Polymer
What kind of liner needed to be set
Updip-?
Lateral
Down dip-?
Lateral

H-Well
V-Well

Which one will be the best?
Key Issue of Design

- Surface topography
- Subsurface Geology
- Dip Angle of Formation
- Porosity & Permeability
- Well Types
- Well Spaces

Basic Principles

- Economy
- Maximum production
- Super combination between surface and subsurface geology
Two Key Issues For Design

• Well Types
• Well space

Does software can solve such problems completely?

It depends on detail analysis of specific region and production test and super Combination with all the controlling factors from the professional team’s hard work.
Drilling and Completion

- Actual drilling and the design
- Horizontal formation
- Wavy Formation
- Main hole size
- Fracture
- Casing or open hole
- Liner types: Steel or Polymer
Horizontal drilling in Flat Formation

The Comparison between the design and actual drilling - Case one
Horizontal drilling in Wavy Formation

The Comparison between the design and actual drilling - Case Two
The factors of missing seam while drilling in seam

- Wrong judgement
- Horizontal Formation with wavy trajectory
- Wavy Formation with horizontal drilling
- Poor and less controlling well data
- Formation issue
Dewater

- How many wells drilled within one pilot area
- What kinds of wells drilled
- Well Space
- The completing method of wells
- All above factors will affect the Dewater time and production accordingly
Economic Evaluation

- Economy evaluation for all wells drilled
- The economic value for different types of wells
- The economic value for the space of wells within one pilot well
- Performance of production wells on the yearly basis
- Well types and well space should be updated after the analysis of all the wells drilled
- Well types and well space will be viewed regularly
Reserve and Resource Classification

Fig 2-1- Reserve and Resource Classification Framework (From Page 7 at PRMS guidelines, Nov, 2011)
Evaluation

- Current production
- Proved Developed Producing Reserve
- Potential value
### Economic Evaluation

**Reserves and Revenue Estimation**

<table>
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<tr>
<th>Period</th>
<th>Gross Production</th>
<th>Net Production</th>
<th>Average Price</th>
<th>Company Revenue</th>
<th>Royalty Deduced</th>
<th>Capital Expensed</th>
<th>Cost Summary</th>
<th>Total</th>
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**Economic Index Summary**

- Net Present Value (Discounted): $X
- Economic Index: 
  - Inception NPV: $Y
  - After-tax NPV: $Z

**Exploration and Development Plan**

- Drilling plan: 
  - Year: X
  - Gross Production: Y
  - BRLPDC: Z

**G3DEM-CBM Enhanced Production Technology**

- MicroPlus Petroleum Consulting Inc.
# Evaluation Summary

## Table A Summary of reserve estimation, as of Dec 31, 2012

<table>
<thead>
<tr>
<th>Category</th>
<th>Net Reserve</th>
<th>Future Net Revenue(M$)</th>
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<td>Oil, MBBL</td>
<td>Gas, MMCF</td>
<td>Total</td>
<td>NPV 10%</td>
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<td>Proved Developed Producing</td>
<td>667.1</td>
<td>1250.7</td>
<td>43,666.9</td>
<td>25,197.9</td>
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<td>Proved Developed non-Producing</td>
<td>333.5</td>
<td>625.4</td>
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<td>Proved Undeveloped</td>
<td>1,558.9</td>
<td>2,935.5</td>
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<td>Total Proved(1P)</td>
<td>2,559.4</td>
<td>4,811.6</td>
<td>158,180.2</td>
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<td>Probable</td>
<td>4,091.7</td>
<td>7,733.2</td>
<td>248,672.2</td>
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<td>Proved + Probable(2P)</td>
<td>6,651.1</td>
<td>12,544.7</td>
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<td>Possible</td>
<td>4,247.6</td>
<td>8,005.4</td>
<td>246,573.6</td>
<td>91,030.6</td>
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<td>Proved + Probable+ Possible(3P)</td>
<td>10,898.7</td>
<td>20,550.1</td>
<td>653,426.0</td>
<td>276,783.3</td>
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</table>

- **Current production-PDP**
Management

• The management will make the final decision regarding the well location, well type and well space, drilling and operation even the technical work done by geologists and reservoir engineers.

• Well organized management which include Geologist, reservoir, drilling, production is always the key for the success for any projects.
What We Supplied

• CBM Geological Management
• Well types design
• Well location deployment
• Well space models
• Horizontal design
• Remote Geosteering in CBM
• Production diagnoses and forecast
• Reserve and resource estimation
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