The Depth Distribution of Chinese Coal Resource

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Introduction

- China is relatively abundant of coal, at the time-being, the depth of coal exploitation is about 400~500m, (in some special cases, it is 600m).
- Alongside with the increase of depth, exploitation cost, safety, etc. are very serious problems.
- Generally speaking, the coal seams with depth more than 1000~1500m are not suitable for exploitation. Because of the difference of absorb ability of CO$_2$ and CH$_4$, injection of CO$_2$ to replace CH$_4$ is a win-win strategy.
- From aspect of CO$_2$ sequestration, detailed survey, study and analysis of the deep unminable coal seams will be of significant importance.
**Chinese Coal Resource**

**Total Resource Amount**

5569.7 billion tons

- Reserves Proved up
  1017.6 billion tons

- Possessed Reserves
  1003.2 billion tons

- Exploitable Reserves
  114.5 billion tons

**Forecasted Resource**

4552.1 billion tons
The Depth Distribution of Chinese Coal Resource

Depth 1000 - 1500 m
1,340.38 Billion Tons

Depth 1500 - 2000 m
1,367.68 Billion Tons

Depth < 1000 m
1,844.05 Billion Tons

Chinese Forecasted Coal Reserves Distribution by Depth (4,552.1 Billion Tons)
**Chinese Forecasted Coal Reserves**

- **Shaanxi, Gansu, Ningxia, Qinghai and Xinjiang**: 2359.88 billion tons
- **Shanxi, Inner Mongolia and Hebei**: 1675.1 billion tons
- **Sichuan, Guizhou and Yunnan**: 263.86 billion tons
- **Other provinces**: 253.27 billion tons
Chinese Forecasted Coal Reserves Distribution by Depth

Chinese Forecasted Coal Reserves Distribution by Depth

i Hebei, Shanxi and Inner Mongolia
ii Anhui, Shandong and Henan
iii Sichuan, Guizhou and Yunnan
iv Shaanxi, Gansu, Ningxia, Qinghai and Xinjiang
Chinese Forecasted Coal Reserves (Depth<1000m)

Shaanxi, Gansu, Ningxia, Qinghai and Xinjiang 1174.21 billion tons

Shanxi, Inner Mongolia and Hebei 450.46 billion tons

Sichuan, Guizhou and Yunnan 157.68 billion tons

Other provinces 61.7 billion tons
Chinese Forecasted Coal Reserves (Depth within 1000m)

- Inner Mongolia
- Xinjiang
- Yunnan
- Qinghai
- Guizhou
- Sichuan
- Shanxi
- Ningxia
- Shaanxi
- Others
Shanxi, Inner Mongolia and Hebei 565.27 billion tons

Shaanxi, Gansu, Ningxia, Qinghai and Xinjiang 602.31 billion tons

Sichuan, Guizhou and Yunnan 69.32 billion tons

Other provinces 103.48 billion tons
Chinese Forecasted Coal Reserves (Depth 1000 - 1500m)
Chinese Forecasted Coal Reserves (Depth: 1500-2000m)

- Shanxi, Inner Mongolia and Hebei: 659.36 billion tons
- Shaanxi, Gansu, Ningxia, Qinghai and Xinjiang: 583.36 billion tons
- Sichuan, Guizhou and Yunnan: 36.82 billion tons
- Other provinces: 88.09 billion tons
Chinese Forecasted Coal Reserves (Depth 1500-2000m)
Number of Chinese Coal Mines

State-owned principal coal mines 736
Local state-owned coal mines 2176
Coal mines owned by villages and towns 24500
Number of American Strip Mines and Pithead Mines

<table>
<thead>
<tr>
<th>Year</th>
<th>Strip Mine</th>
<th>Pithead Mine</th>
</tr>
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<tbody>
<tr>
<td>1999</td>
<td>842</td>
<td>749</td>
</tr>
<tr>
<td>2002</td>
<td>1300</td>
<td>1100</td>
</tr>
</tbody>
</table>
Chinese Coal Mine Exploration Depth

- East China
- Northeast China
- Southwest China
- Middlesouth China
- North China

Average Depth 456m

The Biggest Vertical Depth 1300m
Reserves of American Strip Mines and Pithead Mines

EIA1999 (Unit: billion tons)
The Output of Main Coal Producers’ (Strip Mine and Pithead Mine)
Chinese Coal Output 1949-2004 (Unit: Million Tons)
The composition of coal output of China in 2004

- State-owned key coal mines: 47%
- Local state-owned coal mines: 15%
- Coal mines owned by villages and towns: 38%
Conclusion Remarks

- Exploitation of the coal with depth more than 1500~2000m is very difficult ---- increase of cost, unsafety, disaster gas blast.

- Injection of CO$_2$ into unminable coal seams is a win-win strategy ---- exploitation of huge amount of CH$_4$ and a nature reservoir of CO$_2$ storage.

- The unminable deep coal reserves is about 30% of the total, in average, absorbed CH$_4$ in coal is 10~20m$^3$/t.
  - The amount of CH$_4$ in deep coal seams which could be obtained by CO$_2$ injection is 13Tm$^3$ (37% of the total estimated reserves in China).
  - Theoretically, 2mols of CO$_2$ could “squeeze” out 1mol of CH$_4$.
  - The amount of CO$_2$ which could be stored in unminable deep coal seams is 30Gt (10 times of the CO$_2$ emitted in China annually).
Conclusion Remarks

- The areas of abundant unminable coal reserves are coincide with the areas of abundant minable coal reserves (with depth less than 1000m). It is easy to be arranged:
  - On-site exploitation
  - On-site transformation (power, liquid fuels, chemical...) via Polygeneration
  - On-site capture (sequestration)
  - On-site injection and sequestration (enhancement of CBM production)
Further Works

- Detailed survey and analysis of reserves of deep unminable coal seams, their distribution, the physical and chemical characteristic of the coal (permeability, contents of CBM, etc.)
- The absorb ability and desorb ability of CH$_4$ and CO$_2$ for diverse coal, the basic mechanism, establishment of mathematical model, experimental and simulation study
- The flow pattern of underground injected CO$_2$ and desorbed CH$_4$, the requirement of well-drilling and distribution, modeling and simulation
- Strengthen the international cooperation (Alberta Research Council, Canada and other institutions)