An Overview of the Chinese Programme on UCG

★ Li Yulan
★ Liang Xinxing
★ Liang Jie (Professor)

China University of Mining & Technology (Beijing) (CUMTB)
ucgrc@sohu.com
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closing
1 Introduction

★ Coal takes about 70% of the primary energy resource construction in China
★ The serious environmental pollution
★ About 50% of the coal resource is left underground unmined
★ Clean coal technologies are needed
★ Underground coal gasification (UCG) meets this demand
1 Introduction

The UCG Research Centre of CUMTB has carried out research since 1984:

- Shaft-UCG technology (no-shaft)
- CBM-UCG technology
- Producing H₂ technology by UCG
- Disposal method of CO₂
1 Introduction

★ Key studies

- Temperature field, Concentration field
- Heat Resistance
- Cavity growth
- Monitoring and controlling techniques
There are three functions:

(1) Simulate UCG process of different coal quality, coal seam obliquity, coal thickness and coal depth

(2) Test at different UCG parameters (two-direction blast, assistant-hole blast, pressing-in and absorbing-out)

(3) Test of different parameters of gasifier (blast, $O_2$ supplying and equipment for $H_2O_{(g)}$ generation)
Model rig of UCG (CUMTB)
enhance cooperation with all countries
schematic diagram of UCG principle

C + O₂ → CO₂ + Q
C + 1/2 O₂ → CO + Q
CO + 1/2 O₂ → CO₂ + Q

CO₂ + C → CO + Q
H₂O + C → H₂ + CO + Q
CO + H₂O → H₂ + CO₂ + Q
C + 2 H₂ → CH₂ + Q

Coal → CH₄

Reduction zone
Oxidation zone
Dry distillation zone
Gasification tunnel
Coal bed
Airflow tunnel
Assistant hole
Gas inlet
Gas outlet
Ash
## Table 1: Gas Component, Heat Value, and Production Rate

<table>
<thead>
<tr>
<th>Coal Kind</th>
<th>Gas Component</th>
<th>%</th>
<th>Gas Value</th>
<th>Production Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>H₂</td>
<td>CO</td>
<td>CH₄</td>
<td>CO₂</td>
</tr>
<tr>
<td>Lignite</td>
<td>36~45</td>
<td>20~30</td>
<td>1~5</td>
<td>25~35</td>
</tr>
<tr>
<td>Soft Coal</td>
<td>33~42</td>
<td>25~35</td>
<td>4~10</td>
<td>20~25</td>
</tr>
<tr>
<td>Hard Coal</td>
<td>35~45</td>
<td>25~35</td>
<td>2~8</td>
<td>25~30</td>
</tr>
</tbody>
</table>
2 UCG model test

★ Theoretical research work

1) temperature field, concentration field
2) velocity field, velocity of gasification reaction
3) extending rule of cavity
4) stability of UCG process
5) technology of measuring and controlling
6) CO$_2$ eliminating and CO transferring to generate H$_2$
Monitoring and controlling system
Temperature field at different time of model test
3 UCG field trial

The sketch of the “long-tunnel, large-section, two-stage” UCG
<table>
<thead>
<tr>
<th>Mine</th>
<th>Xinhe</th>
<th>Liuzhuang</th>
<th>Xinwen</th>
<th>Feicheng</th>
<th>Xiyang</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal kind</td>
<td>Fat coal</td>
<td>Gas coal</td>
<td>Gas coal</td>
<td>Fat coal</td>
<td>Anthracite</td>
</tr>
<tr>
<td>Depth, m</td>
<td>80</td>
<td>100</td>
<td>100</td>
<td>80-100</td>
<td>190</td>
</tr>
<tr>
<td>Thickness, m</td>
<td>3.5</td>
<td>2.5-3.5</td>
<td>1.8</td>
<td>1.3-1.8</td>
<td>6</td>
</tr>
<tr>
<td>Obliquity, °</td>
<td>68-75</td>
<td>45-55</td>
<td>25</td>
<td>5-13</td>
<td>22-27</td>
</tr>
<tr>
<td>Gas heat value, MJ/m³</td>
<td>11.83</td>
<td>12.24</td>
<td>5.21</td>
<td>5.09</td>
<td>11.91</td>
</tr>
<tr>
<td>H₂ %</td>
<td>58.29</td>
<td>47.14</td>
<td>54.79</td>
<td>17.4</td>
<td>54.30</td>
</tr>
<tr>
<td>CO %</td>
<td>8.59</td>
<td>13.36</td>
<td>9.72</td>
<td>3.83</td>
<td>4.10</td>
</tr>
<tr>
<td>CH₄ %</td>
<td>9.28</td>
<td>12.38</td>
<td>8.75</td>
<td>6.22</td>
<td>12.20</td>
</tr>
<tr>
<td>CO₂ %</td>
<td>19.63</td>
<td>20.48</td>
<td>20.75</td>
<td>22.9</td>
<td>20.20</td>
</tr>
<tr>
<td>N₂ %</td>
<td>4.21</td>
<td>6.64</td>
<td>5.21</td>
<td>49.5</td>
<td>9.10</td>
</tr>
</tbody>
</table>

Table 2  Status of UCG station
3 UCG field trial

★ UCG demonstration projects at Liuzhuang mine

- Structure of the gasifier
- Gas production and utilization
- Measuring the moving velocity of fire face
3.1 Structure of the gasifier

Liuzhuang UCG gasifier
3.2 Gas production and utilization

Gas composition of air gas
Gasification time/day

Heat value and gas flow of air gas
### 3.2 Gas production and utilization

**Table 3  Composition and heat value of water gas**

<table>
<thead>
<tr>
<th>H₂ (%)</th>
<th>CO (%)</th>
<th>CH₄ (%)</th>
<th>CO₂ (%)</th>
<th>O₂ (%)</th>
<th>N₂ (%)</th>
<th>HV(MJ/m³)</th>
<th>Flow(m³/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>41.46</td>
<td>10.39</td>
<td>9.12</td>
<td>36.68</td>
<td>0.00</td>
<td>2.35</td>
<td>10.22</td>
<td>1500</td>
</tr>
<tr>
<td>45.05</td>
<td>8.18</td>
<td>7.53</td>
<td>34.38</td>
<td>0.00</td>
<td>4.86</td>
<td>9.77</td>
<td>1400</td>
</tr>
<tr>
<td>46.51</td>
<td>9.34</td>
<td>9.19</td>
<td>32.65</td>
<td>0.00</td>
<td>2.31</td>
<td>10.76</td>
<td>1500</td>
</tr>
<tr>
<td>52.92</td>
<td>10.37</td>
<td>9.50</td>
<td>19.55</td>
<td>0.00</td>
<td>7.62</td>
<td>11.84</td>
<td>1200</td>
</tr>
<tr>
<td>45.32</td>
<td>9.13</td>
<td>9.24</td>
<td>33.10</td>
<td>0.00</td>
<td>3.21</td>
<td>10.60</td>
<td>1400</td>
</tr>
</tbody>
</table>
3.3 Measuring the moving velocity of fire face

Change of Radon concentration along the gasification tunnel
4 Market prospect of UCG technology in China

★ the total amount of discovered coal was 10179 x10⁸ tons ( 1997 )
★ The distribution of different coal kind (table 4)
★ the total amount of discovered and forecast coal with depth ≤ 2000m was 55697 x10⁸ tons
★ the forecast coal with depth ≥ 1000m takes up 59.5%
4 Market prospect of UCG technology in China

Table 4 Distribution of coal kind in the discovered coal resources amount (x10^8t)

<table>
<thead>
<tr>
<th>Coal kind</th>
<th>lignite</th>
<th>Lower-grade bituminous</th>
<th>Gas coal</th>
<th>Fat coal</th>
<th>Coking coal</th>
<th>Thin coal</th>
<th>Poor coal</th>
<th>anthracite</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discovered</td>
<td>1291.32</td>
<td>4320.75</td>
<td>1317.31</td>
<td>382.99</td>
<td>682.92</td>
<td>424.47</td>
<td>559.17</td>
<td>1200.16</td>
<td>0.27</td>
</tr>
<tr>
<td>Percent (%)</td>
<td>12.68</td>
<td>42.45</td>
<td>12.94</td>
<td>3.76</td>
<td>6.71</td>
<td>4.17</td>
<td>5.49</td>
<td>11.79</td>
<td></td>
</tr>
</tbody>
</table>
4 Market prospect of UCG technology in China

★ Conclusion

- The amount of lignite and low-grade bituminous takes up more than 55%
- The deep coal seam with depth more than 1000m takes up 59.5%
- UCG has the superiority for mining and utilizing deep coal and low quality coal
5 Closing

- UCG is important to China and other coal-based countries
- UCG makes contributions to the utilization of coal resource and environmental protection
- Enhance cooperation with other countries
Thank you