Synfuels China Technologies
For Heavy Oil Upgrading and CTL

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� Synfuels China (SFC) methodology
� SFC multistage liquefaction technology
� SFC High Temperature Slurry Fisher-Tropsch Process (HTSFTP) Technology
� SFC integrated processes
SFC Background

Synfuels China (SFC)

- Established in 2006
- Registered Capital: 1b RMB

□ PhD 41 & Mater 121
□ Staff 950

SFC R&D Centre
Beijing & Taiyuan
- more than 80 patents

SFC Engineering Co., Ltd. Beijing
Synfuels Americas (USA)
ChemEssen (Seoul, Korea)

SFC Catalyst Factories
Anhui & Inner Mongolia

SFC Inner Mongolia Co., Ltd.
A unique integrated system has been established in SFC to facilitate the R&D and commercialization of SFC technologies.
SFC R&D on F-T Catalyst

Experimental Characterization

Quantum Chemistry

Detailed Reaction Mechanism

Kinetics Study

Catalyst Design

Molecule Simulation

Process Scaling Up

Fe
Fe₂C
Fe₃C
Fe₅C₂
Fe₇C₃
Fe₂O₃
Fe₃O₄

……
Multistage Liquefaction

Fuel Gas

H₂

Catalyst

Coal

LP Steam

Drying

Coal-Oil Slurry Preparation

Coal-Oil Slurry Pre-treatment

Partial Hydrogenation

Product Separation

< 5 MPa

400-450 °C

Dry Gas

Light Oil

H₂

Solvent

Hydrogenation

Heavy Oil

Hot Residual

Gasification

CO Shift

F-T Synthesis

Syncrude

Product Upgrading

Dry Gas

LPG

Fuels

Chemicals

OUR EXPERTISE ENERGY IN FUTURE 我们的事业，能源的未来
80BPD Multistage Liquefaction Pilot Plant

Coal Drying  Pipeline Frame  Storage

Furnace  Reactor  Products
Overall material balance for a typical lignite under ~50 bar and 400-450°C

Dried lignite: 987 kg/h
Catalyst: 72.03 kg/h
Solvent: 98.7 kg/h

Cool trap: 948 kg/h
Hot trap: 395 kg/h
Uncondensed gas

Heavy oil: 396 kg/h
Residue: 385 kg/h

Coal slurry: 44-45%, Conversion: 88%, oil yield: 44.5%
# Heavy Oil Upgrading

## Feedstock Analysis

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>20 °C, g/cm³</td>
</tr>
<tr>
<td></td>
<td>API</td>
</tr>
<tr>
<td>Simulated Distillation</td>
<td>IBP</td>
</tr>
<tr>
<td></td>
<td>&lt;370 °C</td>
</tr>
<tr>
<td></td>
<td>&lt;520 °C</td>
</tr>
<tr>
<td></td>
<td>&lt;720 °C</td>
</tr>
<tr>
<td>Elemental Analysis</td>
<td>C, wt%</td>
</tr>
<tr>
<td></td>
<td>H/C, mol</td>
</tr>
<tr>
<td></td>
<td>H, wt%</td>
</tr>
<tr>
<td></td>
<td>N, wt%</td>
</tr>
<tr>
<td></td>
<td>S, wt%</td>
</tr>
<tr>
<td>Other Properties</td>
<td>Ash, wt%</td>
</tr>
<tr>
<td></td>
<td>H₂O, wt%</td>
</tr>
<tr>
<td></td>
<td>Carbon Residue, wt%</td>
</tr>
<tr>
<td></td>
<td>Asphalt, wt%</td>
</tr>
</tbody>
</table>

## Product Yield

<table>
<thead>
<tr>
<th>Product</th>
<th>Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>C₁-C₂</td>
<td>1.29%</td>
</tr>
<tr>
<td>C₃-C₄</td>
<td>0.70%</td>
</tr>
<tr>
<td>&lt;150 °C</td>
<td>1.71%</td>
</tr>
<tr>
<td>150-370 °C</td>
<td>54.96%</td>
</tr>
<tr>
<td>370-520 °C</td>
<td>27.19%</td>
</tr>
<tr>
<td>H₂O</td>
<td>1.69%</td>
</tr>
</tbody>
</table>

Note: once-through data

**Operating conditions:** 400-500 °C, 4-5 MPa, Oil Yield 85-90%
CO + 2H₂ → (-CH₂-) + H₂O
ΔH = -165 kJ/mol (-CH₂-)

CO + H₂O → CO₂ + H₂
ΔH = - 41.3 kJ/mol (CO)

Catalyst Features:
✓ high activity
✓ excellent selectivity
✓ high attrition resistance
Scaling Up of F-T Slurry Reactor

Process Parameter
- capacity, gas velocity

Case Dimension, internals requirement

Internals Design
- cold experiment allocation
- heat exchangers

Material
- manufacture
- field assembly
- installation

9.6 m reactor technology

Lab. 1.0L
Pilot 0.3m
Demo 5.3 m
Commercial 9.6 m
Three Demon Plants Using HTSFTP

- **Yitai CTL plant**: coal-water slurry gasifier, 4000bpd, Inner Mongolia
- **Lu’an CTL plant**: fixed bed gasifier (Lurgi), 4000bpd, Shanxi
  - Constructed between 2005 and 2008, commissioned in 2009
  - F-T Reactor Diameter: 5.3m (Yitai), 5.8m (Lu’an)

Shenhua Ningmei 100,000 BPD CTL plant and Luan 25,000 BPD CTL plant are under construction in China to produce diesel as main oil product, using Synfuels China HTSFTP technology. Both plants are to be commissioned late 2016.
SFC HTSFTP can be integrated with various commercial gasification technologies using different feedstocks such as residual from heavy oil processing, coal, natural gas, biomass, etc.
SFC Integrated Processes

Clean and efficient use of “hard” materials where/when lack of oil supply.
Synfuels China has developed proprietary Multistage Liquefaction technology for heavy oil upgrading and low-rank coal such as lignite. For a typical heavy oil with a API of 9.9, once-through oil yield reaches 85%. For a typical lignite, conversion is 88% with an oil yield of 44.5%.

SFC’s proprietary High Temperature Slurry F-T Process (HTSFTP) Technology has been successfully applied in two 160 kt/a CTL demon plants in China. Two large-scale CTL projects (100,000 BPD and 25,000 BPD) are under construction in China using SFC HTSFTP technology, to be commissioned in 2016.
THANK YOU