Introduction to GSP™ gasification technology

SUSTEC GSP China Technology Co. Ltd.
Corporate Structure of Sustec Group

China Shenhua Group
  51%

Shenhua Ningxia Coal Group
  50%

- Sustec GSP China Technology Co., Ltd.
  50%

Sustec Holding AG
  100%

- Sustec AG
  100%
  50%

- Future Energy GmbH
  100%

- Sustec North America
  100%

- Sustec Industries Co.
  100%

- Sustec Schwarze Pumpe GmbH
  100%
## Development Course of GSP™ Gasification Technology

<table>
<thead>
<tr>
<th>Year</th>
<th>Fixed-bed gasification</th>
<th>Year</th>
<th>Entrained-flow gasification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1956</td>
<td>24 gasifiers constructed in the gas combine „Schwarze Pumpe“</td>
<td>1978</td>
<td>Lignite</td>
</tr>
<tr>
<td>1977</td>
<td></td>
<td>1979</td>
<td>Saliferous lignite</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1980</td>
<td>42 lignite varieties</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1981</td>
<td>15 hard coal varieties</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1982</td>
<td>(international)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1983</td>
<td>Pulverized hard coal and lignite</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1984</td>
<td></td>
</tr>
<tr>
<td></td>
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<td>1985</td>
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<td></td>
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<td>1986</td>
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<td>1987</td>
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<td></td>
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<td>1988</td>
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<tr>
<td></td>
<td></td>
<td>1989</td>
<td></td>
</tr>
<tr>
<td>1990</td>
<td>15 municipal and industrial sewage sludges, MSW, waste oil, wood, straw</td>
<td>1994</td>
<td>Slurry, fly ash</td>
</tr>
<tr>
<td>1991</td>
<td></td>
<td>1995</td>
<td>Industrial waste and residues</td>
</tr>
<tr>
<td>1992</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1993</td>
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<td>2001</td>
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<td>2004</td>
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<td></td>
</tr>
<tr>
<td>2005</td>
<td></td>
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</tbody>
</table>

**Commercial plants**

- **DBI**
- **Schwarze Pumpe**
- **Seal Sands**
- **Noell**
- **Babcock**
- **Vernova**

**Future Energy**
Engineering / R&D Center in Freiberg

- Deutsches Brennstoffinstitut Freiberg (DBI) 1991
- Novell GmbH 1999
- Babcock Borsig Power GmbH 2002
- Future Energy GmbH 2004
- Sustec Holding AG 2004

SUSTEC GSP CHINA TECHNOLOGY CO., Ltd.
GSP™ Gasification Test Facilities of FUTURE ENERGY GmbH in Freiberg

Gasifier VV100
- Reactor with cooling wall
- 2-3 MW, max. 30 bar

Pulverized fuel
dosing and feeding system
- up to 10 t/h

Inert gas plant
- 1000 Nm³/h
- 80 bar

Oxygen plant
- max. 300 Nm³/h
- 80 bar

Sewage sludge drier
- 500 kg/h

Pyrolysis unit
- 500 kg/h

SulFerox desulfurization unit
- Waste water treatment
- COS hydrolysis
- HCN hydrolysis
Synthesis Gas Generation Technology

- **Air** separation unit
  - Oxygen
  - **Fuel** preparation (Pulv. coal)
  - **Gasification Quenching** (24 - 40 bar, 1100 - 1700 °C)
  - **Scrubbing** (200 – 220 °C)
  - **CO shift conversion** (350 °C)
  - **COS/HCN hydrolysis** (200 °C)
  - **Heat recovery** (120 °C)
  - **Cooling** (30 °C)
  - **Desulfurization CO₂ removal** (30 °C)
  - **Sour gas to Claus plant**

- **Synthesis**
- **Pressure swing adsorption**
- **Combined cycle power plant**
- **Methanol**
- **Automotive fuels**
- **Hydrogen**
- **Electricity**

-SUSTEC GSP CHINA TECHNOLOGY CO., Ltd.
Pneumatic Conveying and Feeding System for Pulverized Solid Materials

Material

Storage bin

Nitrogen

Depressurization

Lock hopper

LIA

PI

TI

Nitrogen

Depressurization

Lock hopper

Nitrogen

Nitrogen

Feeding vessel

Material to gasifier
GSP™ Gasification Reactor Designs

Reactor with cooling screen

- Burner
- Cooling screen
- Gas and slag outlet
- Gas outlet
- Total quench

Reactor with cooling wall

- Burner insert
- Cooling wall
- Refractory lining
- Partial quench unit
- Refractory lining
- Gas outlet
Cooling Screen of the Gasification Reactor

- Membran wall
- Pressurized water
- Ramming mass
- Pipe coil with studs

Liquid slag
Solid slag
Cooling Screen Stratification in Coal Gasification 150 kW/m²

<table>
<thead>
<tr>
<th>Material</th>
<th>Diameter</th>
<th>Thermal Conductivity (W/mK)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>3.5 mm</td>
<td>50</td>
</tr>
<tr>
<td>SiC</td>
<td>13 mm</td>
<td>8</td>
</tr>
<tr>
<td>Slag</td>
<td>5.5 mm</td>
<td>1</td>
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</table>

- ~1400 °C
- ~500 °C
Views of the Cooling Screen after 10 Years in Service
Views of the Cooling Screen after 10 Years in Service
Burner for Coal Gasification

- Ignition voltage
- Flame signal
- Fuel gas to pilot
- Oxygen/steam
- Cooling water
- Cooling water
- Cooling water
- Pulverized coal
- Cooling water
- Cooling water
- Cooling water
Pulverized Coal Burner 30 t/h
# Composition of Raw Gas from Different Feedstock

<table>
<thead>
<tr>
<th>Component</th>
<th>Unit</th>
<th>Hard coal</th>
<th>Pet coke</th>
<th>Lignite</th>
<th>Oil</th>
<th>Biomass</th>
<th>Domestic refuse</th>
<th>Sewage sludge</th>
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</thead>
<tbody>
<tr>
<td>vol.-% H₂</td>
<td></td>
<td>27</td>
<td>22</td>
<td>31</td>
<td>45</td>
<td>27</td>
<td>29</td>
<td>32</td>
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<tr>
<td>vol.-% CO</td>
<td></td>
<td>64</td>
<td>65</td>
<td>55</td>
<td>48</td>
<td>50</td>
<td>49</td>
<td>49</td>
</tr>
<tr>
<td>vol.-% CO₂</td>
<td></td>
<td>3</td>
<td>5</td>
<td>8</td>
<td>4</td>
<td>14</td>
<td>16</td>
<td>12</td>
</tr>
<tr>
<td>vol.-% CH₄</td>
<td>&lt; 0.1</td>
<td></td>
<td></td>
<td>&lt; 0.1</td>
<td>&lt; 0.1</td>
<td>&lt; 0.1</td>
<td>&lt; 0.1</td>
<td>&lt; 0.1</td>
</tr>
<tr>
<td>vol.-% N₂</td>
<td>5.5</td>
<td></td>
<td></td>
<td>4.3</td>
<td>2.9</td>
<td>6.3</td>
<td>5.6</td>
<td>6.7</td>
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<tr>
<td>vol.-% H₂S</td>
<td>0.46</td>
<td></td>
<td></td>
<td>0.20</td>
<td>0.1</td>
<td>0.12</td>
<td>0.36</td>
<td>0.28</td>
</tr>
<tr>
<td>vol.-% COS</td>
<td>0.04</td>
<td></td>
<td></td>
<td>0.02</td>
<td>0.01</td>
<td>&lt; 0.1</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>vol.-% HCN</td>
<td>1.0</td>
<td></td>
<td>0.8</td>
<td>1.0</td>
<td>0.2</td>
<td>0.3</td>
<td>0.01</td>
<td>2.0</td>
</tr>
<tr>
<td>vol.-% NH₃</td>
<td>0.4</td>
<td></td>
<td>0.3</td>
<td>0.24</td>
<td>0.4</td>
<td>0.4</td>
<td>0.25</td>
<td>0.3</td>
</tr>
<tr>
<td>Calorific value</td>
<td>MJ/Nm³</td>
<td>11.1</td>
<td>10.9</td>
<td>10.3</td>
<td>11.2</td>
<td>9.3</td>
<td>9.4</td>
<td>9.7</td>
</tr>
</tbody>
</table>
Advantage of GSP™ gasification process

- **Multiple-fuel feeding**
  - Lignite, bituminite, anthracite and petrol coke as feedstock due to the high reactive temperature.
  - Additional feeding of liquids, slurries, gases or others is possible.
  - Flexible operation at different ash contents and composition.
  - Especially coal with high ash and sulfur content as well as high ash flow temperature can be gasified.

- **Excellent technical indicators (depend on different coal)**
  - High reaction temperature 1350°C ~ 1750°C
  - High Carbon Conversion >99%
  - Raw Synthesis Gas without hydrocarbons, i.e. absolutely tar free
  - No dioxin/furan formation despite high chlorine content in the gasification
  - Syngas (CO+H2) content >90%
  - Cold coal gas efficiency >80%
Advantage of GSP™ gasification process

- **High availability and low maintenance cost**
  - Cooling screen compared to refractory lining
  - Expectation of Cooling screen life time 25 years
  - Expectation of burner (excluding front tip) life time >10 years
- **Short start-up and shutdown time (about 1 hour)**
- **High flexible operation**: Load flexibility of single gasifier can be adjust from 70% to 110%
- **High auto control level**: Process and equipment simple and safety
- **Environmental friendly**: slug contained no hazardous substance can used as building materials
- **Short process flow, small equipment, low investment, short building period and low operation cost**
Size Relation of Different Scale GSP Entrained-Flow Gasifiers (4.0 MPa)

- **200 MW**
  - ~55,000 Nm³/h
  - (H₂+CO)

- **500 MW**
  - ~125,000 Nm³/h
  - (H₂+CO)

- **1000 MW**
  - ~246,000 Nm³/h
  - (H₂+CO)

- **1500 MW**
  - ~360,000 Nm³/h
  - (H₂+CO)
Industrial Reference

Waste Recycle Center „Schwarze Pumpe“
(Sustec Schwarze Pumpe GmbH)

1984  Plant construction finished and commissioning

1986–1990  (Peak load) plant operations on common / saliferous lignite

1990  Plant operations on other feed stocks such as Nature gas, Tar oil and sewage sludge

1996  120,000 t/a methanol and 75 MW IGCC in operation

Oct. 1 2005  Acquisition by Sustec Industries AG with all rights included

Technical data
Type of reactor  entrained-flow, cooling screen
Coal capacity  720t/d (brown coal)
Syngas  50,000Nm³/h
Pressure  2.8MPa(g)
Industrial Reference

BASF(UK) Plastic Plant

Designation of Plant: Entrained-flow
Client: BASF plc, Sealsands
Location: Middlesbrough, UK
Commissioning: 2001

Technical data:
Type of reactor: Entrained-flow, cooling wall
Thermal capacity: 30 MWth
Pressure: 2.9 MPa(g)
Feeding system: Liquid feeding
Feedstock: Liquid wastes from Nylon synthesis processes, HCN and nitric-loaded by-products, organics containing ammonia sulfate
Product: Fuel gas
Industrial Reference

**Sokolovskd uhelnd Plant**

- **Designation of plant:** Entrained-flow
- **Client:** Sokolovskd uhelnd, a.s.
- **Location:** Vresovd, Czech Republic
- **Commissioning:** 2006

**Technical data**
- **Type of reactor:** Entrained-flow, cooling wall
- **Thermal capacity:** 175 MWth
- **Pressure:** 2.8 MPa(g)

**Feedstock:**
Generator tar and other liquid by-products of 26 fixed bed gasifiers for 440 MW IGCC

**Product:** Raw gas for IGCC
Project Reference

Anhui Huainan Chemical Group Co., Ltd

Capacity: 300,000 t/a Ammonia
Feedstock: Huainan coal
(FT: 1610 ºC, Ash: 25-32%)
Pressure: 4.0 MPa(g)
Type of reactor: cooling screen
2 gasifiers Total coal capacity: 2,000 t/d
Estimated commissioning: 2008
Project Reference

Shenhua Ningxia Coal Group Co., Ltd.

- Capacity: 600,000 t/a Methanol, first phrase of 830,000 t/a DME project
- Feedstock: Ningxia Coal
- Pressure: 4.0 MPa(g)
- Type of reactor: cooling screen
- 2 gasifiers Total coal capacity: 4,000 t/d
- Estimated commissioning: 2008
Jiangsu Linggu Chemical Industry Co., Ltd.

Capacity: 300,000 t/a Ammonia
Feedstock: Shenhua coal
Pressure: 4.0 MPa(g)
Type of reactor: cooling screen
2 gasifiers Total coal capacity: 2,000 t/d
Estimated commissioning: 2008
Contact us

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