Air Products’ coal gasification technology: An advanced solution for efficient coal-to-products value chains

Rob van den Berg
Technology Manager Coal Gasification
Air Products Syngas Solutions

November 29, 2018
Gasification potential

- Gas/Residue/Coal/Biomass
  - Oxygen, Steam
  - Gasification & Gas Treating
  - Clean syngas (CO + H₂)
  - Sulphur
  - CO₂

- Power Generation
- Chemicals
- Methanation (F-T)
- Liquefaction (F-T)
- Enhanced Oil Recovery

- Steam/Electricity
- Hydrogen, Ammonia, Methanol, Oxo-alcohols
- Synthetic Natural Gas (SNG)
- Transportation Fuels

Enhanced Oil Recovery
APSS Gasification technology portfolio

RESIDUE GASIFICATION PROCESS
with residue feedstock e.g. for refineries (hydrogen, steam and power) in partnership with Shell

COAL GASIFICATION PROCESS
with solid feedstock (coal/petcoke and biomass) e.g. for chemicals, hydrogen, steam and power

“One proven technology, two line-ups”
APSS licensing reference in Asia Pacific region

- Almost 20 years of commercialization
- 27 license projects, 31 gasifiers in operation, 6 gasifiers under construction

22 gasifiers with >2000 t/d coal intake capacities
Largest gasifier delivered 3,200 t/d, started-up mid 2018
Mature core of the technology: reactor and burners

Protection against high operating temperatures via a slag layer on a membrane (water) wall

Syngas and flyash leave at the top
Membrane wall protected by slag layer
Multiple (4-6) opposed burners
Slag leaves at the bottom

GASIFIER SPACE
(1500-1600°C
40-45 barg)

molten slag flows downwards

solid slag on tube wall

BOILER FEED WATER TUBE
(50-60 bar
270-300°C)
Syngas cooler process line-up

Process line-up with Syngas Cooler (SGC) offers high efficiency and small environmental footprint

- Coal/Petcoke
- Milling/Drying
- Coal Feeding
- Quench Gas (200°C)
- Gasifier
- HP Steam
- MP Steam
- HPHT Filter
- Wet Scrubbing
- Water Treatment
- Flyash System
- Flyash to Storage
- Salts
- Raw Syngas
Broad operating experience on many different kinds of coal

**FEED FLEXIBILITY**
- Handled over 200 different kinds of coal covering the whole reactivity spectrum from lignite to anthracite, ash contents from 6-37%.
- Four projects successfully used petcoke blended with coal, with excellent operational results.

**DEEP INSIGHT IN PROCESS**
- Based on extensive operating experience, several modelling tools were developed to confidently assess novel coals, optimize coal blends, and provide reliable guarantees.

<table>
<thead>
<tr>
<th>Property range of feedstocks operated on</th>
<th>100%</th>
<th>2000°C</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ash (MF) wt%</td>
<td>36.4%</td>
<td>&gt;1500°C</td>
<td>35.0%</td>
</tr>
<tr>
<td>FT, °C</td>
<td>5.9%</td>
<td>1140°C</td>
<td>3.8%</td>
</tr>
<tr>
<td>Moisture wt%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feedstock</td>
<td>Lignite</td>
<td>Sub-bituminous</td>
<td>Bituminous</td>
</tr>
</tbody>
</table>
APSS - SGC Lu’an CTL project

- Lu’an Coal-to-liquids project is the flagship coal chemical project of Shanxi province. JV between Luan and Air Products to own and operate ASU, gasification and gas treating plants.

- **Lu’an CTL Project dimensions:**
  - **Location:** Changzhi city, Shanxi Province
  - **Scale:**
    - 825 kNm³/hr (CO+H₂)
    - 4x3,200 ton/d AP coal gasifiers
    - 4x3,000 ton/d AP ASUs
  - Producing 1.8 Mton/yr of high-quality oil products (Fischer-Tropsch liquids)

- **Excellent operational track record:**
  - JV project closed in April 2018
  - Three gasifiers on stream July 2018
  - Milestone reached on September 26, 2018 with all four gasifiers in operation
Chinese project management in Jinxin (Inner Mongolia)

- **Contract signed**: Jan-Feb 2014
- **Construction kick-off**: June 2014
- **Erection**: March 2015
- **MCI**: Nov. 2015
- **Handover**: April 2016
- **Start-up**: 18 June 2016
Gasification of high-ash coals

Myth: Because of their high ash content and high Ash Fluid Temperature Indian coals are extremely difficult to gasify
Rich operating experience with petcoke gasification

Tianfu was the first dry-feed gasification plant in China that successfully demonstrated petcoke/coal blending.

Now four APSS plants in China have operational experience on petcoke.

Petcoke blending gives good operational performance and reliability: long, continuous operating runs (of up to 291 days) and longest number of running days in a year (341 days).

Excellent way to improve a high-ash feedstock and run more economically!
Overall reliability figures for 2016/2017:

- Overall APSS plant reliability: 98.6% / 98.4%
- Longest A run (continuous run without stop): 242 days / 248 days
- Longest B run (run with short stop < 24 hours): 254 days / 296 days
- 14 sites / 18 sites achieved >300 on-stream days per year, with a maximum of 348 days / 340 days in operation

Several months of 100% technology reliability

Top-quartile operating performance 2012-2017

- Actual ave 2012: 91
- Actual ave 2013: 94
- Actual ave 2014: 96
- Actual ave 2015: 96.3
- Actual ave 2016: 98.6
- Ave YTD 2017: 98.4
Full technical support from design to stable operation
Looking to the future

With the acquisition of world-class gasification technologies Air products aims to contribute to a cleaner energy future.

Continuous improvement has seen the reliability of Air Products’ technologies steadily improve in recent years.

Air Products has a strong reference list in coal gasification and offers proven technology in different line-ups: dry feed and slurry feed, syngas cooler and quench, it all depends on the economic requirements of a project.

Our dedicated gasification teams offer comprehensive and experienced support in all phases of a project.
Thank you...
tell me more
Back-up slides
Simplification and standardization of technology

On APSS coal gasification technology: “Dry feed with high efficiency, low oxygen consumption, steam recovery, and much less black water treatment”

Yong Wang Li, Synfuels China (Freiberg Conference 2015)
Gasification of high-ash coals

Myth: Because of their high ash content Indian coals are extremely difficult to gasify

Operational data from a Chinese customer

DESIGN WINDOW