Carbon dioxide for coal gasification and waste treatment

Gasification permit to use pipes for coal transportation

° coal to Syngas: solid to gas
° Wood and biomass to syngas: solid to gas
° Fisher Tropsch: syngas to synfuel

• coal and Waste by plasma gasification process electricity to syngas and to synfuel
FISCHER-TROPSCH SYNTHESIS

Basic reactions in the F.T. synthesis

Paraffins formation

\[(2n + 1) \, H_2 + n \, CO = C_n \, H_{(2n + 2)} + n \, H_2O\]

Olefins formation

\[2 \, n \, H_2 + n \, CO = C_n \, H_{2n} + n \, H_2O\]

Alcohols formation

\[2 \, n \, H_2 + n \, CO = C_n \, H_{(2n + 1)} \, OH + (n - 1) \, H_2O\]

Other reactions may occur during the F.T. synthesis depending on catalyst conditions and working parameters of the reactor

Water gas shift

\[CO + H_2O = CO_2 + H_2\]

Bondouard disproportionation

\[2 \, CO = C + CO_2\]
• Most important aspects for F.T. reactors are

1 – High reaction heats

2 – Large number of products produced by varying vapor

3 – Temperature HTFT = 340°C pressure or LTFT 220-240°C

• Main reactors developed since 1950

1 – Slurry bubble-column reactors with internal cooling tubes

2 – Multi tubular fixed-bed reactors with internal cooling

3 – Circulating fluidized bed reactor with circulating solids, gas recycle, cooling in the gas/solid recirculation loop

4 – Fluidized bed reactors with internal cooling

Gaseification to fisher tropsch process: synfuel synthesis

For more detailed information, see: “Technology Intelligence for Coal-to-Liquids Strategies,” a 550-page report recently published by SRI Consulting (Menlo Park, Calif.; see box on p. 27).

Gerald Ondrey
Coal to liquid gaséification steps

**FIGURE 1.** In direct coal liquefaction, coal is pulverized and mixed with oil and hydrogen in a pressurized environment. This process converts the coal into synthetic crude oil that can then be refined into a variety of fuel products.

For more detailed information, see: “Technology Intelligence for Coal-to-Liquids Strategies,” a 550-page report recently published by SRI Consulting (Menlo Park, Calif; see box on p. 27).

Gerald Ondrey
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Fluent simulation of coal gaseification (DOE/NETL)

S. Shi, M. Shahan and M. Syamlal (Fluent Inc)
S.E. Zitney, W.A. Rogers (National Energy Technology Laboratory, Morgan Town)


Syngas Composition (mole%)
- CO: 39.2%
- H2: 23.7%
- H2O: 23.0%
- CO2: 10.3%
- CH4: 1.5%
- H2S: 0.7%
- Ar: 0.8%
- N2: 0.8%

Contours of temperature (left) and mole fraction of CO (right) on the center plane of the gasifier.
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FutureGen power plant with gasifier [2]

Syngas Composition (mole%)

CO: 30.3%
CO2 to synfuel: a new process

Producing Transportation Fuels with Less Work

Diane Hildebrandt, David Glasser, Brendon Hausberger, Bilal Patel, Benjamin J. Glasser

Coal, H₂O → Gasification → CO₂ + H₂ + CO₂ → Highly exothermic, Low T (500 K)
Less exothermic, Low T (500 K)

Fischer-Tropsch → CO₂ + H₂ → Highly endothermic, High T (1500 K)
Less endothermic, High T (1500 K)

Reducing the work. Improvements in efficiency of the Fischer-Tropsch process can be achieved with a carbon dioxide and hydrogen route, rather than the traditional carbon monoxide and hydrogen route. The processes shown would produce 80,000 barrels of liquid fuel per day and have a theoretical minimum work of 350 MW; the work (via heat) inputs for each stage and for the overall processes are shown as red and green arrows.


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INNOVATION PROCESSES FOR FISHER TROPSCH SYNTHESIS

Capacity of the Process 80.000 barrel/day form coal (131.000 MWh)

△ Conventional route Fisher-Tropsch and M-T-O processes (methanol to olefins) Energy from network Theoretical minimum 350MW

3 C + 4 H₂O → 2 CO + 4 H₂ + CO₂ → 2 (- CH₂-) alcane + 2 H₂O + CO

1000 MW

△ Innovation route

3 C + 6 H₂O → 3 CO₂ + 6 H₂ → 2(-CH₂-) + 4 H₂O + CO₂

820 MW → 15 % reduction of CO₂ than the conventional route

→ 20 % less work to the gasifier

△ ⇒ if H₂ is produced via { nuclear wind solar

this process becomes a method for consuming CO₂ and may bypass the difficulties in the direct use of H₂ as a fuel

CHINA: Coal to liquid plant in Mongolia

- A new coal to liquid plant in Erdos
- Operate by Shenhua Group, the biggest coal producer in China
- Production of 1 million tons per year of diesel and petrochemical products
- Capture and storage 3.6 millions tons of CO2 in oil fields

- Science 25 sept 2009 vol 325 p 1646