Opportunities in Poland for coal gasification as an example of a high-efficiency clean coal technology

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Scope of presentation

- Introduction
- Outlook of Clean Coal Technologies
- Driving forces for coal gasification start up
- Coal Gasification: case studies for Poland
- Future Coal Technologies – R&D program
- Conclusions
Institute for Chemical Processing of Coal

- Establishment: 1955
- Supervision: Polish Ministry of Energy
- Employment: 160

Zabrze (Poland)
Clean Coal Technology Center

Zabrze

The technical media store area

Technological Building I (PDU scale installation and testing plants)

By-products station

Coal preparation station

Coal storage yard

Technological Building II (bench scale sets and testing plants)

Workshop

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Clean Coal Technology Center
(technological building no 1)
Clean Coal Technology Strategy

Cleaner Power Generation

Better Fuel Choice

More Value-added Conversions

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Global energy trend: increasing H/C ratio

Better Fuel Choice: Coal as A Secondary Energy Source
Initiatives to Revitalize and Grow Fossil
Coal gasification

1 mln ton of coal

= 0,4 bln m³ natural gas

ccoal consumption for gasification around 300-400 mln t/y

few hundreds commercial gasifiers
Coal gasification – commercial technologies

- Entrained flow technologies
  - Water slurry and dry feeding
- Fluidized bed technologies
- Fixed bed technologies

- East China University of Science and Technology (OMB: Opposed Multi-Burner Gasifier)
- Northwest Research Institute (MCSG: The Multi-Component Slurry Reactor)
- Aerospace Science and Technology Corporation (HT-L: Pressurized, Down-Flow, Entrained Reactor)
- Institute of Coal Chemistry (AFB: Ash Agglomerated, Fluidized-Bed Reactor)
Driving forces for coal gasification start up

Which factor is the most important for society (ordinary people) in EU?
Is it the same for all European countries?
Driving forces for coal gasification start up

Key question:

Why is so difficult to start up coal gasification in EU?

- Not stable market prices for coal and natural gas
- Not enough profitable business & high investment risk
- Decarbonisation Policy of European Commission
- Restrictive environmental protection regulations

Please find – No one talk about technological risk!!
Driving forces for coal gasification start up

Prices of coal and oil – trends for last 30 years

- Oil
- Coal
Driving forces for coal gasification start up

Comparison of annual prices of natural gas (USA, EU) and coal prices at the CIF ARA level (2017)

Driving forces for coal gasification start up

High business risk - IGCC Kemper Plant (US)

7 bln USD vs. 220 days of operation
Driving forces for coal gasification start up

EU environmental policy:

- **Winter package:**
  - limit of CO₂ emission 550 kg/MWh
  - not obtainable for coal

- **ETS:**
  - not free allowances for energy generation
  - free allowances for chemical production?
Driving forces for coal gasification start up

- **USC**
  - Efficiency >40%
  - $\text{CO}_2 = 820 \text{ kg/MWh}$

- **IGCC**
  - Efficiency >46% (50%)
  - $\text{CO}_2 = 650 \text{ kg/MWh}$

- **A-USC**
  - Efficiency >45%
  - $\text{CO}_2 = 710 \text{ kg/MWh}$

- **IGFC**
  - Efficiency 55-60%
  - $\text{CO}_2 \approx 550 \text{ kg/MWh}$

- **Power production efficiency**
  - 40%
  - 45%
  - 50%
  - 55%
  - 60%

- **Now**
- **2020**
- **2030**

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- Tomasz Chmielniak, Marek Ściążko, Aleksander Sobolewski, Energetic efficiency of coal gasification technology, Nowa Energia, nr 5-6(59-60)/2017 (in Polish)
Coal gasification: case studies

- Oxygen
- Coal
- Steam water

Gasification → Power generation

Power generation → IGCC
  - Electricity

Power generation → CHP
  - Electricity
  - Heat

Gasification → Chemical industry

Chemical industry
  - Hydrogen separation
    - Hydrogen
  - MeOH production
    - Methanol
  - Fuel production
    - Petrol
    - Diesel
  - Other
    - According to the economy and the needs of the National Economy

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Grupa Azoty SA – chemical production

Stage I: „Verification of Assumptions” (2010)
- for the Feasibility Study of polygeneration power plant”
- Contractor: IChPW

- Complete Feasibility Study
- Location: Grupa Azoty, Zakłady Azotowe Kędzierzyn S.A.
- Contractor: Amec Foster Wheeler Italiana

Stage III: Pre-FEED – Chemical Plant (methanol or ammonia) (2016)
- Contractor: Amec Foster Wheeler Italiana
- The first unofficial reports pointed to the high profitability of the project!
- No official information and decision from almost 2 years
Coal gasification: case studies

TAURON SA – power generation

Feasibility Study of waste coal gasification integrated with coal fired boiler (2017/18)
- Fluidized bed reactor – SES technology (USA)
- Gas burn into the coal fired boiler

- By proper usage of fuel mixture of Waste Coal, Coal, Biomass and RDF, it is possible to:
  - Effective utilize of waste coal
  - Increased boiler flexibility
  - Obtain interesting economic factors
  - Reduce CO₂ emission under 550 kg/MWh
Coal gasification: case studies

Enea SA – power generation

- IGCC – Integrated Gasification Combine Cycle
- air gasification
- Power Block – class 500 MWe
- Expected efficiency >48%
- Hard coal from Bogdanka mine (Poland)
- Feasibility study – ready in 2018
Future Coal Technologies – R&D project

Idea:
Road Map for coal utilization in Europe until 2050

Project:
Feasibility Study Concerning the Sustainable Usage of Lignite / Coal
„Options and Prospects of Closed Carbon Cycles”

Main goals:
• mid- and long-term solution for effective and zero-emission usage of domestic coal reserves,
• increase of national energy and resource security,
• change in European Comission’s approach for using coal in energy and chemical sectors in the 2050 perspective,
• ensuring the sustained perspective of economic development for regions strongly connected with mining industry.
Carbon as a feedstock

- Electricity
- Heat
- Synthetic fuels: SNG, F-T
- Feedstock for Chemistry: SNG, MeOH, DME, etc.

1 mln tones of coal = 0.4 bln m³ of natural gas
Carbon as a feedstock

- Electricity
- Heat

- synthetic fuels:
  - SNG
  - F-T

- Feedstock for Chemistry
  - SNG
  - MeOH
  - DME
  - etc.

... beyond standards!
Basic technological idea
Basic technological idea

Synthetic crude oil and SNG
Different country – different feedstock

Feedstock:
- Lignite/coal
- Biomass
- CO2
- Wastes

Products:
- SNG
- Crude synthetic oil
- Chemicals

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Technology Development

1. Is the process possible?
2. Is the process/technology viable?
3. Is the process/technology cost effective?
4. Is the process/technology socially acceptable?

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Final remarks
and
conclusions
Conclusions

- Clean Coal Technologies are and will be necessary in Europe as a part of new energy strategy and our security.

- EU environmental regulations (eg. “winter package” and ETS) are barriers for clean coal technologies development – especially for start up of new demo plants.

- Future Coal Technologies R&D program is an interesting idea of international collaboration for new CCT development (liquefaction, gasification).

- We must find in EU a balance between economy and environmental requirements. Thinking about future should be realistic at present.
Conclusions

- Detailed analysis of the potential for coal gasification in Poland for chemical production and power generation both has been done.

- Qualitative and quantitative analysis of the Polish coals usefulness for gasification is confirm.

- Collected and analyzed detailed information on the investment and operating costs, economic efficiency of different production directions and internal and external markets for products has been prepared.

Poland is ready to take the strategic decision to implement the first industrial coal gasification plant.
Conclusions

“Decarbonization Policy” vs Future of coal

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Thank you for your attention!

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