The Potential for Underground Coal Gasification in Indiana

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CCTR Advisory Panel Meeting, June 5, 2008

Indiana and Coal Gasification

- Coal gasification is promising for the future use of Indiana coals.
- The gasification process produces syngas (CO/H_2), which can be used to generate electricity or produce liquid hydrocarbon fuels, natural gas surrogates and other valuable chemical products.
- Advanced coal gasification methods include solutions for CO_2 capture.
- Earlier feasibility analyses focused on the construction of new coal gasification plants in Indiana.
- An alternative method: underground coal gasification (UCG).

CCTR Project on UCG

- Participants:
  - Purdue's School of Chemical Engineering
  - Indiana Geological Survey (sub-contractor)
- Period: April 2008 – January 2009
- Objective: analyze the feasibility of using UCG in Indiana, specifically
  - Analyze the current status of UCG technology and determine criteria for site selection
  - Analyze available data on Indiana's coal resources and determine suitable locations for UCG
  - Identify the most promising UCG locations and provide characteristics for each that allow comparison and selection

What is Underground Coal Gasification (UCG)?

- Injection and production wells are drilled and linked together in a coal seam.
- Air or oxygen is injected and the coal is ignited.
- Groundwater is utilized.
- The gasification process produces primarily H_2, CO, CH_4 and CO_2.
- The produced gases flow to the surface through the production well and cleaned.

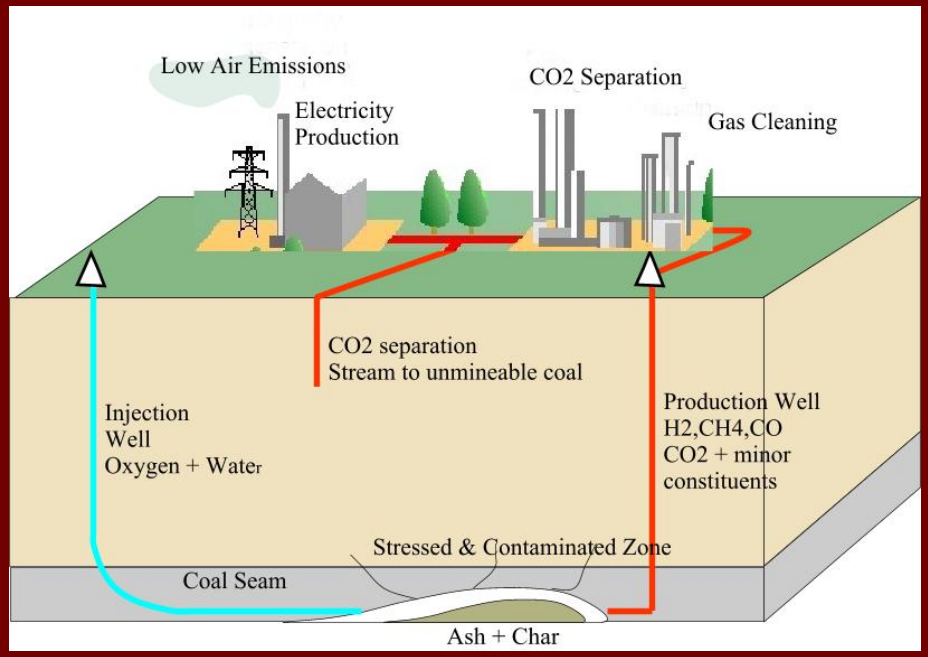


Image: UCG Engineering, Ltd., http://www.coal-ucg.com

Advantages of UCG over Conventional Mining and Surface Gasification

- Lower capital costs
- No human labor underground
- Lower surface disruption
- Increased coal resource availability
- No handling of coal and solid wastes at the surface
- Direct use of groundwater
- Cavities formed as a result of UCG can be used for CO_2 sequestration

Potential Problems of UCG

- Difficulties in linking the injection and production wells
- Insufficient thicknesses of coal seams
- Variation of product gas composition
- Lower heating value of the produced gas
- Groundwater pollution
- Subsidence
- Public concerns about potential loss of control

History of UCG

- Proposed by brothers Siemens in 1868
- First patent: A.G. Betts in 1909
- FSU: over 17,000,000 metric tons coal gasified by 1996
  - 1928: Development started
  - 1937: The first commercial-scale UCG plant
  - 1996: The last UCG plant in Russia shut down
  - A power plant in Angren, Uzbekistan, remains in operation after ~50 years

C.W. Siemens

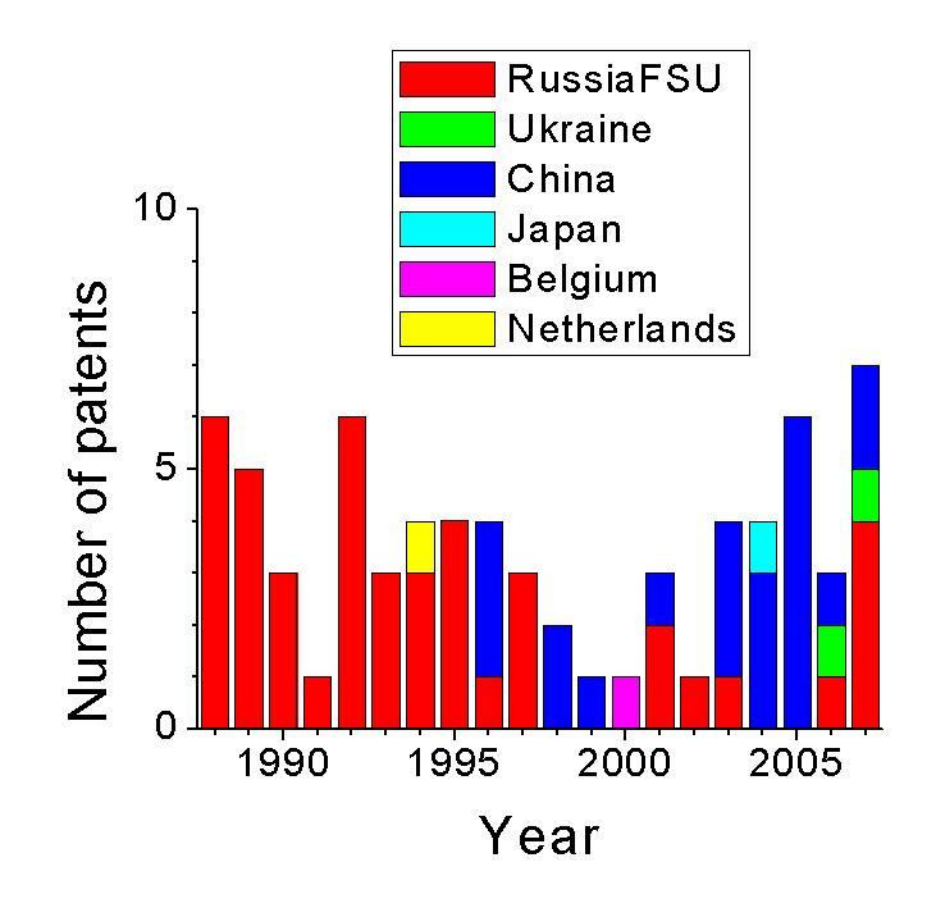
Image: ucg-uz.by.ru

History of UCG, cnt'd

- USA: 1972-1988
  - Over 30 UCG experiments, 50,000 tons coal gasified
- Western Europe: 1982-1999
  - Trials in Belgium, France, Germany, Spain, and UK
- China: 1980s-present
  - At least 16 tests, several commercial UCG projects
- Australia: 1999-present
  - A large pilot (Chinchilla) produced syngas for 3 years before a controlled shut-down and controlled restart, 35,000 tons coal gasified.

History of UCG, cnt'd

- Patents from 1988 to 2008
  - Russia: 44
  - China: 22
  - North America: 0



Current Status of UCG

- Modeling
  - Lawrence Livermore National Laboratory
  - University of Queensland, Ergo Exergy
- Commercial projects, to produce electric power, liquid fuels, and synthetic natural gas
  - Australia (Linc Energy)
  - China (XinAo)
  - Canada (Laurus)
  - India (GAIL)
  - South Africa (Eskom)
  - USA (GasTech)

CCTR Project: Plan of Work

- Phase 1: Analysis of UCG current state of science and technology and determination of criteria for site selection
  - IGS has defined criteria for underground mining, but the criteria for UCG are different
  - Specific requirements for the depth and thickness of coal seams (contradictory information on the thickness, unclear effects of partings, splits, etc.)
  - Literature search, consultations with experts, modeling
  - Purdue will determine the UCG criteria

CCTR Project: Plan of Work, cnt'd

- Phase 2: Analysis of Indiana's coal resources and determination of suitable UCG locations
  - Using the available database of Indiana coal resources and characteristics, IGS will create maps to identify locations that match the UCG criteria
  - For the suitable locations, additional important information will be provided:
    - coal heating value
    - concentrations of sulfur, mercury and other impurities
    - the feasibility to use the UCG cavities for CO_2 sequestration
    - the availability of other potential sequestration locations

CCTR Project: Plan of Work, cnt'd

- Phase 3: Selection of the most promising UCG locations
  - Locations that are suitable for UCG will be analyzed by Purdue and IGS to select the most promising UCG locations
  - In particular, product transportation issues will be considered
  - Special attention will be paid to environmental aspects, including the risks of groundwater pollution and uncontrolled combustion

CCTR Project: Expected Results

- The Final Report will include
  - Characteristics of UCG current status
  - Conclusions on the feasibility to use UCG in Indiana
  - A list of the most promising locations
  - A list of characteristics for each location that allow comparison and selection