Synthesis of Gasoline from SynGas via Underground Coal Gasification

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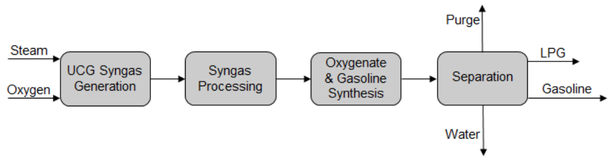
Abstract

Underground Coal Gasification (UCG) has the capability of producing large volumes of synthesis gas via inaccessible coal deposits. Syngas is an intermediate in the process of creating synthetic natural gas (SNG), which is an inherently costly synthesis process. The conversion of syngas to gasoline (STG) can be maximized in a one-step approach through the addition of a bifunctional transition metal zeolite catalyst. The resulting product stream contains readily available drop in liquid fuels at a competitive price.

Block Flow Diagram



Novelty

UCG provides access to previously inaccessible coal reserves without the need for underground human labor. Additionally, environmental concerns related to traditional mining are eliminated. The HZSM-5 zeolite functions as a bifunctional catalyst which enables both oxygenate and gasoline synthesis reactions to occur in one reactor.

Important Reactions

1st: Oxygenate Synthesis

$CO + 2H_2 \rightarrow CH_3OH$

$2CH_3OH \rightarrow CH_3OCH_3 + H_2O$

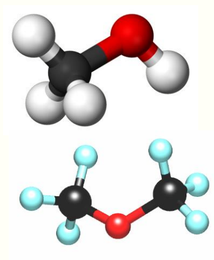
$CO + H_2O \rightarrow CO_2 + H_2$

2nd: Gasoline Synthesis

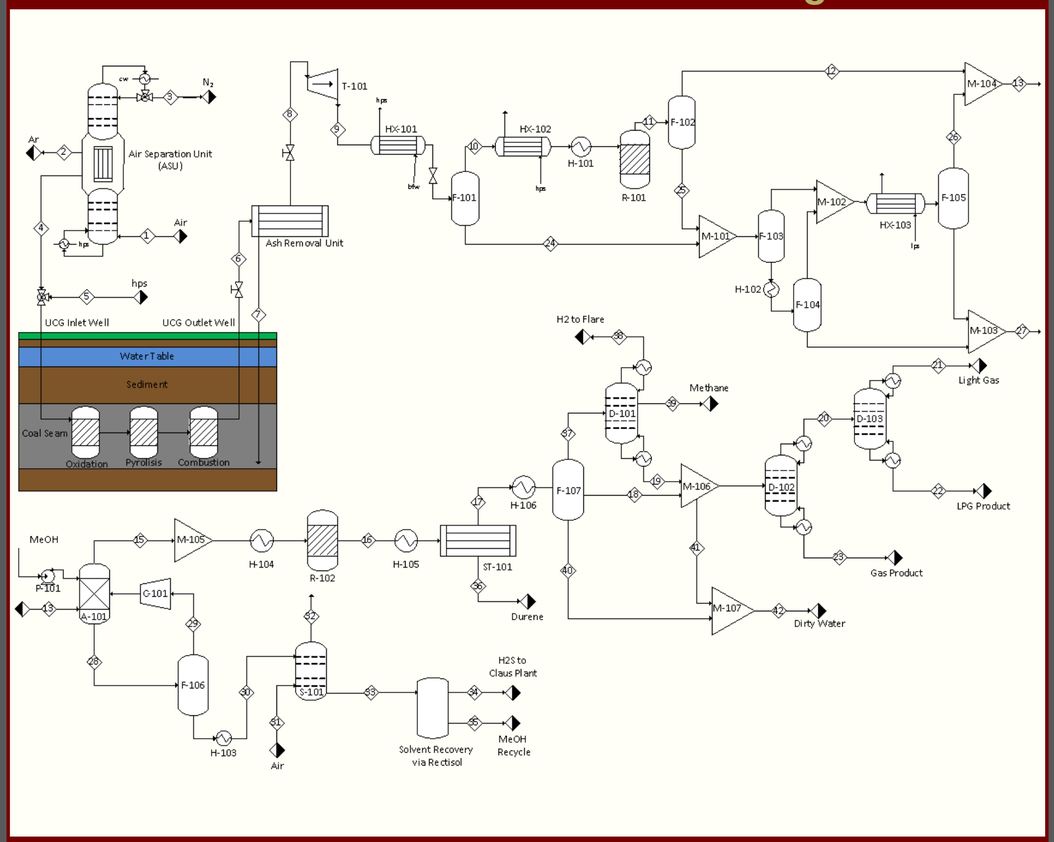
$nCH_3OH \rightarrow n(CH_2) + nH_2O$

$nCH_3OCH_3 \rightarrow n\,2(CH_2) + nH_2O$

$MeOH/DME \rightarrow C_{1\text{-}2} + C_{3\text{-}4}$ (LPG) $+ C_5 +$ Gasoline $+ H_2O +$ heat



Process and Instrumentation Diagram



Production Streams

Stream	Primary Component	Molar Purity	Molar Flowrate (kmol/hr)
21	CO_2/Light Gas	83.15%	453.90
22	LPG	94.63%	212.69
23	Gasoline	99.94%	387.85
36	Durene	99.99%	3.09
38	H_2/Flare Gas	93.18%	1542.00
39	Methane	99.95%	1967.70
42	Water	99.87%	3974.43

Equipment Summary

Equipment Name	Quantity	PID Designation
Turbine	1	T-10X
Heat Exchanger	3	HX-10X
Flash Separator	7	F-10X
Heater	6	H-10X
Reactor	2	R-10X
Distillation Column	3	D-10X
Absorber	1	A-10X
Compressor	1	C-10X
Settler	1	ST-10X
Stripper	1	S-10X

Current Work

- **Environmental Impact Study**
- **Economic Analysis**
- **Column Optimization**
- **CO_2 Capture and Sequestration**
- **Simulation of Acid Gas Solvent Recovery**

Conclusions

UCG allows for an STG plant to be an economically viable operation by providing a cheaper feedstock. A 97.5% conversion of syngas to fuel range hydrocarbons can be achieved using a bifunctional transition metal zeolite catalyst. This cheap feedstock and a high conversion allows for an STG plant to compete with current fuel production methods. Production of gasoline from syngas provides a means to subsidize the current global demand for fossil fuels.

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