Synfuels GTE TRANSPORT

A Mother and Child Reunion
The Synfuels GTL Process

Pyrolysis

Absorber

Oligomerization

Hydrogenation

Absorbent

Power Production

Gasoline Blendstock

Natural Gas

Oxygen

Acetylene
The Synfuels GTE Process

Pyrolysis

Absorber

Hydrogenation

Purification

Natural Gas

Oxygen

Absorbent

Power Production

Polymer Grade Ethylene

H₂

CO

CO₂

H₂

CO

CO₂

H₂

CO

Absorbent
Ethylene is separated from the other gases and purified to chemical or polymer grade

Synfuels Purification Process

- A cryogenic process to make polymer grade ethylene using well known technology

- Individually separated gases can be used for energy generation or for other chemical processing
Technology

- Small Pyrolysis reactors that are easy to install
- Fixed bed catalyst reactors that operate at moderate pressure and temperature
- Stable, self moderating liquid phase hydrogenation
- All Vaporizable Hydrocarbons Qualify as Feed
- Single pass design
Mission One

- Convert Low Value Natural Gas to High Value Ethylene

  - Gas Cost in US between $2 and $3 /MSCF long term
    - $100 and $150 /tonne
  
  - High Value Ethylene ($800 to $1600/tonne) globally
Plant Size: 100 MMSCFD
Ethylene Value: $1000/tonne
Gas MW: 18.75
### IRR vs Gas Cost, Plant Size, Ethylene Value and Gas Quality

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<th>GAS FEED RATE (mmcf/d)</th>
<th>Ethylene Value</th>
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Gas Cost is $2/MSCF

Gas Cost is $3/MSCF
The Synfuels GTE Process can make Ethylene from Methane and Heavier Natural Gas

Excellent Returns can be Expected for Natural Gas in the range of $2 to $3 per MSCF
Mission Two

- Provide a means to Transport Ethylene Made at Low Cost to High Value Regions
  - Ethylene is typically not made from Natural Gas
  - Little Ethylene is transported by sea going vessel
  - There is a wide manufacturing cost difference globally
  - Naphtha, an Ethylene Precursor, is growing expensive
LNG Ships are Available

LNG shipping capacity
- 48 Million cubic meters (20.3 Million Tonnes)
- 800 Million cubic meters annual transport capacity

LNG annual transport
- 390 Million cubic meters (165 Million Tonnes) in 2008
- 520 Million cubic meters (220 Million Tonnes) in 2010

A THIRD OF THE EXISTING SHIPPING CAPACITY IS DORMANT
The LNG Transport Cycle

- Liquefaction Plant
- LNG Loading Terminal
- Ocean Transportation
- LNG Carrier (Loading)
- LNG Carrier (Discharging)
- LNG Terminal
- Regasification
- Power Station
- Gas Utilities
- Pipeline
- Gas Fields
- Gas Processing Facilities
- LNG Tank
Ethylene Transpor ted with LNG

Very Few Changes to Existing LNG Facilities are Needed

Cryogenic Separation of Ethylene from LNG
Build 215 MMSCFD GTE Plant. Install Modifications ($500 million) to Handle Blends. Gas Price is $2.50/MSCF. Methane Feed.

- Cost to produce Ethylene is $610/tonne
- Production: 0.51 Million tonnes/year

Use single 138,000 Cubic Meter displacement LNG ship, fill with 75 wt% ethylene, one delivery per month. Ethylene value is $1200/tonne. Estimated Delivery cost is $50/tonne. Zero value assumed for LNG.

- Added Value per shipment $38 Million
- Annual return: $459 Million
- IRR of 23%
The Synfuels Gas Transport Technology can move relatively low cost ethylene to locations where its value is high.

Excellent Returns can be Expected for Natural Gas in the range of $2 to $3 per MSCF.
Partnerships

- TAMU - gave Synfuels access to novel process and patents
- AREF - provides marketing access to MENA countries for production

Patent Applications

USPTO 20120017639 - METHODS AND SYSTEMS FOR STORING AND TRANSPORTING GASES, January 26, 2012

USPTO 20110041518 - METHOD OF STORING AND TRANSPORTING LIGHT GASES, February 24, 2011