Synfuels Gas to Liquids (GTL)

- A 3 Reactor / 4 Step Process
The Synfuels GTL Process

Pyrolysis

Absorber

Hydrogenation

Oligomerization

Power Production

Gasoline Blendstock

Natural Gas

Oxygen

Absorbent

Acetylene

CO₂

H₂

CO

H₂

CO₂

CO₂

H₂

CO

H₂

CO₂

H₂

CO₂
Step 1 - Pyrolysis

Gas To Acetylene (GTA)

- Natural Gas
- Oxygen
- Acetylene
- CO
- CO₂
- H₂
- CO
Step 1 - Pyrolysis

- Pyrolysis reactor converts hydrocarbon gas to acetylene and other components

- The Synfuels Pyrolysis Reactor is
  - *Small*
  - Operates at *high temperature*
  - Has *no internal fixtures* or moving parts
  - Constructed from conventional *stainless steel*

- A person can touch the exterior while the interior is at 2500°C.
Step 1 - Pyrolysis

Gas To Acetylene (GTA)

With Ethane instead of Methane

- 75% More Product
- Half of Product is Ethylene
- Uses 40% Less Energy

+ Ethylene
Step 2 - Hydrogenation

Gas To Ethylene (GTE)
Step 2 - Hydrogenation

- The Hydrogenation reactor converts acetylene to ethylene

- The Synfuels Hydrogenation Reactor
  - Operates in the *liquid phase*
  - *Precludes thermal runaway*
  - Demonstrates 97% *conversion* to ethylene
  - Provides for *easy separation of ethylene*
  - Uses pyrolysis byproduct hydrogen
Step 2 - Hydrogenation

Gas To Ethylene (GTE)

With Ethane instead of Methane

- Ethylene Made in Step 1
  Avoids Hydrogenation
- Comparatively Smaller Operation
Step 3 - Oligomerization

Gas To Liquids (GTL)
The Oligomerization Reactor converts ethylene to gasoline blendstock

Synfuels Oligomerization Reactor

- Converts ethylene to heavy hydrocarbons in the presence of CO, CO2, H2 and CH4
- Utilizes a commercial catalyst
Step 3 - Oligomerization

Gas To Liquids (GTL)

With Ethane instead of Methane

3½ to 4 Times More Product!
100% Fuel Production, no waste!

Synfuels Produces All Gasoline Blendstock

- Synfuels Petrol 100%

Fisher-Tropsch vs Synfuels Product Distribution - weight basis

<table>
<thead>
<tr>
<th>Synfuels Representative Product Composition</th>
<th>Synfuels Product Distribution Example</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>vol%</strong></td>
<td><strong>Specific Gravity</strong></td>
</tr>
<tr>
<td>Paraffins</td>
<td>12</td>
</tr>
<tr>
<td>Iso-paraffins</td>
<td>35.9</td>
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<tr>
<td>Olefins</td>
<td>1</td>
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<tr>
<td>Naphthenes</td>
<td>9.8</td>
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<tr>
<td>Aromatics</td>
<td>38.5</td>
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</table>
Verified by 5 World Class Engineering Firms

Global Leader in Petrochemical Industry Analyses
Assesses Synfuels as a Commercial Leader in Ethylene

Global Engineering Leader with SASOL 2 GTL Experience
Conducted Technology Verification Assessment

Global Engineering Leader
Conducted Economic Verification

Large US Engineering Firm
Developed Complete FEL2 Design

Respected US Petrochemical Engineers
Conducted Mid-Development and Completion Analysis
Flexible & Small Plant Design
Synfuels Technology is covered by 30+ US Patents, several Foreign patents and dozens of patents pending:

<table>
<thead>
<tr>
<th>Method</th>
<th>Patent Number</th>
</tr>
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<tbody>
<tr>
<td>Method for Converting Natural Gas to Liquid Hydrocarbons</td>
<td>6,130,260</td>
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<tr>
<td>Method for Converting Natural Gas to Liquid Hydrocarbons</td>
<td>6,323,247</td>
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<tr>
<td>Method for Converting Methane-Containing Gaseous Hydrocarbon Mixtures to Liquid Hydrocarbons</td>
<td>6,433,235</td>
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<tr>
<td>Method for Converting Natural Gas to Liquid Hydrocarbons</td>
<td>6,602,920</td>
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<tr>
<td>Process for Liquid Phase Hydrogenation</td>
<td>7,045,670</td>
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<td>Method for Converting Natural Gas to Olefins</td>
<td>7,119,240</td>
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<td>Process for Conversion of Natural Gas to Hydrocarbon Liquids</td>
<td>7,183,451</td>
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<td>Process for Conversion of Natural Gas to Ethylene</td>
<td>7,208,647</td>
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<tr>
<td>High Temperature Hydrocarbon Cracking</td>
<td>7,250,449</td>
</tr>
<tr>
<td>Process for Liquid Phase Hydrogenation</td>
<td>7,408,091</td>
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</table>
Partnerships

- TAMU - gave Synfuels access to novel process and patents
- AREF - provides marketing access to MENA countries for production
- Major E&C Firms – brings excellent world wide reputation in engineering, construction, marketing and project management
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
- Broad range of feedstock gas
- No harmful byproducts
- Single pass design
Engineering Readiness

- Complete FEL II Engineering Package
- Due Diligence Package Ready to Transmit
  - HMB, Equipment List, Detailed Cost Estimate, etc.
- Fully Operational Process Demonstrated in Bryan, TX
- Pyrolysis Reactor Demonstrated at Near-Commercial Scale
- Proven for Wide Range of Hydrocarbon Feeds
- 30+ US and International Patents
- Validated by Independent Technology Assessors
Advantages of Ethane Feed from Cryogenic Separation Plant (CSP)

- Synfuels ASU supplies Nitrogen to CSP
- Cryogenic Heat Exchange Increases Synfuels Light Product Production
  - Additional C4 and C3 recovered
- CO2 Recovered for Oil or Gas Reservoir Stimulation
- Water Production Sold for Hydraulic Fracturing
- CSP Adds Fungible and High Value Revenue Source from Low or Negative Cost Resource
- CSP Eliminates Cost of Ethane Transport