Synfuels International, Inc.  
Upstream GTL Solutions for Flaring  
Edward Peterson, PhD, P.E.,  
Chief Engineer
Why Synfuels pursued an economical GTL & GTE process

- Government restrictions on flaring
- Global Environmental concerns
- Increasing demand for ‘transportable’ liquid fuel in emerging economies
- Laws favouring cleaner fuels
- Need for greater utilization of resources
- Rising energy prices
Fischer-Tropsch (F-T) Limitations

- F-T needs huge plants to create the necessary economies of scale
- F-T’s minimum economic size is about 300 MMSCFD
- Primary F-T product has wide molecular weight distribution – lots of waxes and light ends
- Of 15,000+ gas fields outside North America’s pipeline network, less than 200 can support mega-scale F-T plants

“Smaller fields need smaller plants that require much less capital than Fischer-Tropsch demands.”
• Innovative new approach – Not a F-T modification
• Lower operating pressure than F-T. Therefore, lower cost and easier fabrication
• Near 0% recycled gas. This reduces operating costs
• Demonstrated effective down to 30 MSCFD
• Most economical between 10 and 250 MMSCFD
Synfuels International GTE/GTL Technology

Pyrolysis

Absorber

Hydrogenation

Oligomerization

Gasoline Blendstock

H₂
CO
H₂
CO
CO₂
H₂
CO
CO₂
Absorbent

Acetylene

Ethylene

Natural Gas

Oxygen
50 MMSCFD Plant Design
Clean Gasoline from Methane

**Synfuels GTL Product Properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Gravity</td>
<td>0.7599 (Water=1)</td>
</tr>
<tr>
<td>°API Gravity</td>
<td>54.71 @ 60°F</td>
</tr>
<tr>
<td>Molecular Weight</td>
<td>100.422</td>
</tr>
<tr>
<td>Weight</td>
<td>6.33 Lbs/Gal</td>
</tr>
<tr>
<td>Gross Heating Value</td>
<td>124190 BTU/CF</td>
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</table>

**Synfuels GTL Product Composition**

<table>
<thead>
<tr>
<th>Component</th>
<th>vol%</th>
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<tbody>
<tr>
<td>Paraffins</td>
<td>12</td>
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<tr>
<td>Iso-paraffins</td>
<td>35.9</td>
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<tr>
<td>Olefins</td>
<td>1</td>
</tr>
<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>
Gas-Phase Hydrogenation Problems

- Must limit acetylene concentration for reaction and temperature control
- High temperature can lead to a “run-away” reaction
- Requires processing large volumes of diluents rich gas
- Tends toward over-conversion to ethane
Synfuels Uses Liquid-Phase Hydrogenation of Acetylene

- Selectively absorbs acetylene
- Rejects unwanted gases
- Greatly reduces volume of processed gas
- Operates at moderate conditions
- No thermal “run-away” reaction
- Much higher acetylene concentrations can be used
Extended Duration Conversion and Selectivity

- Ethylene (mol%)
  - Ethylene: 97.42
  - Acetylene: 0.52
  - Butene: 1.35
  - Heavy: 0.11

- Ethylene selectivity

- Time on Stream (HR)
Plant Results

Hydrogenation Results

<table>
<thead>
<tr>
<th>Date</th>
<th>ABSORPTION</th>
<th>SELECTIVITY TO ALL OLEFINS</th>
<th>CONVERSION</th>
<th>CONVERSION AVERAGE</th>
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</thead>
<tbody>
<tr>
<td>23/01/2007</td>
<td>98.5</td>
<td>99</td>
<td>95.5</td>
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<td>25/01/2007</td>
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Synfuels Technology is covered by 10 US Patents and dozens of patents pending:

<table>
<thead>
<tr>
<th>Method</th>
<th>Patent Number</th>
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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>
</tr>
<tr>
<td>Method for Converting Methane-Containing Gaseous Hydrocarbon Mixtures to Liquid Hydrocarbons</td>
<td>6,433,235</td>
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<td>Method for Converting Natural Gas to Liquid Hydrocarbons</td>
<td>6,602,920</td>
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<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>
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<tr>
<td>Process for Liquid Phase Hydrogenation</td>
<td>7,408,091</td>
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Summary

- A unique, patented natural gas to gasoline or ethylene process
- Established, fully scalable, industrially proven design
- Synfuels liquid-phase hydrogenation is the technology’s cornerstone
- Breakthrough technology reduces recycle, compression and system volumes resulting in low capital and operating cost and High IRR
- Flaring problems eliminated with Synfuels Gas-to-Gasoline plants erected up-stream, on-site
Synfuels Top Team

Synfuels International, Inc.
Mr. Ben Weber, CEO
Mr. Thomas Rolfe, President
Mr. Charles Matar, Managing Director, MENA
Dr. Ed Peterson, Chief Engineer

Bryan Research and Engineering
Prof. Jerry Bullin, President
Dr. Joel Cantrell, Development Engineer

Texas A&M University
Prof. Kenneth Hall, former Head of Chemical Engineering