

# Gasoline Blendstock/Ethylene from Methane - The Synfuels Process Today

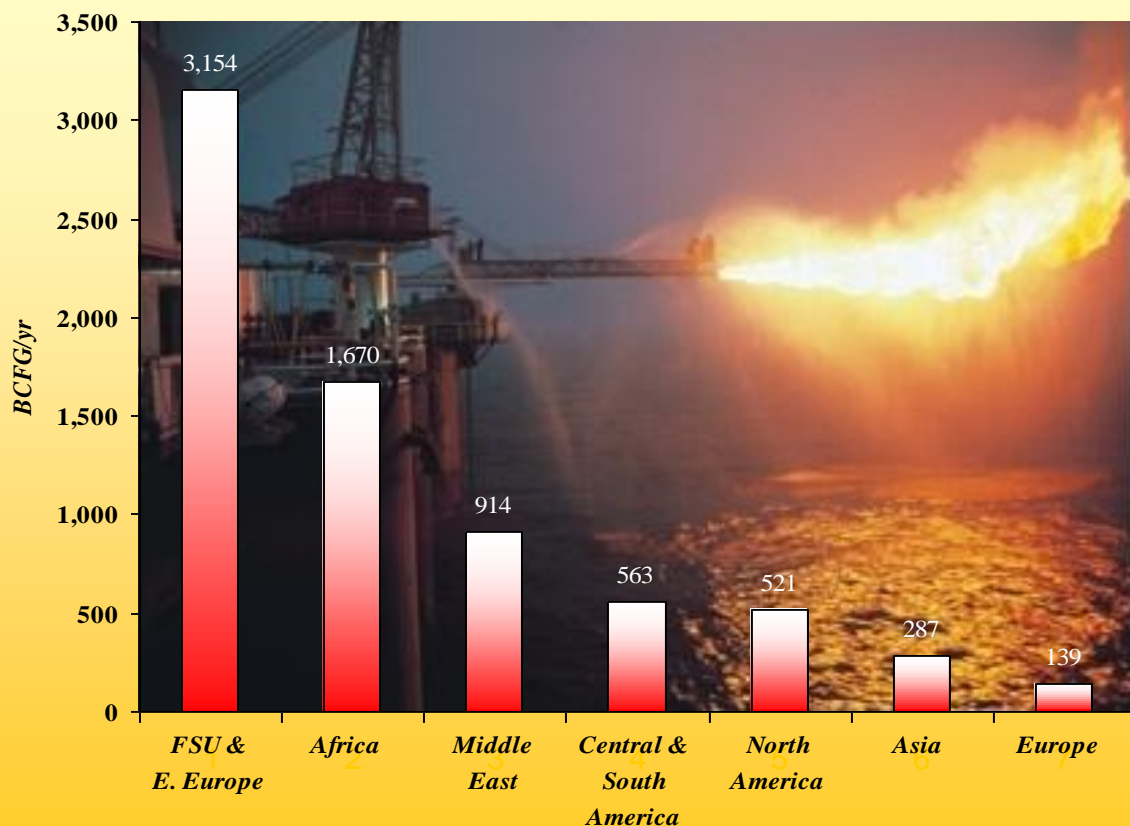
Presented by

Edward Peterson, PhD, P.E.,  
*Chief Engineer, Synfuels International*

**AREF**

## Gas-To-Liquids (GTL) A New Source of Fuel

**Annual Gas Flared  
By Continent**



- Over 75% of the world's known gas reserves are remote and/or stranded
- About 15.5 trillion ft<sup>3</sup> of stranded gas is flared, vented, or re-injected each year
- Could yield **1.5 billion** barrels of fuel per year
- Over **4 million** barrels per day

**AREF**

## *Incentives to pursue an economical GTL process*

- Rising energy prices
- New source of fuel
- Government restrictions on flaring and emissions
- Environmental concerns
- Laws for cleaner fuels
- A country's desire to monetize its resources

**AREF**

## Fischer-Tropsch based GTL Limitations

*“In fact, most, if not all, GTL plants to date would not have been built if it were not for governmental subsidies or political restrictions or influences.”*

- Mega-scale plants planned and under construction
  - Need huge plants to create the necessary economy of scale
  - Enormous capital cost is primary concern
- Over 15,000 gas fields outside North America
  - Less than 200 can support mega-scale plants

*“Smaller fields need smaller plants that require much less capital.”*

**AREF**





**NEW**

- Innovative new approach – Not an F-T modification
- Achieves *better* returns than mega-plants at a *fraction* of their capacity and capital requirements
- Thousands of gas fields capable of utilizing a Synfuels GTL plant

**AREF**

# FT Risks

## Major Projects

- Arzew – 36M B/D cancelled 5/2007
- ExxonMobil - 154M B/D cancelled 5/2007
- Oryx – 34M B/D at 1/3 cap 9/2007
- Pearl - 120M B/D (2010)
- Escravos - 120M B/D (2009)
  - In many cases, costs have more than *tripled* for planned projects.

AREF

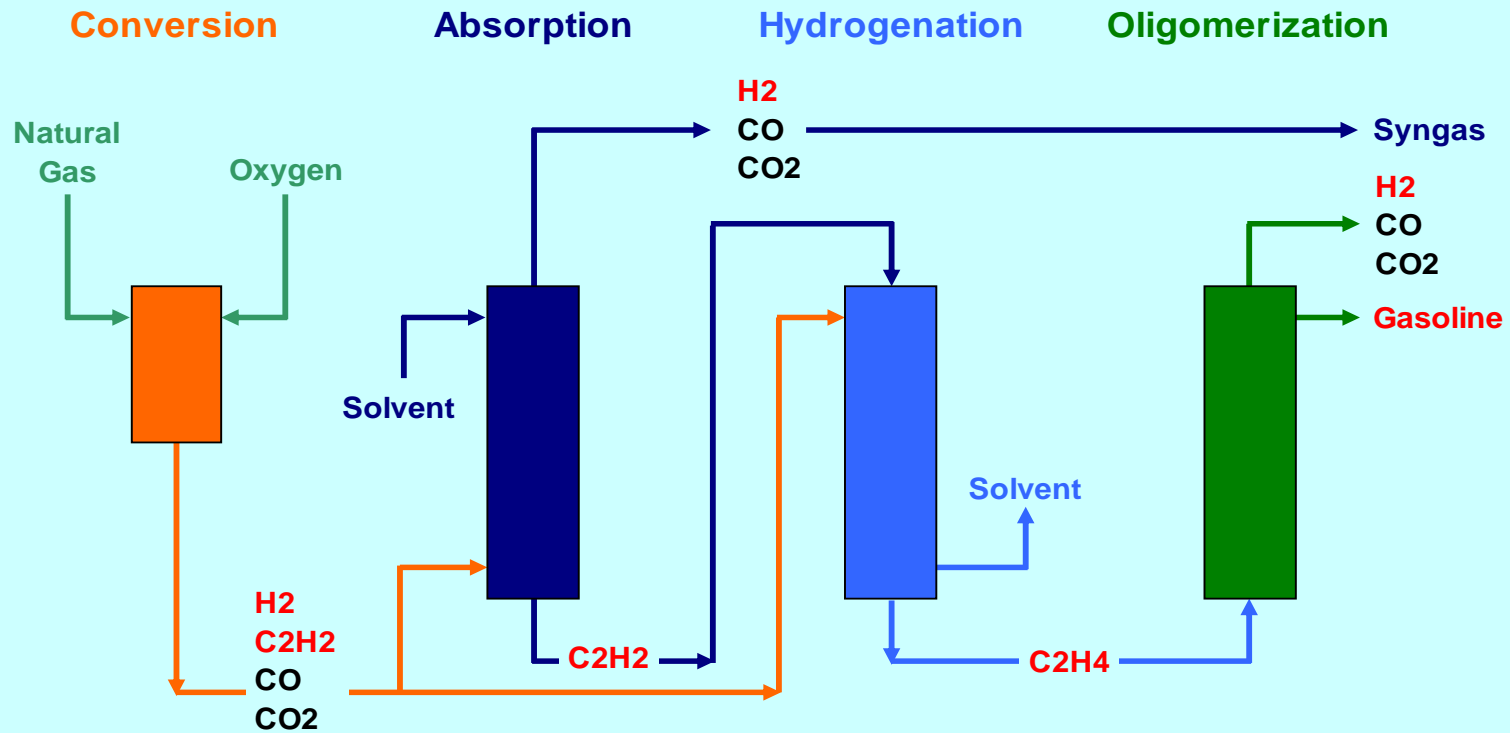
# FT Risks

- Many Players/Many patents
  - Since 1976 the following companies collectively have been granted 151 patents granted related to Fischer-Tropsch Technology. The chance of one of these being accused of infringing upon another's protected art is substantial.

Chevron	36
Shell	29
Exxon	17
ExxonMobil	14
Sasol	13
ConocoPhillips	13
Mobil	10
Rentech	10
Syntroleum	7
ChevronPhillips	1
Conoco	1

**AREF**

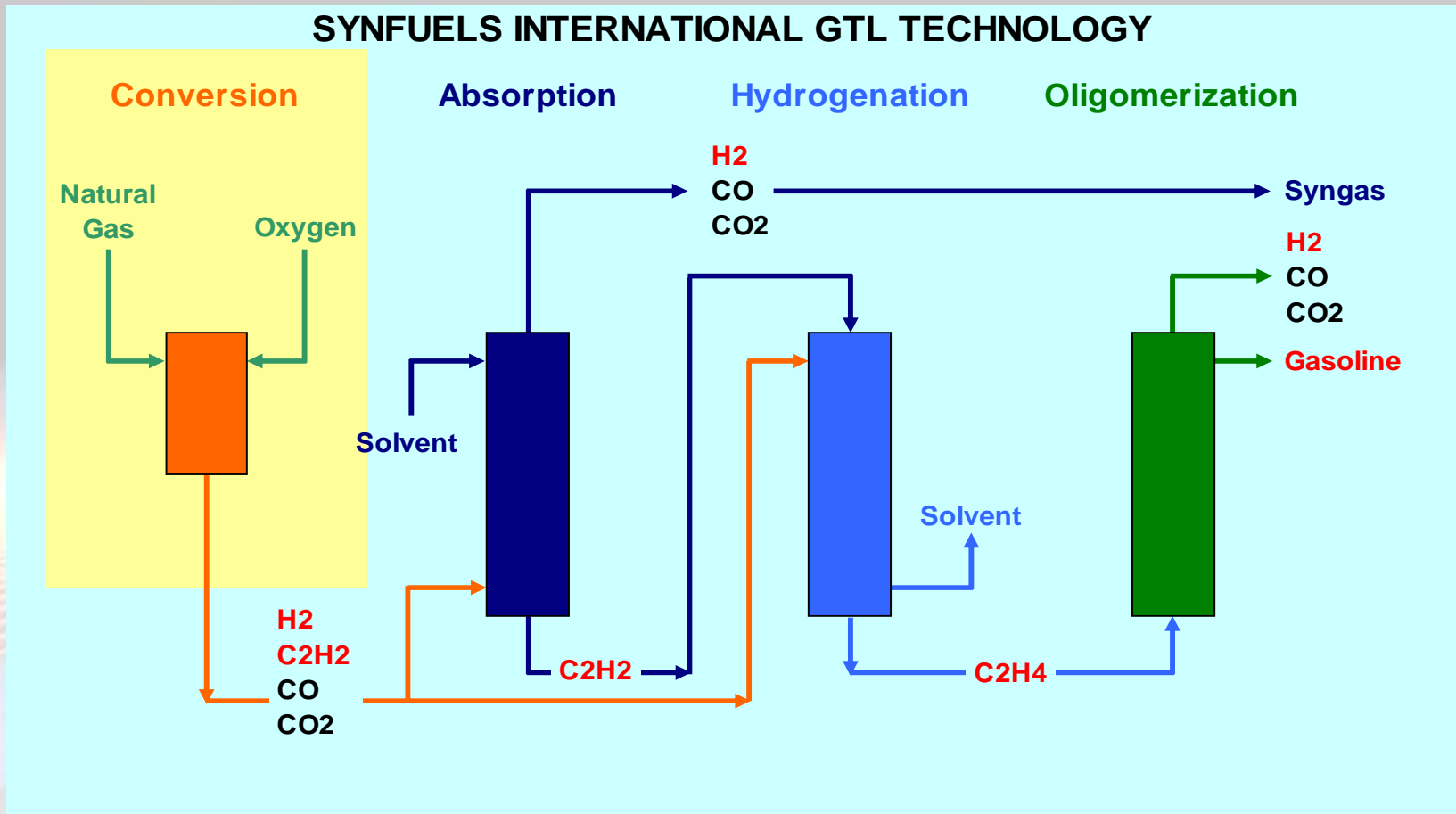
**SYNFUELS INTERNATIONAL GTL TECHNOLOGY**



**AREF**

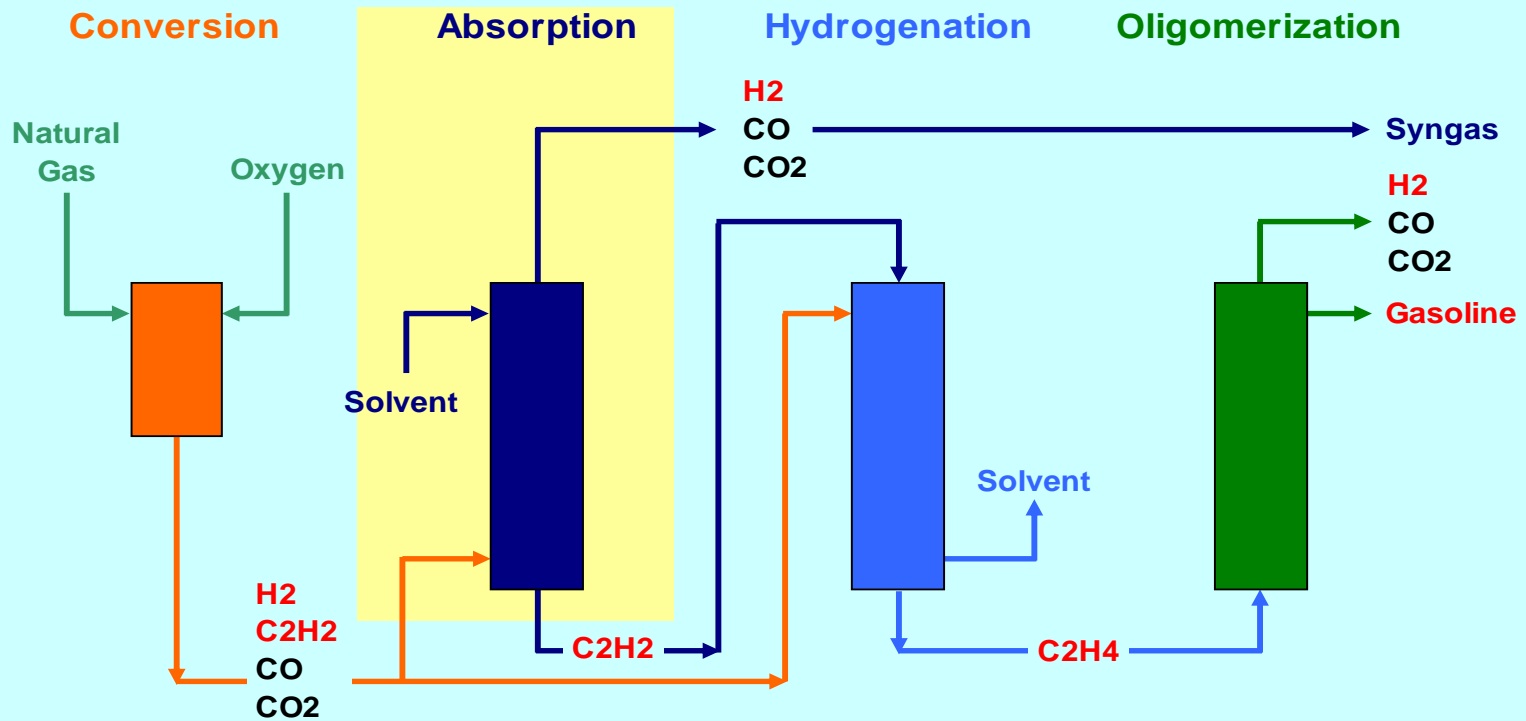


**SYNFUELS INTERNATIONAL GTL TECHNOLOGY**



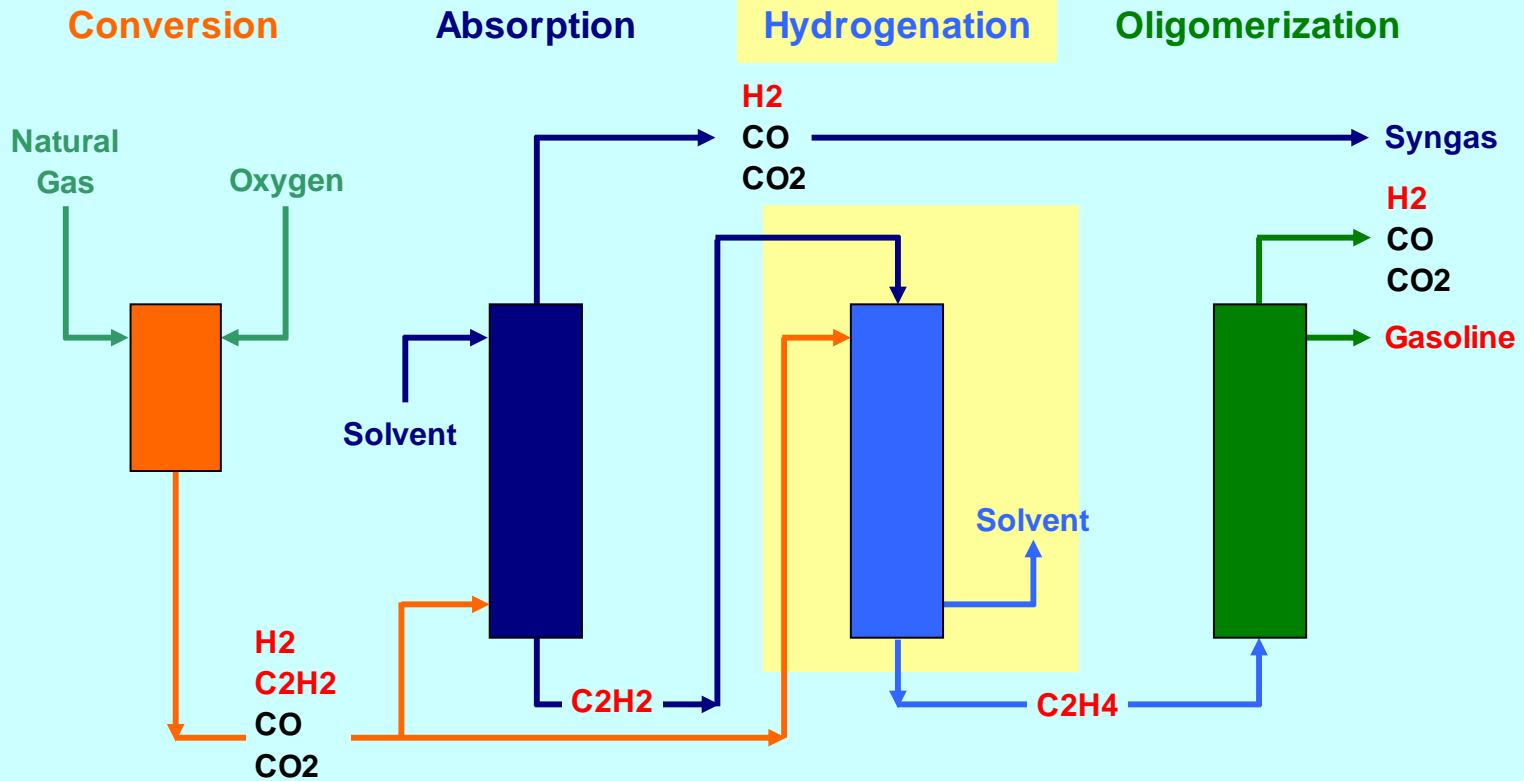
**AREF**

**SYNFUELS INTERNATIONAL GTL TECHNOLOGY**



**AREF**

**SYNFUELS INTERNATIONAL GTL TECHNOLOGY**



**AREF**

Basically unchanged

## Gas-Phase Hydrogenation Problems

- Must limit acetylene concentration for reaction and temperature control
- Requires processing large volumes of gas
- High temperature can lead to a “run-away” reaction
- Tends toward over-conversion to ethane

AREF

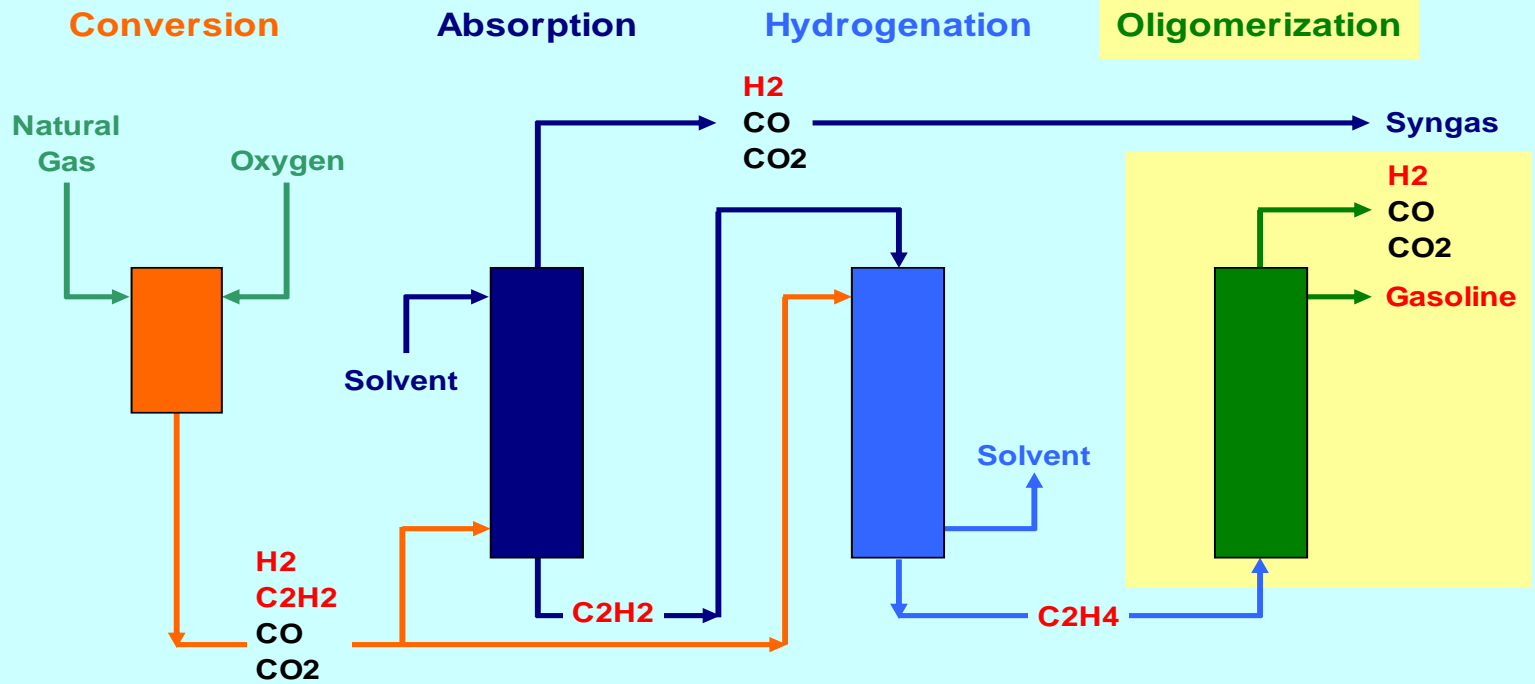
## Synfuels Process using Liquid-Phase Hydrogenation of Acetylene

- Selectively absorbs acetylene
- Rejects unwanted gases
- Greatly reduces reaction volume
- Operates at moderate conditions
- No thermal “run-away” reaction
- Much higher acetylene concentrations can be used

**AREF**

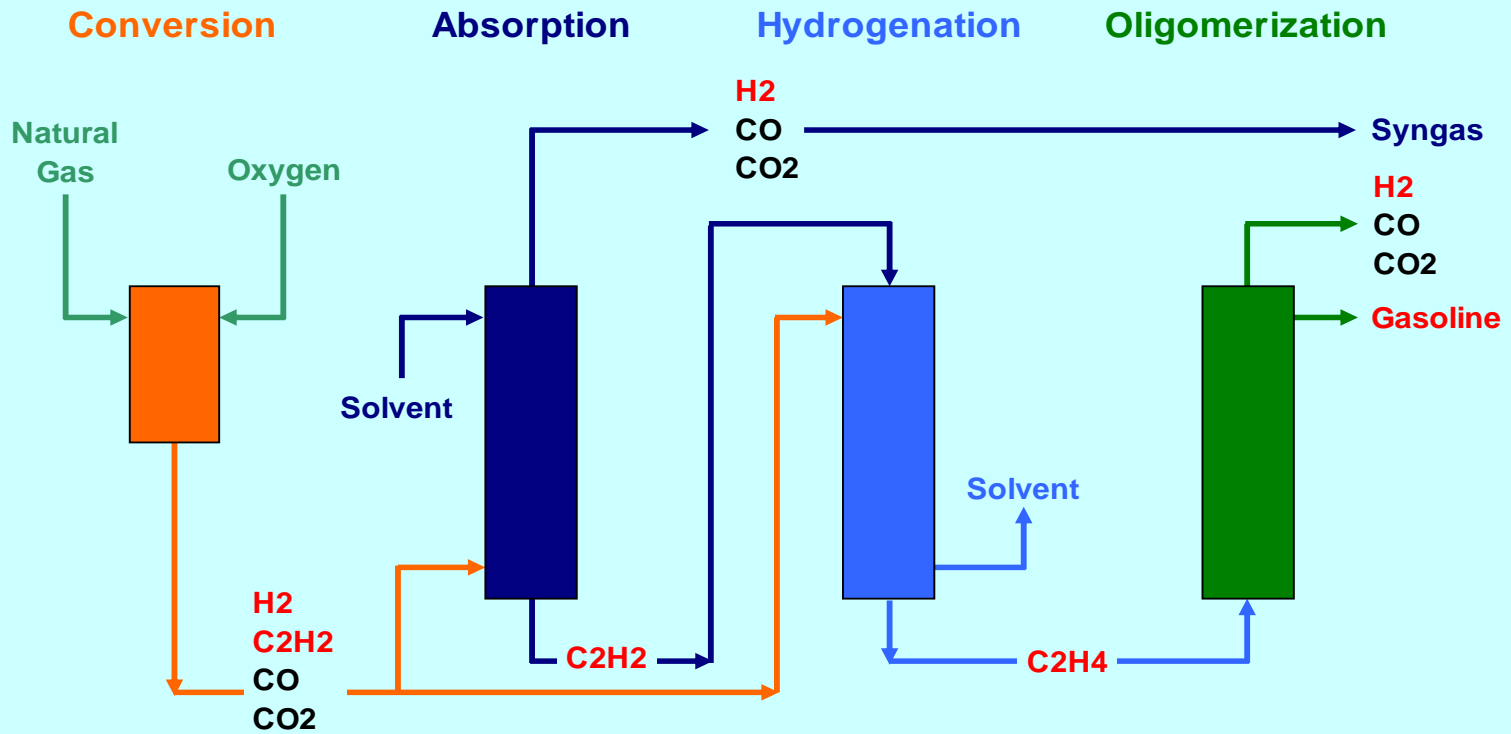


**SYNFUELS INTERNATIONAL GTL TECHNOLOGY**



**AREF**

**SYNFUELS INTERNATIONAL GTL TECHNOLOGY**



**AREF**

- Synfuels Product Properties

<b>Specific Gravity</b>	<b>0.7599 (Water=1)</b>
<b>API Gravity</b>	<b>54.71 @ 60 F</b>
<b>Molecular Weight</b>	<b>100.422</b>
<b>Weight</b>	<b>6.33 Lbs/Gal</b>
<b>Gross Heating Value</b>	<b>124190 BTU/CF</b>

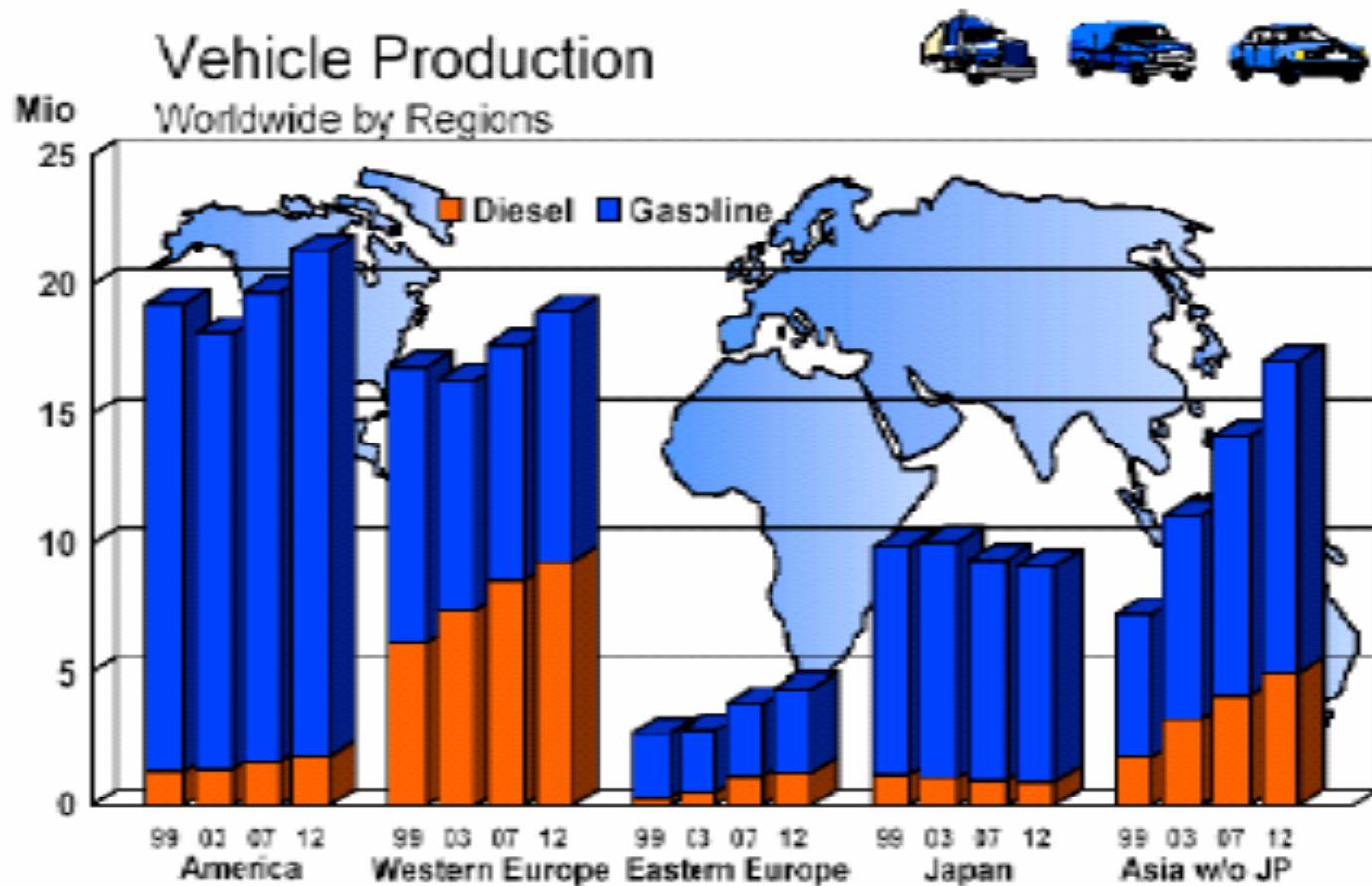
- Synfuels Product Composition

	<b>vol%</b>
<b>Paraffins</b>	<b>12</b>
<b>Iso-paraffins</b>	<b>35.9</b>
<b>Olefins</b>	<b>1</b>
<b>Naphthenes</b>	<b>9.8</b>
<b>Aromatics</b>	<b>38.5</b>

**AREF**

# World Market Vehicle Trends

- Source: Bosch at Hart 2004 World Fuel's Conference Rio de Janeiro via International Fuel. Doha. 2004



**AREF**

## Intellectual Property

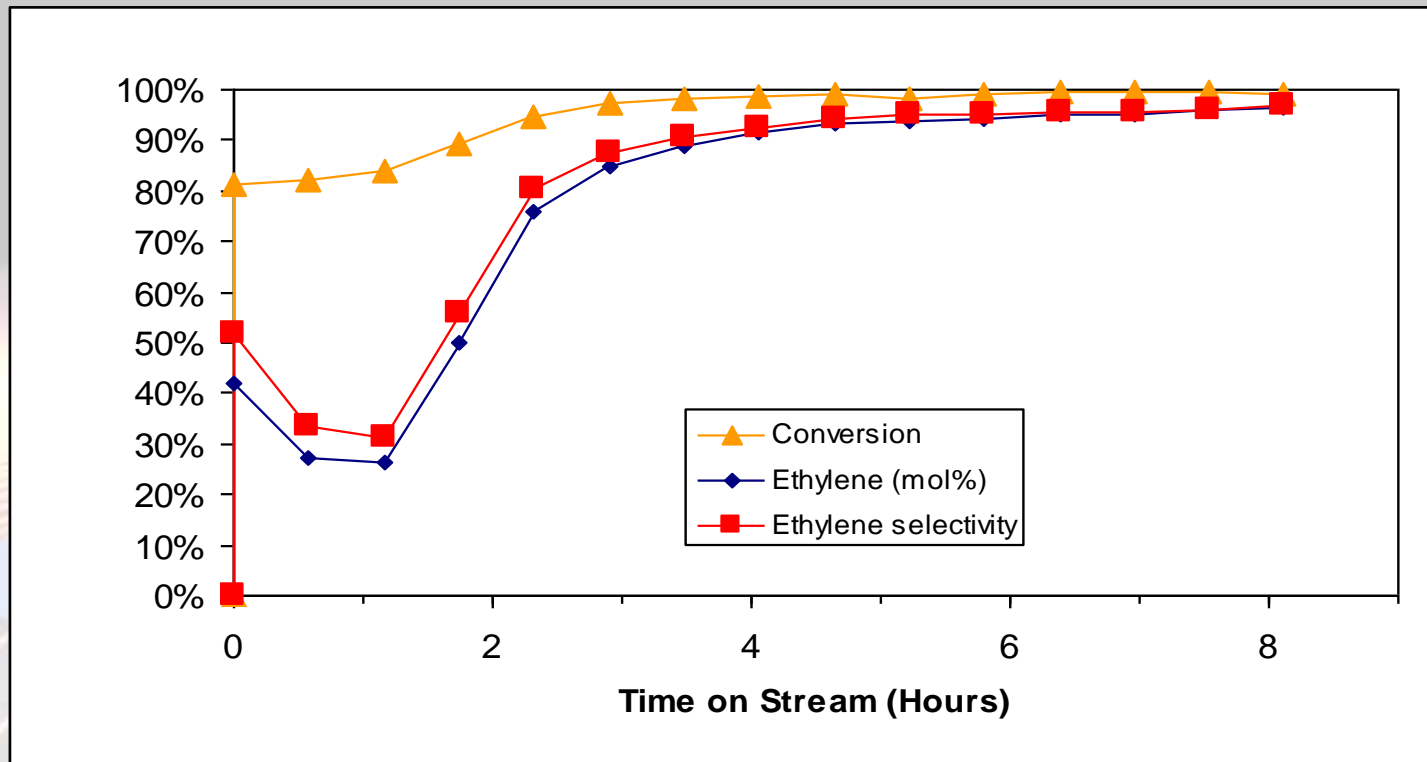
Synfuels Technology is covered by 8 US Patents and dozens of patents pending:

<b>6,130,260</b>	Method for converting natural gas to liquid hydrocarbons
<b>6,323,247</b>	Method for converting natural gas to liquid hydrocarbons
<b>6,602,920</b>	Method for converting natural gas to liquid hydrocarbons
<b>7,045,670</b>	Process For Liquid Phase Hydrogenation
<b>7,119,240</b>	Method for converting natural gas to olefins
<b>7183451</b>	Process For The Conversion Of Natural Gas To Hydrocarbon Liquids
<b>7208647</b>	Process For The Conversion Of Natural Gas To Reactive Gaseous Products Comprising Ethylene
<b>7,250,449</b>	High temperature hydrocarbon cracking

The word "AREF" is written in large, bold, red, 3D-style block letters with a blue outline, positioned in the bottom right corner of the slide.

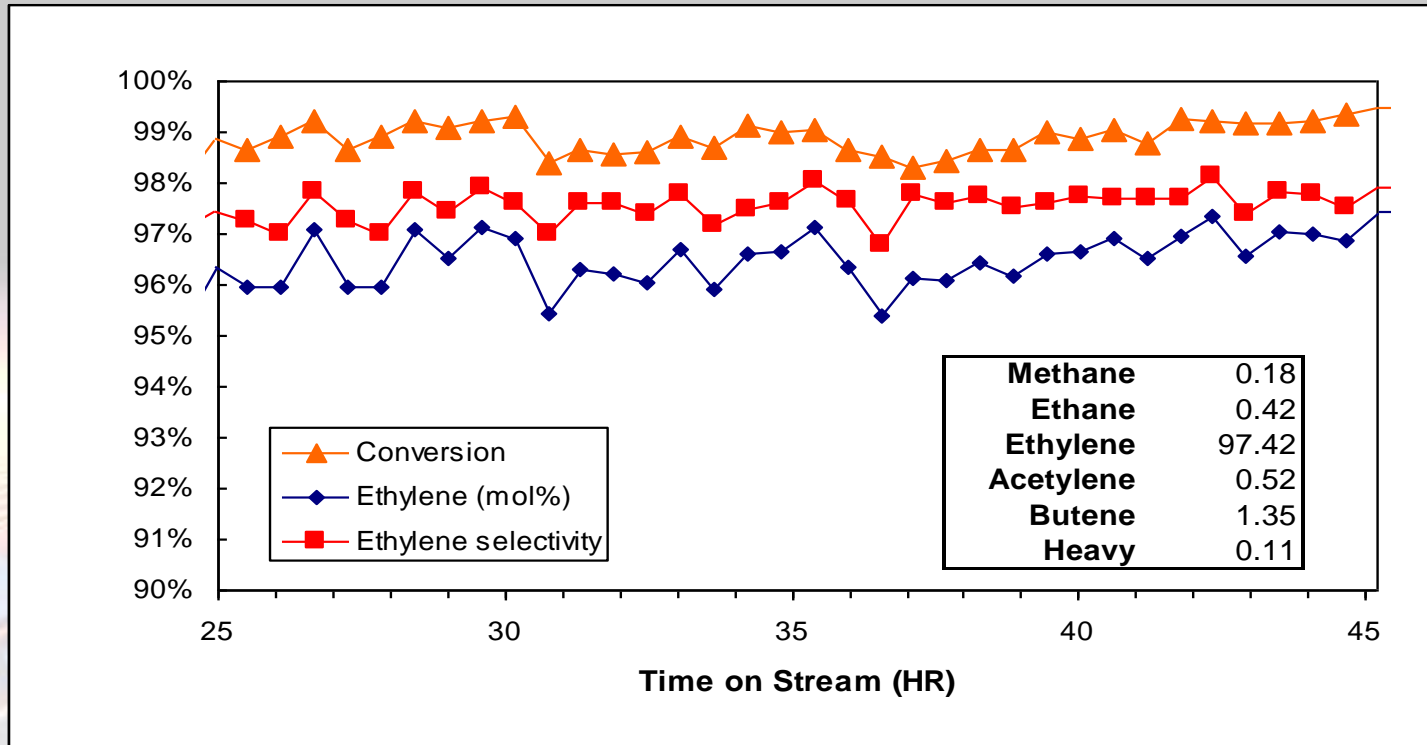


## Typical Hydrogenation Conversion and Selectivity Lab Data



**AREF**

## Extended Duration Conversion and Selectivity – Lab Data



<b>Methane</b>	0.18
<b>Ethane</b>	0.42
<b>Ethylene</b>	97.42
<b>Acetylene</b>	0.52
<b>Butene</b>	1.35
<b>Heavy</b>	0.11

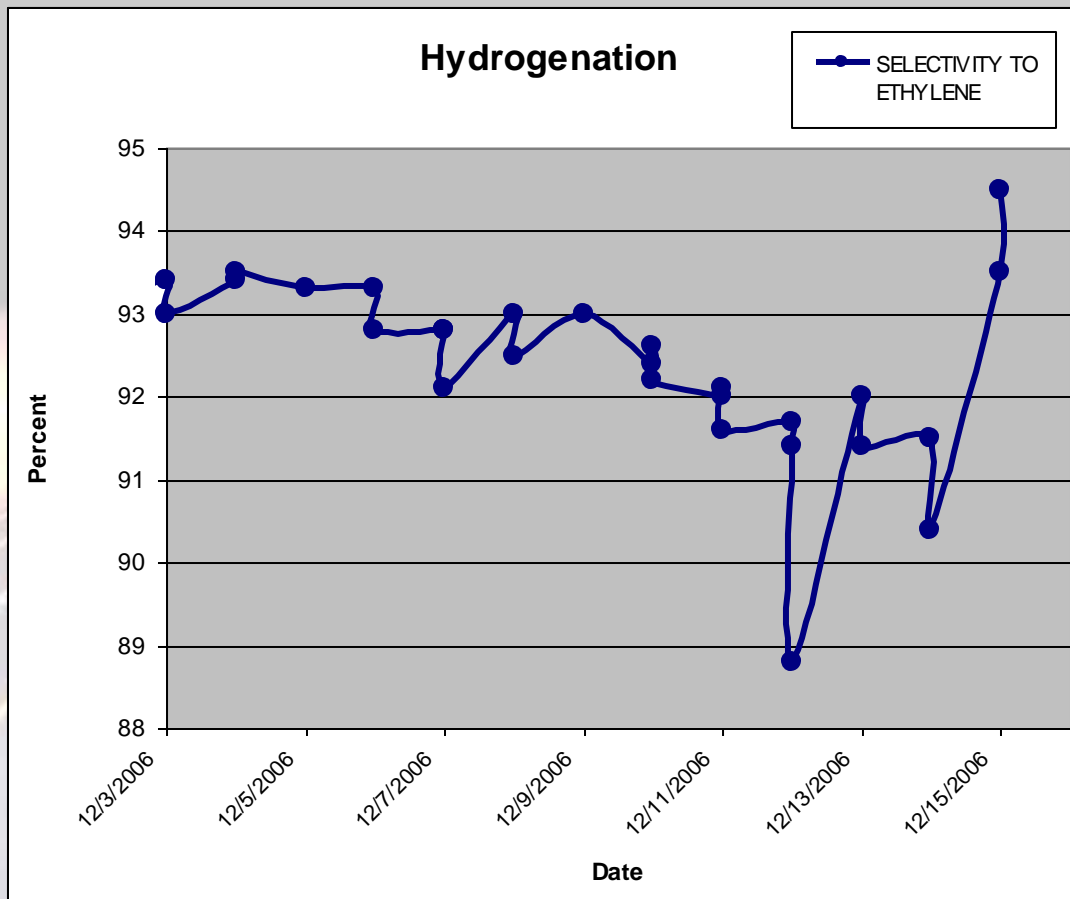
**AREF**

## Demonstration Unit



**AREF**

## Pilot Plant Data



**AREF**

## Summary

- New Synfuels GTL Process dramatically reduces capital cost
- Now majority of stranded gas fields can be utilized
- Unique new technology that blends established industrial practices with patent protected innovation
- Key to the Synfuels process are the innovative steps that isolate and convert intermediates, reducing recycle, compression, and system volumes
- Synfuels liquid-phase hydrogenation is the technology's cornerstone
- Liquid-phase hydrogenation may be applicable to other hydrogenation processes outside GTL

Large, bold, red 3D-style text with a blue outline, reading "AREF".



## The Synfuels Team

- **Synfuels International, Inc.**
  - Ben Weber, CEO
  - Tom Rolfe, President
  - Charles Matar, Managing Director
  - Ed Peterson, Chief Engineer
- **Bryan Research and Engineering**
  - Jerry Bullin, President
  - Joel Cantrell, Operations Manager
- **Texas A&M University**
  - Kenneth Hall

**AREF**