# CLEAN FUELS & CHEMICALS GROUP

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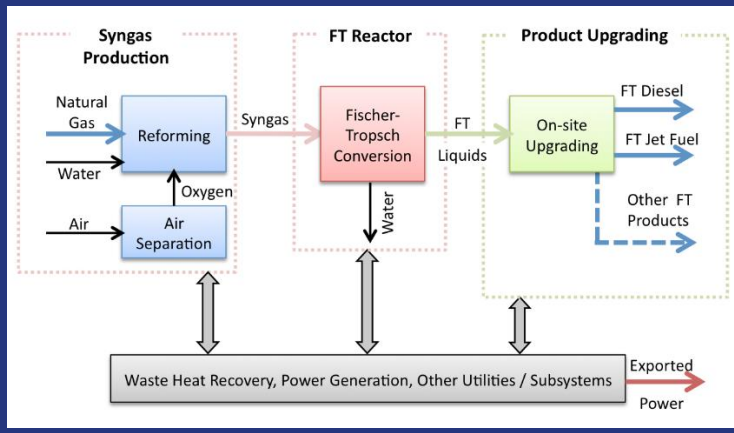
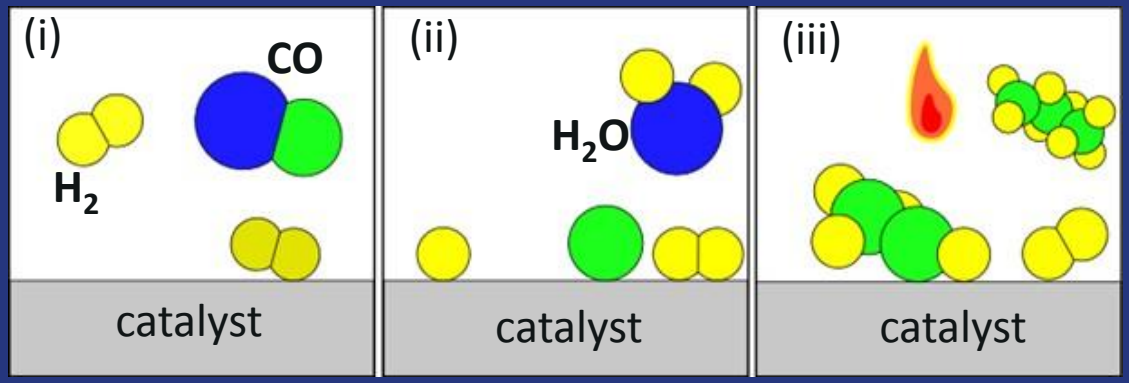
# What does this group do?

❑ Gas-to-liquid technology (GTL) also known as Fischer-Tropsch synthesis (FTS).

- ✓ Conversion of syngas (a mixture of CO and $H_2$) into liquid transportation fuels
- ✓ In presence of Fe, Co or Ru catalysts
- ✓ T=200-350°C & P=20-30 atm




## Fischer-Tropsch Chemistry




i. Hydrogen and carbon monoxide flow to the catalyst
ii. Hydrogen and carbon "stick" to the catalyst, water diffuses away
iii. Hydrocarbon chains form – gasoline, jet fuel, diesel

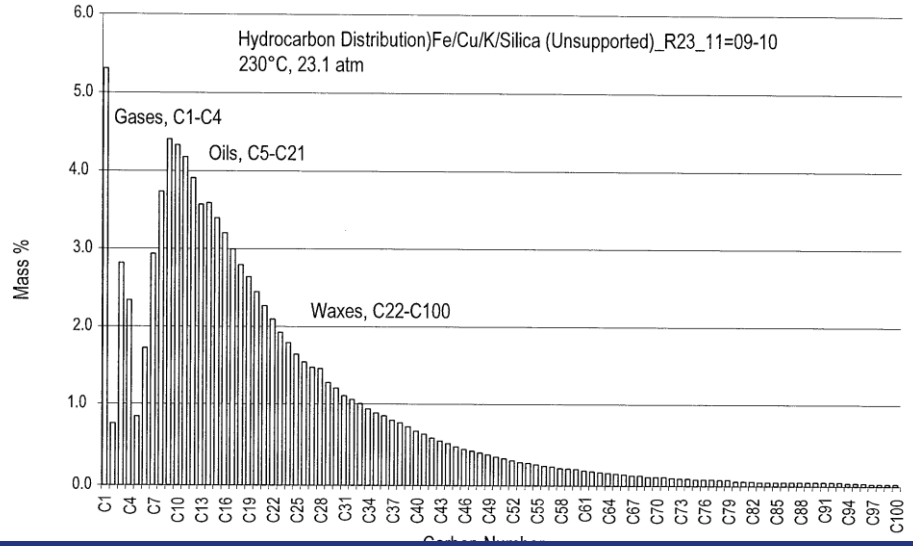
# Advantages of FT fuels

- ✓ US Energy Policy Act of 1992 designates GTL products derived from natural gas as an “alternative fuels”
- ✓Minimize environmental impacts
- ✓It can be used directly or blended with conventional fuels
- ✓GTL gasoline and GTL jet fuel are virtually sulfur free
- ✓GTL diesel has higher cetane number

# “FT” a versatile process

## Oil Fractions

| Name | Carbon atoms per molecule | Uses |
|---|---|---|
| Gases | 1 to 4 | Fuel |
| Petrol | 4 to 9 | Fuel for cars |
| Naphtha | 8 to 14 | Chemicals |
| Paraffin | 10 to 16 | Aircraft fuel |
| Diesel | 15 to 20 | Lorry fuel |
| Residue | More than 20 | Lubricating oil, tar, wax etc. |



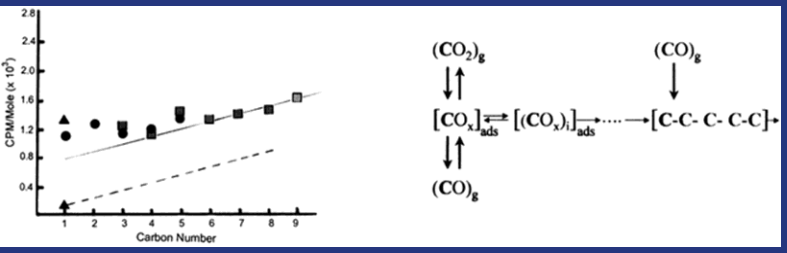

Hydrocarbons as fuel with varying carbon numbers

Typical product distributions from FT process

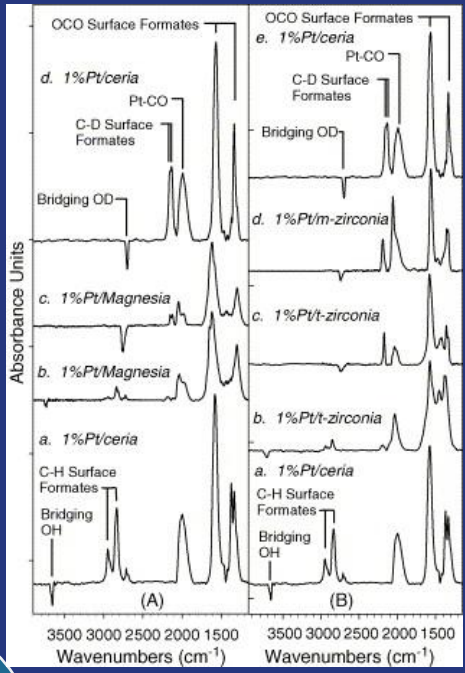
- **Problems:**
  - ✓ **Highly exothermic – heat control**
  - ✓ **Methane Selectivity**
  - ✓ **Maximize the selectivity to desired product**
  - ✓ **Mechanism of FT reaction – more complex**

# Research Interests

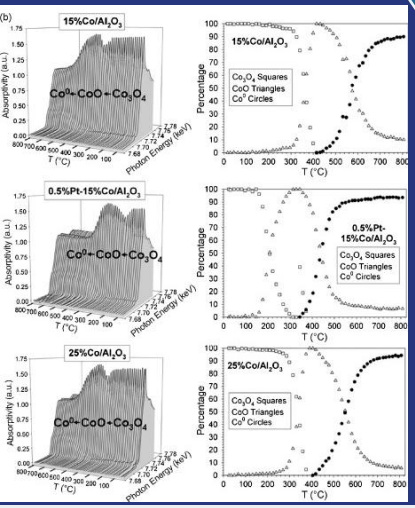
- $14CO_2$-tracer study



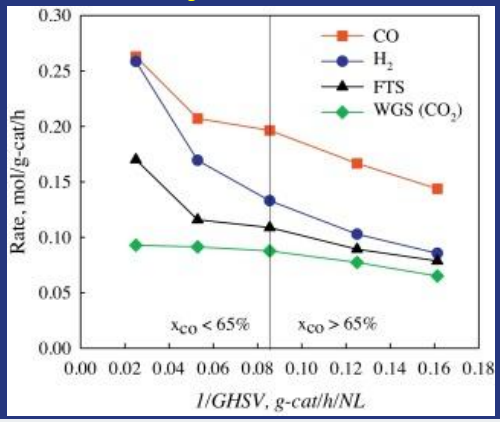

- Water-gas shift reaction: support effect




- Promoter effect on the reduction of supported cobalt oxide




- FT and WGS Kinetics for a iron catalyst




Isotope tracer studies

X-ray absorption techniques (XANES, and EXAFS)

Investigation of catalyst structure and its reactivity

DRIFTS-IR studies

Kinetics of Fischer-Tropsch synthesis

# Facilities

- **Analytical equipment**:
  - GC-FID 4 units (Agilent-7890), GC-MS, Sulfur analyzer (SRI-GC). CO and $CO_2$ analyzers.
- **Catalyst characterization techniques:**
  - BET surface area analyzer (Micromeritics)
  - TPR/TPO (Altimara)
  - FT-IR attached to DRIFTS cell for insitu analysis
  - HR-TEM, XANES and EXAFS (external)
- **Catalyst testing equipment:**
  - 1L CSTR (22 reactors), Bench-scale fixed bed reactors (2 units), small fixed-bed reactors (6 units)

# Additional Information

- **Where does the CFC group get funding from?**

  *Catalyst producing company (e.g. Clariant); Department of Energy; NASA.*

- **Where does the CFC group publish?**

  *All major catalysis related journals such as ACS catalysis; Journal of Catalysis; ChemCatChem; RSC Advances; Applied Catalysis; Catalysis Today; Catalysts; Chemical Reviews; Catalysis Science and Technology.*

- **Where does the CFC group present its results?**

  *AICHE; ACS; North American Catalysis; Tri-state Catalysis Society meetings*.

- **Where do students that work in the CFC group go afterwards?**

  *Industry (e.g. Chevron, Clariant)*

  *Government (e.g. National Laboratories)*

  *Graduate School (e.g. UC Berkeley; Uni. of Alberta, Canada; Uni. of Wits, South Africa)*