

A background pattern of stylized floral and leaf motifs in dark purple, light green, and light blue. The motifs are scattered across the white background, with some larger, more detailed branches and leaves in the foreground and smaller, simpler shapes in the background.

GROUP 6

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SYNTHETIC FUELS

OVERVIEW

- Introduction
 - Production
 - Fischer-Tropsch Process
 - Process Description
 - Product Upgrading
 - Qualities of synthetic fuels
 - Advantages of the Process
-

INTRODUCTION

– **WHAT ARE SYNTHETIC FUELS?**

- Synthetic fuel is a category of fuels that includes any fuel “produced from coal, natural gas or biomass feed stocks through chemical conversion” [Source: U.S. Energy Information Administration].
- Another name for synthetic fuel is synfuel, gaseous fuel, Fischer Tropsch liquids.

INTRODUCTION

– HISTORY OR BACKGROUD OF SYNTHETIC FUELS.

- Started in Germany in the 20th century.
- First person was Friedrich Bergius. A scientist.
- The other two persons were Franz Fischer and Hans Tropsch.
- Main reason was to solve pollution and economic problems.

PRODUCTION OF SYNTHETIC FUELS

– Synthetic fuel can be produced from coal by two main methods:

– **Direct liquefaction:**

- *Pyrolysis and carbonization*
- *Hydrogenation*

– **Indirect liquefaction:**

Syngas production by gasification followed by fischer-tropsch synthesis to produce liquid fuels

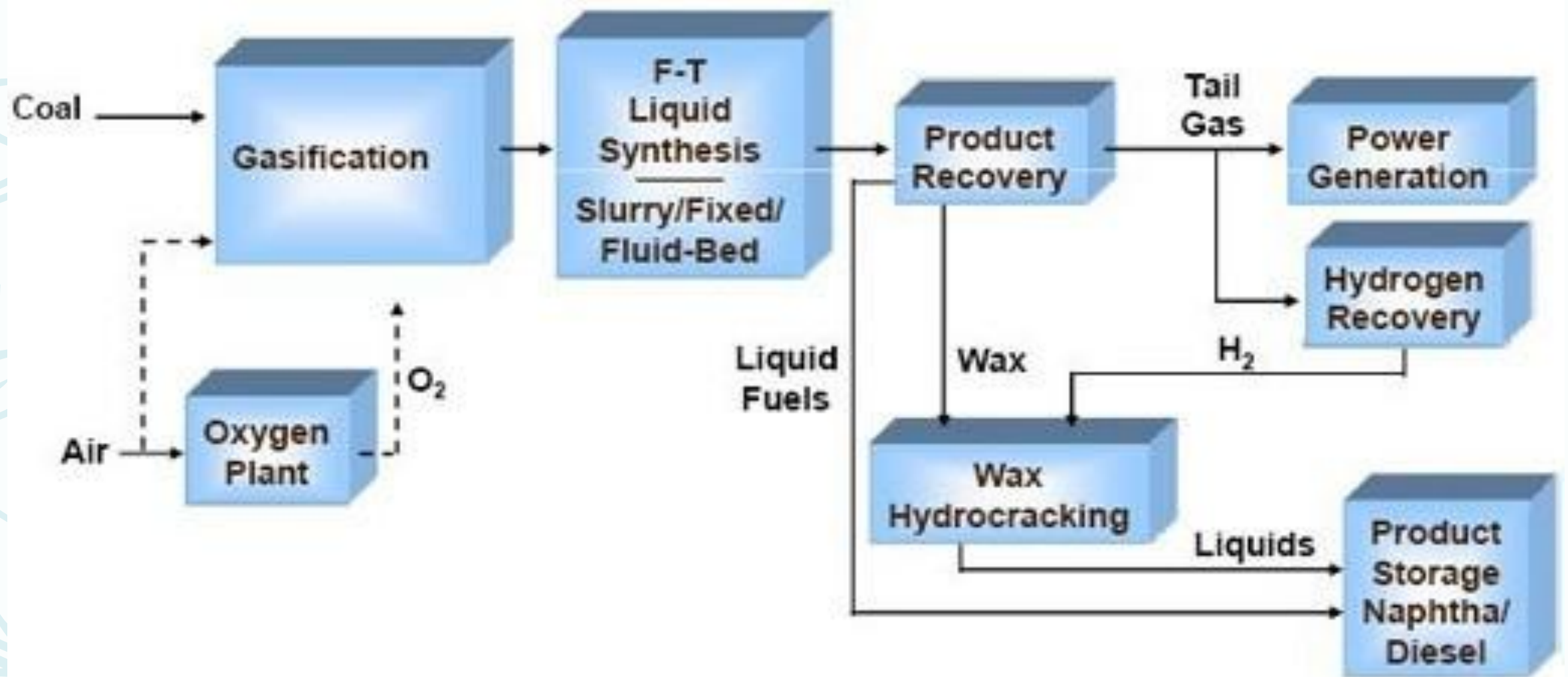
PRODUCTION OF SYNTHETIC FUELS

- Another route to synthetic fuel(**gasoline**)
 - *Via methanol. Called methanol to gasoline process.*
 - *It was developed by ExxonMobil.*

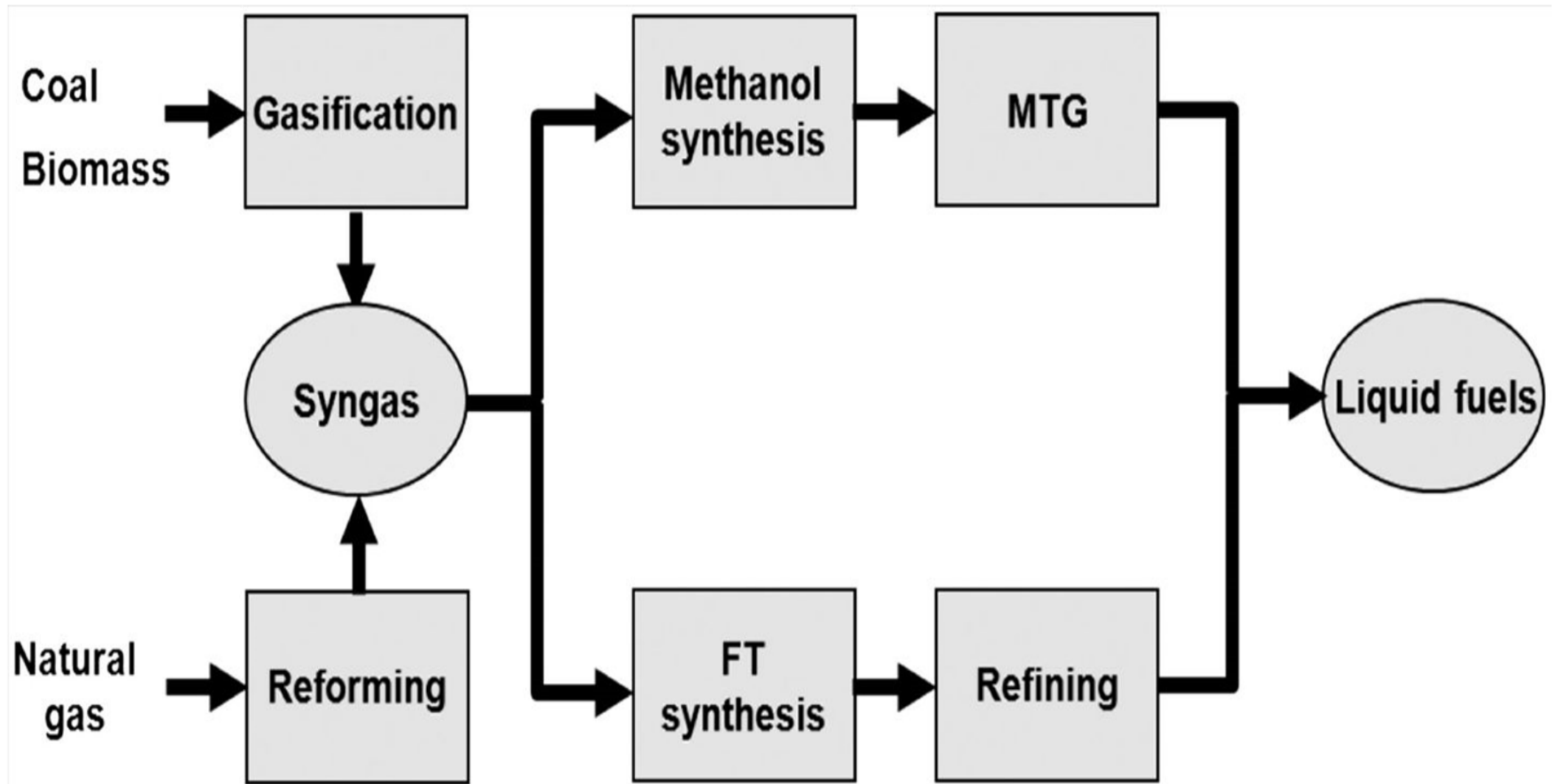
INTRODUCTION

Coal _____

Air _____

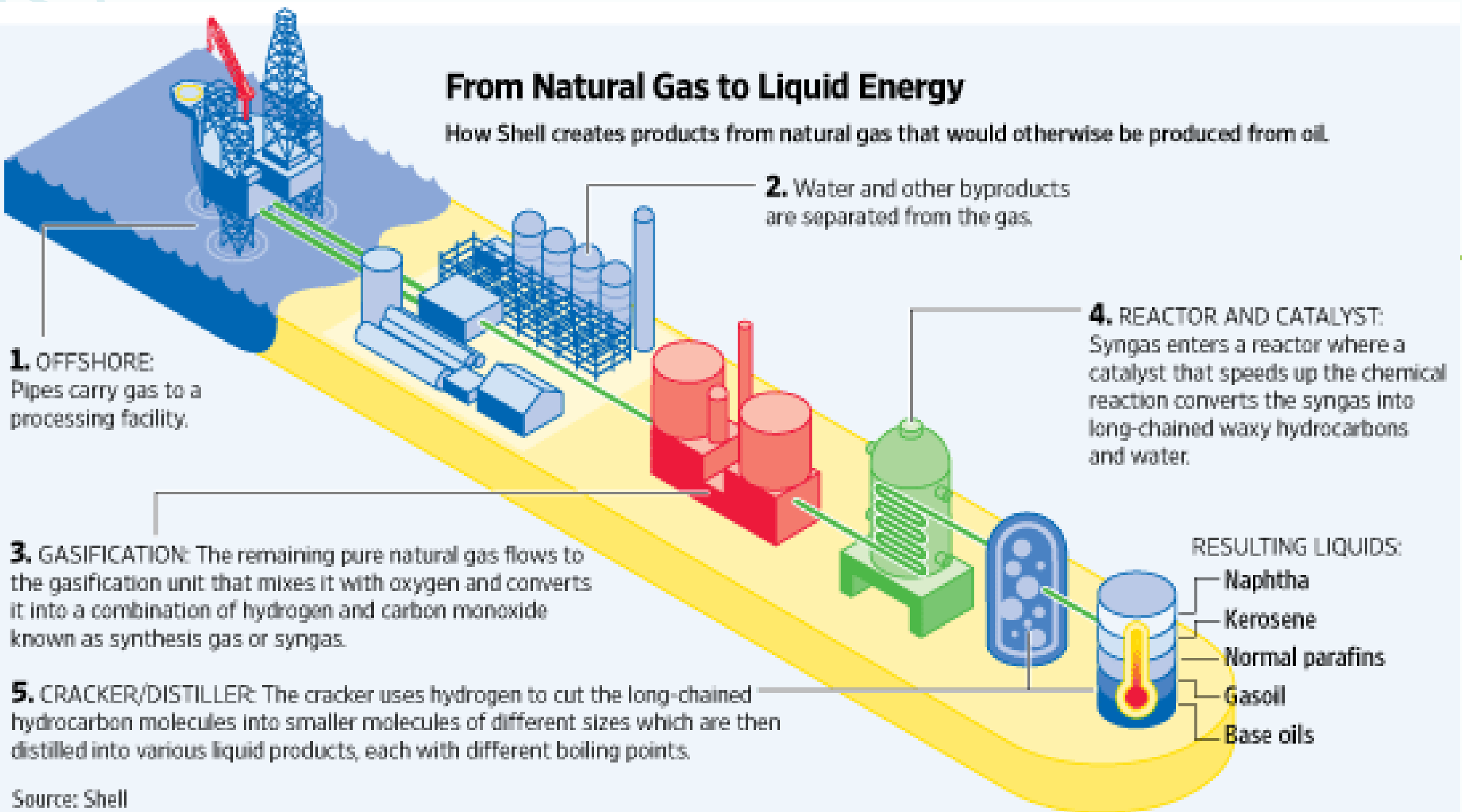


PRODUCTION OF SYNTHETIC FUELS (DIFFERENT FEEDSTOCKS)



From Natural Gas to Liquid Energy

How Shell creates products from natural gas that would otherwise be produced from oil.



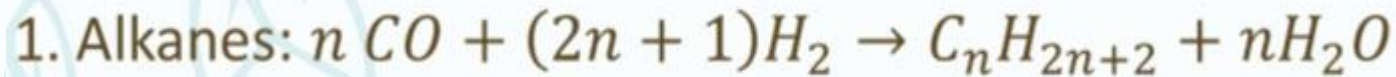
FISCHER-TROPSCH (F-T) SYNTHESIS

○ REACTIONS

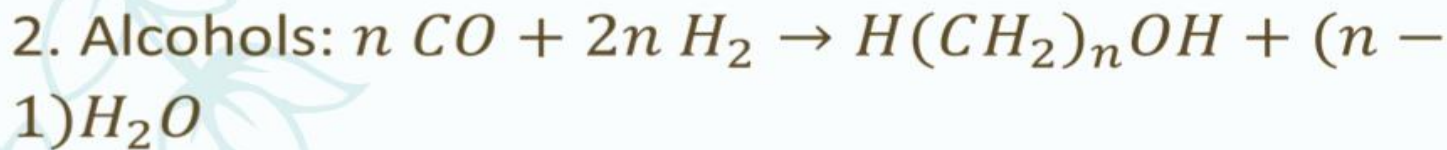
- The syngas feed into the system has mainly carbon monoxide and Hydrogen gas.
- The reaction is highly exothermic.
- Reaction is a catalytic reaction (Co or Fe).

REACTIONS

○ Main reactions:



○ Side reactions



PROCESS DESCRIPTION

- The Fischer-Tropsch reaction is highly exothermic; therefore heat removal is an important factor in the design of a commercial reactor.
- Reaction occurs in two temperature ranges: high temperatures(300-350 °C), 15-25 atm. Low temperatures(220-270 °C), 20-25 atm.
- Some of the reactors used are;
 - a. Multitubular fixed bed reactor (Arge)
 - b. Slurry- phase reactor
 - c. Circulating fluidized bed reactor(Synthol)
 - d. Fixed fluidized bed reactor(Sasol Advanced Synthol, SAS)

Catalysts

1. IRON: high water gas shift activity. Suitable for producing gasoline and linear alkanes. High and low temperature applications.
2. Cobalt: No water gas shift activity. More active and suitable for producing diesel and waxes. Low temperature applications.

PRODUCT UPGRADING

- Two kinds of liquids are produced after the fischer-Tropsch process.
 1. Heavy Fischer-Tropsch liquids
 2. Liquid Fischer-Tropsch Liquids

PRODUCT UPGRADING

Also three by products are produced. They are;

1. - water,
2. tailgas, and
3. heat

PRODUCT UPGRADING

- Specifically in a Syntroleum GTL fuel plants
- The upgrader consists of
 1. Distillation
 2. Hydro processing units.

QUALITY OF SYNTHETIC FUELS

– **Synthetic Diesel (S-2)**

- Also known as S-2.

– Properties

1. highly paraffinic
2. high-cetane distillate product suitable for conventional and advanced compression ignition diesel engines and fuel cells.

QUALITY OF SYNTHETIC FUELS

3. The diesel is similar to petroleum-based diesel fuels, but with superior combustion emission characteristics.

4. At ambient temperature and pressure S-2 is a

1. colourless,
2. stable,

QUALITY OF SYNTHETIC FUELS

5. environmentally safe liquid that can be *shipped, stored and dispensed using the same fuel distribution and handling procedures as petroleum diesel. Due to its attributes, it outperforms diesel fuel produced from crude oil.*

QUALITIES OF SYNTHETIC FUELS

– Synthetic Naphtha (FC-2)

– Properties

1. It is ultraclean, synthetic naphtha
2. It is saturated with hydrogen and has many applications in the petrochemical and fuel industry.
3. FC-2 is free of aromatics, metals and sulphur.
4. It is composed of more than 99.99 percent naphtha.

QUALITIES OF SYNTHETIC FUELS

– Synthetic Naphtha (FC-2)

– USES

1. FC-2 can be utilized for feed stocks in ethylene crackers, fuel cells, and low-compression engines
2. or undergo further processing into upgraded products such as high-octane gasoline and liquefied petroleum gas.

QUALITIES OF SYNTHETIC FUELS

- **Synthetic LPG**
- Synthetic LPG is used for domestic heating, cooking and transportation
- has outstanding qualities when compared to conventional LPG.
- Synthetic LPG contains no contaminants such as hydrogen sulphide, carbon dioxide, oxygen compounds and moisture that are commonly found in conventional LPG.

QUALITIES OF SYNTHETIC FUELS

- **Synthetic LPG**

- Because of these attributes, synthetic LPG does not require any gas conditioning, such as dehydration or amine processing.
- The lack of contaminants also implies that synthetic LPG can be handled more safely and will have a higher performance for end-use markets, especially in terms of emissions.

BY PRODUCTS

- **Water**

- The water contains contaminants including suspended paraffin and small amount of dissolved oxygenates, such as alcohols, and inorganic ions such as ammonia. The water is fed to a wastewater stripper, where volatiles are removed and sent to a pre-performer for recovery of hydrocarbon value.

BY PRODUCTS

- **Water**

- The stripped water is routed to the wastewater treatment plant for conditioning as makeup water for cooling towers and process boilers

BY PRODUCTS

- The second by-product, tailgas, is a clean-burning and abundant source of energy that fuels low-Btu heaters, gas turbines, and any additional power generation. The tailgas displaces the use of natural gas and therefore reduces operating costs and increases plant efficiency. The tailgas can also be sold to nearby refineries for steam or power generation.

BY PRODUCTS

- The final by-product is high-pressure and medium-pressure steam, raised from FT reactor, respectively. The steam is used in a variety of applications, ranging from steam turbine operations for power generation and or compression to water reclamation, such as water stripping and desalination.

ADVANTAGES OF THE PROCESS

- The entire process has several advantages over competing processes.
- **Advantages**
 1. The process utilizes air instead of pure oxygen to generate FT liquids. This reduces the cost of the plant and increases the safety of plant personnel.

ADVANTAGES OF THE PROCESS

2. The process produces several recoverable by products like tailgas, heat and water.
3. The lack of contaminants, sulphur, aromatics and heavy metals simplifies the refining section of the plant.

International synthetic fuel producers and their production rate

Company	Location	Feedstock	Reactor (catalyst)	Operation	Current liquids output (b/d)
Sasol (I)	Sasolburg, South Africa	initially coal, currently natural gas	fixed bed (Fe) CFB (Fe) slurry (Fe)	1955 – present 1957–1993 1993 – present	5000
Sasol (Sasol Synfuels ^a)	Secunda, South Africa	coal, currently supplemented by natural gas	CFB (Fe) FFB (Fe)	1980–2000 1995 – present	160 000
PetroSA ^b	Mossel Bay, South Africa	natural gas	CFB (Fe)	1991 – present	30 000
Shell	Bintulu, Malaysia	natural gas	fixed bed (Co)	1993 – present	14 700
Sasol-Chevron/Qatar Petroleum (Oryx)	Ras Laffan, Qatar	natural gas	slurry (Co)	2007 – present	34 000
Shell/Qatar Petroleum (Pearl)	Qatar	natural gas	fixed bed (Co)	2011/2012	140 000
Sasol-Chevron	Escravos, Nigeria	natural gas	slurry (Co)	2013	34 000



REFERENCES

- Robert A. Meyers (2003). Handbook of Petroleum Refining Processes, Third Edition. Published by: McGraw-Hill Handbooks. ISBN:0-07-139109-6. Pp 15.16-15.23.
- U.S Energy Department. Website: www.netl.doe.gov.