

Making Fischer-Tropsch

**A GTL/CTL/BTL PLANT PRODUCES
FISCHER-TROPSCH (F-T)
FUELS AND PETROCHEMICAL FEEDSTOCKS
SOME OF THE CLEANEST FUELS
IN THE WORLD**

BUT WHAT IS THE F-T PROCESS?

The Fischer-Tropsch Synthesis




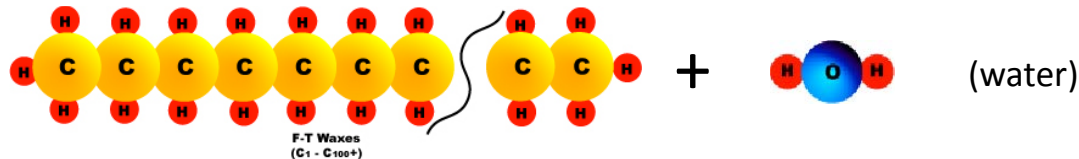
Okay, don't let the
chemistry scare you!

Let's take a look.....

Three Steps in GTL/CTL/BTL Refining Process to make F-T Fuels

GTL/CTL/BTL Processes use 3 distinct steps, all commercially proven to convert a gas, liquid or solid into synthetic transport fuels:

- Step 1 - Syn-Gas generation (H_2 & CO) 
- Step 2 - The F-T reaction (long paraffin chains \rightarrow wax)



- Step 3 - Product upgrading (hydrocracking of the long chain F-T paraffin to produce the desired end product – similar to a crude oil refinery)
 - Kerosene – Diesel – Gasoline - Jet Fuel – Naphtha

$C_{10}-C_{13}$

$C_{14}-C_{20}$

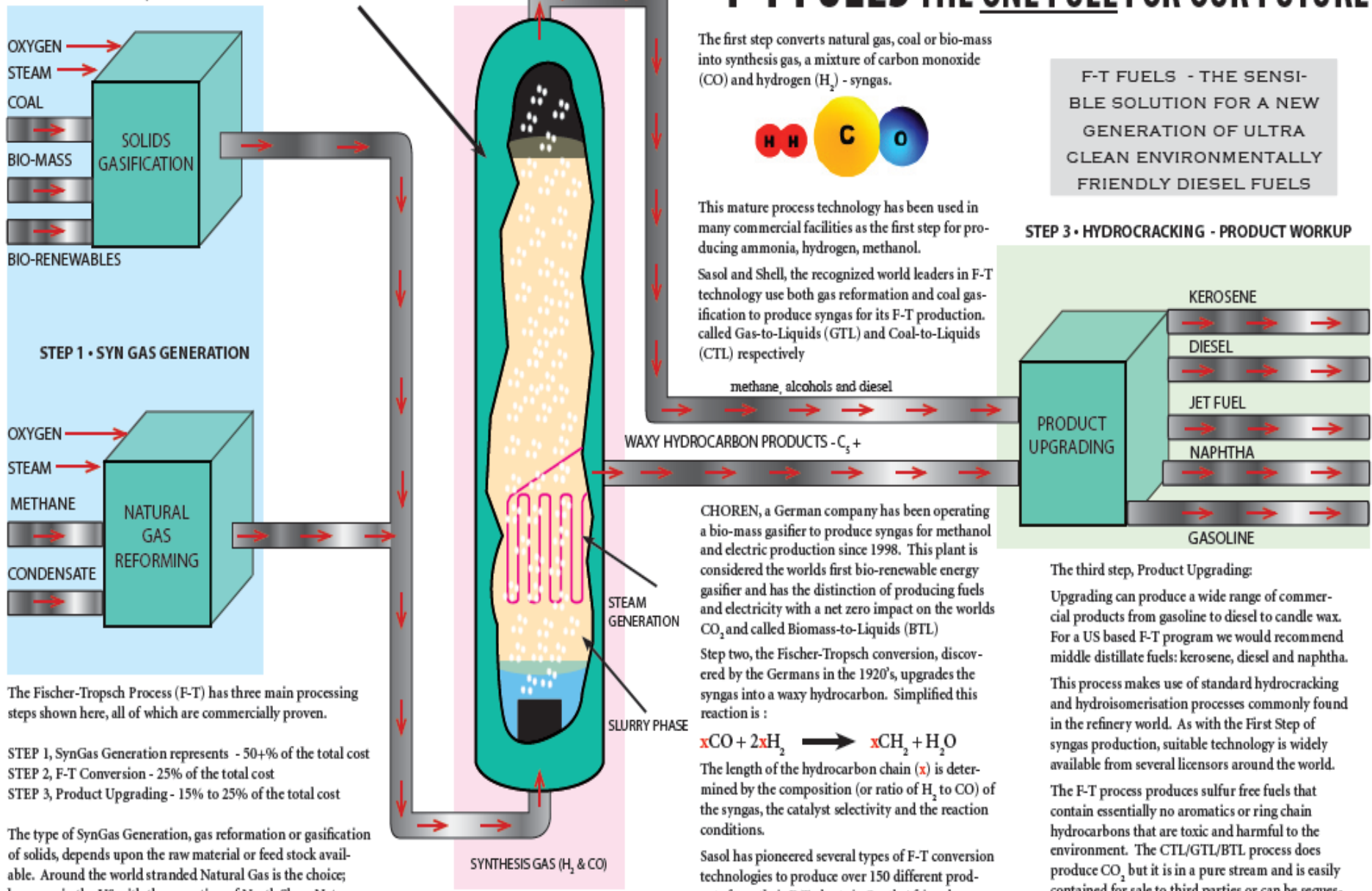
C_5-C_{10}

$C_{10}-C_{13}$

C_4-C_{10}

Note: Although the Sasol F-T reactor is illustrated here, the Shell F-T technology (SMDS) is also commercially proven

FISCHER-TROPSCH REACTOR



F-T FUELS THE ONE FUEL FOR OUR FUTURE

The first step converts natural gas, coal or bio-mass into synthesis gas, a mixture of carbon monoxide (CO) and hydrogen (H₂) - syngas.

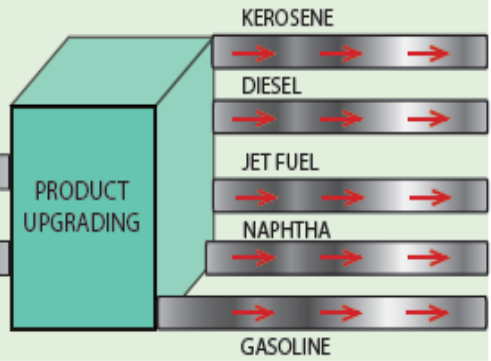


This mature process technology has been used in many commercial facilities as the first step for producing ammonia, hydrogen, methanol.

Sasol and Shell, the recognized world leaders in F-T technology use both gas reformation and coal gasification to produce syngas for its F-T production. called Gas-to-Liquids (GTL) and Coal-to-Liquids (CTL) respectively

F-T FUELS - THE SENSIBLE SOLUTION FOR A NEW GENERATION OF ULTRA CLEAN ENVIRONMENTALLY FRIENDLY DIESEL FUELS

STEP 3 • HYDROCRACKING - PRODUCT WORKUP



CHOREN, a German company has been operating a bio-mass gasifier to produce syngas for methanol and electric production since 1998. This plant is considered the worlds first bio-renewable energy gasifier and has the distinction of producing fuels and electricity with a net zero impact on the worlds CO₂ and called Biomass-to-Liquids (BTL)

Step two, the Fischer-Tropsch conversion, discovered by the Germans in the 1920's, upgrades the syngas into a waxy hydrocarbon. Simplified this reaction is :



The length of the hydrocarbon chain (x) is determined by the composition (or ratio of H₂ to CO) of the syngas, the catalyst selectivity and the reaction conditions.

Sasol has pioneered several types of F-T conversion technologies to produce over 150 different products from their F-T plants in South Africa alone. The hydrocarbon stream (xCH₂) is sent to product workup and the water (H₂O) is sent to the water recovery unit.

The third step, Product Upgrading:

Upgrading can produce a wide range of commercial products from gasoline to diesel to candle wax. For a US based F-T program we would recommend middle distillate fuels: kerosene, diesel and naphtha.

This process makes use of standard hydrocracking and hydroisomerisation processes commonly found in the refinery world. As with the First Step of syngas production, suitable technology is widely available from several licensors around the world.

The F-T process produces sulfur free fuels that contain essentially no aromatics or ring chain hydrocarbons that are toxic and harmful to the environment. The CTL/GTL/BTL process does produce CO₂ but it is in a pure stream and is easily contained for sale to third parties or can be sequestered for injection into underground wells.

F-T Fuels, clean fuels for our future that will reduce US dependence on foreign crude oil and products.

The Fischer-Tropsch Process (F-T) has three main processing steps shown here, all of which are commercially proven.

- STEP 1, SynGas Generation represents - 50+% of the total cost
- STEP 2, F-T Conversion - 25% of the total cost
- STEP 3, Product Upgrading - 15% to 25% of the total cost

The type of SynGas Generation, gas reformation or gasification of solids, depends upon the raw material or feed stock available. Around the world stranded Natural Gas is the choice; however, in the US with the exception of North Slope Natural Gas, coal, bio-mass (garbage), bio-renewables (trees and plants) represent the majority of available feedstock for a US based F-T program!

GTL/BTL/CTL is really clean technology because all of the impurities listed below if present are captured and disposed of:

Impurities that are removed from Syngas before it enters the F-T reactor in step two. This is the main reason F-T fuels cost so much and are so clean

•CO₂

•Catalyst Poisons:

–H₂S

–COS

–HCN

–HCl

–Fe(CO)₅

–Ni(CO)₄

–Hg

–Traces of Cd, Se and other metal vapors

SYNTHETIC DIESEL

**F-T DIESEL
AS CLEAN AS CNG**

**U.S. EPA*
APPROVED**

NON-TOXIC

**U.S. FDA
APPROVED**



**ZERO SULFUR
ZERO AROMATICS**

70 + CETANE

PM10 ≤ CNG