



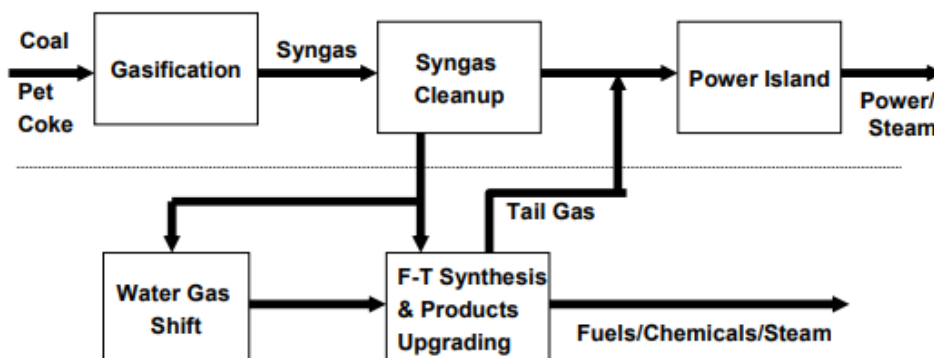
Application Note on Fischer Tropsch Synthesis

Fischer Tropsch (FT) Synthesis

It has been almost a century since FT was first conceptualized but recent developments are leading to a renewed interest in this proven technology to convert gas to liquids. At Amar we are seeing many customers contact us for help in designing and fabricating skids to perform lab and pilot scale testing of FT processes.

Fundamentally, FT allows catalytic conversion of syn gas (a mixture of H₂ and CO) to higher hydrocarbons such as diesels or gasoline. Historically the interest was producing fuels but in recent years gas to chemicals projects are becoming more common. The refinery of the future would have a larger emphasis on producing chemicals and FT processes can be tuned to produce specific products such as higher alcohols.

One such mode of operation starts from coal and a typical block diagram is given below based on work by the US-Department of Energy (Reference: Fischer-Tropsch Synthesis, Catalysts and Catalysis by Burton Davis Elsevier 2007):



Most FT processes produce a complex mixture of Hydrocarbons which distribution can be predicted with an ASF (Anderson Schulz Flory) distribution. The main goal of lab and pilot work is to fine tune this product slate distribution in the syn crude (synthetic crude) that a Fischer Tropsch Plant would produce. FT is a catalytic process and historically Iron and Cobalt have been the dominant catalysts. However, catalyst design is still an art and most customers want to build rigs to either test commercially available catalysts or to characterize the results of their own catalyst development efforts.

Below are photos of some recent pilot plants designed by Amar for customers for their FT project



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Some of the major industrial scale FTS plants are the ones below:

1. **Sasol Secunda Plant (South Africa):** Sasol's Secunda complex in South Africa is one of the largest Fischer-Tropsch facilities in the world. It converts coal and natural gas into liquid fuels and chemicals using Fischer-Tropsch technology. The plant has been operational since the 1950s.
2. **Shell Pearl GTL (Qatar):** The Pearl Gas-to-Liquids (GTL) plant in Qatar is a joint venture between Shell and Qatar Petroleum. It is one of the world's largest GTL plants and uses Fischer-Tropsch synthesis to convert natural gas into high-quality liquid fuels and chemicals.
3. **Oryx GTL (Qatar):** Another GTL plant in Qatar, the Oryx GTL facility, is operated by Qatar Petroleum and Sasol. It also employs Fischer-Tropsch technology to convert natural gas into synthetic fuels.
4. **PetroSA Mossel Bay (South Africa):** PetroSA's gas-to-liquids refinery in Mossel Bay, South Africa, utilizes Fischer-Tropsch synthesis to produce synthetic fuels and chemicals from natural gas.
5. **ENI Sannazzaro de' Burgondi (Italy):** ENI's refinery in Sannazzaro de' Burgondi, Italy, has a GTL unit that uses Fischer-Tropsch technology to convert natural gas into synthetic diesel and other products.
6. **PetroChina Ordos (China):** PetroChina operates a Fischer-Tropsch plant in Ordos, Inner Mongolia, China. This facility converts coal into synthetic fuels and chemicals using Fischer-Tropsch synthesis.

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These are just a few examples of operational plants that employ Fischer-Tropsch synthesis on a large scale. The technology is of interest to regions with abundant natural gas or coal resources, as it allows them to convert these resources into valuable liquid hydrocarbon products. Additionally, research and development efforts are ongoing to make Fischer-Tropsch synthesis more efficient and sustainable, with potential applications in carbon capture and utilization (CCU) and renewable energy storage.

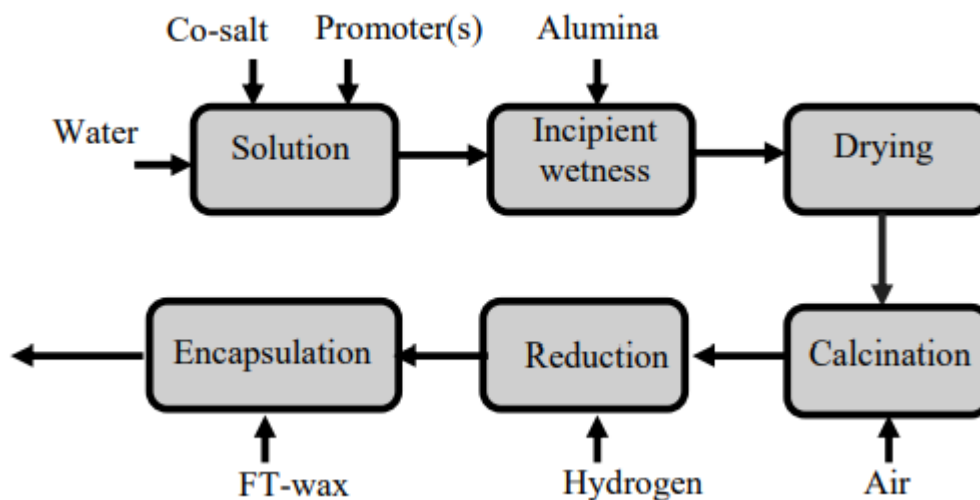
Niche clients such as the airline industry typically cannot use batteries or hydrogen in a realistic manner to cater to their sustainability goals. For aircraft engines the only viable option is to create Jet Fuel / Aviation Turbine Fuel that has been produced from renewable feedstock. One option is to generate syngas from biomass and then use FT to convert this to suitable liquid fuels. This is a practical option since most of the existing fuel distribution network can be used and aircraft systems (especially engines) will not require to be redesigned.

However, a major challenge is tough and stringent regulations that are mandated for the quality of aircraft fuels. Past customers have designed FT pilot plants to generate test quantities of ATF for testing and regulatory approval. We welcome you to approach our Pilot Plant design team at Amar for all your FT testing requirements.

FT is a highly exothermic reaction and much of the reactor innovations are driven by designs that improve heat transfer. Customers also use our reactors to prepare the catalyst required for FT projects. A typical flowsheet from work by Statoil, Norway (Reference: Fischer-Tropsch Synthesis, Catalysts and Catalysis by Burton Davis Elsevier 2007) is shown below. Commonly used FTS catalysts include the ones below:

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1. **Cobalt (Co) Catalysts:** Cobalt-based catalysts are widely used and highly effective for Fischer-Tropsch synthesis, particularly for producing liquid hydrocarbons in the fuel range.
2. **Iron (Fe) Catalysts:** Iron-based catalysts are commonly used in FTS, especially for applications like synthetic natural gas (SNG) and wax production.
3. **Ruthenium (Ru) Catalysts:** Ruthenium-based catalysts are known for their high activity and selectivity in Fischer-Tropsch synthesis, although they are less commonly used due to their relatively high cost.



To summarize, Amar has significant past experience designing and building pilot plant and lab testing skids for FTS and associated catalysts. Please contact us for an evaluation by our process design team and fabrication experts.

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