Medium-Temperature
Slurry-bed
Fischer-Tropsch Process
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OVERVIEW

Synthetic fuels are produced from a variety of feedstocks like coal, natural gas, and biomass. The feedstock is gasified to form a mixture of carbon monoxide and hydrogen gas called syngas. The syngas is then converted to liquid hydrocarbons via the Fischer-Tropsch process. Our Medium-Temperature Slurry-bed Fischer-Tropsch Process (MTSFTP®) has high energy efficiency and a proprietary catalyst with high activity, high attrition resistance, and low methane selectivity. This technology was developed by Synfuels China Technology Company, Ltd.

HISTORY

1980-1997 Research and Development (R&D) for a fixed-bed Fischer-Tropsch reactor with iron-based catalyst conducted by the Institute of Coal Chemistry

1997-2000 Fundamental R&D of slurry-bed Fischer-Tropsch reactor and iron-based catalyst led to a breakthrough at laboratory scale

2001-2004 Low-Temperature Slurry-bed Fischer-Tropsch Process (LTSFTP®) and catalyst developed at pilot scale produced 15-20 barrels per day (bbl/d) of synthetic crude oil

2002-2008 Medium-Temperature Slurry-bed Fischer-Tropsch Process (MTSFTP®) and catalyst developed at pilot scale

2008 1,500 tons/annum MTSFTP® demonstration plant commissioned

2009 Three 4,000 bbl/d coal-to-liquids (CTL) demonstration plants constructed and commissioned successfully; Key operation indicators for the international advanced level were achieved or exceeded

2011-present Commercial-scale catalyst prepared; CTL process developed and licensed to 7 projects in China with total productivity over 300,000 bbl/d

2014 12,000 tons/annum Fischer-Tropsch catalyst factory constructed and commissioned for commercial CTL projects

2016 100,000 bbl/d CTL demonstration plant constructed and prepared for commissioning
ADVANTAGES

CATALYST

- High space-time yield: \(1.00 - 1.40 \frac{g}{g \text{ cat} - h}\)
- High oil producing capability: \(1000 - 1500 \frac{\text{tons oil}}{\text{ton catalyst}}\)
- Product selectivity: \(\text{CH}_4 < 3.0\% ; \text{C}_3^+ > 96.0\%\)
- High attrition resistance

MTSFTP®

- Production of high-quality synthetic crude oil with low oxygenate concentrations
- High energy efficiency: 42\% for demonstration plants and 44\% – 47\% for commercial plants
- Efficient recovery of reaction heat
- Low solid catalyst charge required
- Compatible with CTL and gas-to-liquids (GTL) processes
Medium-Temperature Slurry-bed Fischer-Tropsch Process (MTSFTP®)

MTSFTP® has three main stages: Syngas Production, Fischer-Tropsch Synthesis, and Product Upgrading. Figure 2 illustrates how this process works for CTL.

At the Syngas Production stage, the feedstock is converted to syngas. Coal gasification is used for CTL, while natural gas reforming is used for GTL. The syngas is purified with Methyl Diethanolamine (MDEA) to remove CO₂ and acidic gases. The H₂:CO ratio of the syngas is then adjusted to ideal reaction conditions using a water-gas shift reactor.

At the Fischer-Tropsch Synthesis stage, syngas enters the Fischer-Tropsch reactor and undergoes Fischer-Tropsch Synthesis reactions on a proprietary iron-based catalyst. These reactions produce synthetic crude oil containing a wide range of light and heavy hydrocarbons.

At the Product Upgrading stage, the synthetic crude oil is refined into high-value products like diesel, jet fuel, and liquefied petroleum gas (LPG).
OVERVIEW OF FISCHER-TROPSCH SYNTHESIS

Fischer-Tropsch Synthesis converts syngas to hydrocarbons through the following reaction:

\[(2n+1) \text{H}_2 + n\text{CO} \rightarrow C_n \text{H}_{(2n+2)} + n\text{H}_2\text{O}\]

Other side reactions take place in the process, including the water-gas shift reaction, as shown below:

\[\text{CO} + \text{H}_2\text{O} \rightarrow \text{H}_2 + \text{CO}_2\]

These reactions are highly exothermic, so proper heat management is necessary to avoid hot spots in the reactor. Hot spots can destroy the catalyst and damage the reactor. Fortunately, slurry bed reactors have excellent heat transfer properties to prevent hot spots.