TC2C™

Thermal Crude to Chemicals (TC2C™)

Overview

Thermal Crude to Chemicals (TC2C™) technology economically optimizes the production of high-value chemicals from crude oil by tailoring the hydrogen content of selected crude oil components to make an optimum feed for a mixed feed steam cracker. TC2C™ is a large-scale integrated process that converts greater than 70 wt% chemicals. TC2C™ simplifies the crude conversion process compared to conventional crude oils to chemicals technologies while delivering higher chemicals yield. Saudi Aramco Technologies Company, Chevron Lummus Global (CLG), and Lummus Technology jointly developed this innovative and transformative process after several years of intense research at different scales. TC2C™ was first licensed to an Asian refiner in early 2020, and several other grassroots and brownfield opportunities are currently being considered.

Rapid growth in the demand for petrochemicals drives the demand for a more effective conversion of crude oil into chemicals. The growth in per capita consumption of petrochemical end products in major developing countries is outpacing the GDP growth, whereas the demand for conversion of crude oil into transportation fuels is under increased pressure from global energy transition initiatives. The TC2C™ process deploys deep process intensification to manufacture high-value chemicals with reduced greenhouse gas emissions and optimized energy efficiency and scale. TC2C™ is a transformative and profitable solution to the world's rapidly growing need for more efficient resource utilization.

Technical Advantages

Process Features	Process Benefits
Feedstock	Extra Light, Light, Medium Crudes, Condensates, Low Value Refinery and Petchem. Streams
High Chemicals Yield (>70 wt.%)	• Increases return on investments • Optimizes crude intake to achieve target chemical production • Produces high value IMO 2020 compliant very low sulfur fuel oil (VLSFO). Option available for production of other transportation fuels • Considerable CAPEX and OPEX savings (30-40%) compared to conventional processes
Novel Proprietary Separation Devices	• Eliminates the need for conventional crude atmospheric and vacuum distillation units
Breakthrough hydrocracking catalyst	• Tailored mesoporous zeolite for crude to chemical applications • Optimized hydrogen content for steam cracker feedstocks
Optimized process integration of fixed bed and liquid circulation reactors	• Selectively condition crude for mixed feed steam cracking • PyOil from MFC upgraded in crude conditioning section • Permits processing wide API range of crude feedstocks, as well as low value refinery orphan stream such as slurry oil, LCO, etc. • Flexible for deployment in both brownfield and greenfield applications
Process intensification and integration	• Redefined operating objective away from traditional refinery and petrochemicals complexes • Reduced piece count compared to conventional processes • Reduced global utility consumption and carbon footprint
Anchored on commercially proven technologies	• Minimize risk associated with new technology • Reliable technology components to achieve very high on-stream factors

TC2C™

Process Description

TC2C™ technology configurations integrate separation, hydroprocessing and steam cracking.

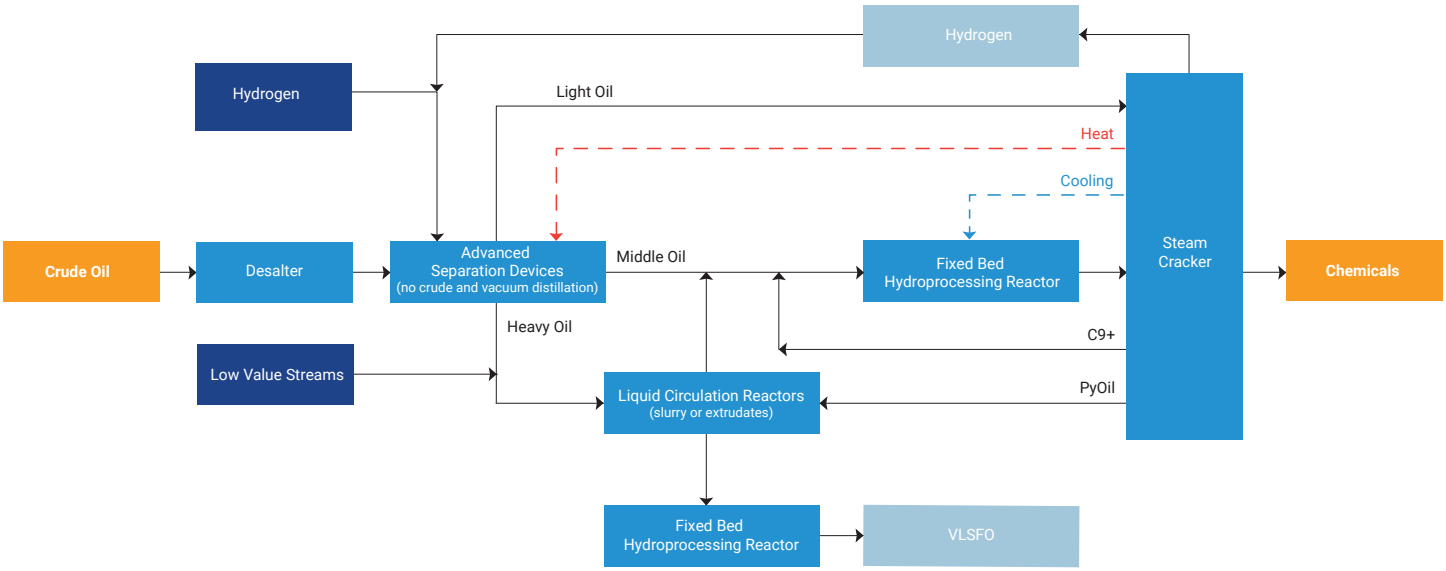
Crude oil is desalted and separated based on hydrogen deficiency into light, middle and heavy oil. Ebullated-bed hydrocracking reactors convert the heavy oil into middle oil, along with recycled pyrolysis fuel oil from the steam cracker. The ebullated-bed reactors sustain a long run-length without pressure drop build-up by continuously replacing part of their catalyst inventory. Hydrotreating the ebullated bed unconverted oil yields stable, IMO 2020 compliant very low sulfur fuel oil (VLSFO). Parallel, fixed bed hydroprocessing reactors upgrade middle oils from crude and ebullated bed reactors into steam cracker feed, along with raffinates made downstream of the steam cracker. A common, high-pressure gas loop serves all reactor platforms, which significantly reduces the required piece count of the facility. The steam cracker converts gaseous hydrocarbons from the gas loop, as-is light oil and hydroprocessed middle oils.

Tailoring steam cracker heaters instead of a separation section to produce the desired streams to the pyrolysis furnaces greatly simplifies the design of the overall facility.

A bank of pyrolysis furnaces steam cracks conditioned crude into building blocks for the petrochemical industry. Staged quenching of the initial gaseous products regenerates steam. A three-stage centrifugal compressor compresses the cooled products, an amine (or a caustic) solution removes gaseous acids, and a molecular sieve removes any remaining water. A refrigerated fractionation system segregates olefins and aromatics at cryogenic conditions. Catalytic hydrogenation removes gaseous byproducts such as acetylene and carbon oxides.

A methanation system purifies the hydrogen, making it fit for reuse within the complex. Recovered methane fuels the complex. Highly integrated super-fractionation towers isolate polymer-grade ethylene and propylene at minimum energy consumption. A gas turbine generator can be integrated with the pyrolysis furnaces to produce electrical power and additional super-high-pressure steam. The hot exhaust gases from the turbine are sent to the furnaces to provide hot combustion air. Utilities required for the facility – steam, cooling water, and fuel – are fully integrated to improve overall efficiency.

Block Flow Diagram



LUMMUS TECHNOLOGY | أرامكو السعودية saudi aramco | CLG Chevron Lummus Global

08.18.21