Comonomer Production Technology – 1-Hexene

LUMMUS TECHNOLOGY

Overview

Lummus Technology's Comonomer Production Technology (CPT) produces comonomer grade 1-hexene from C4 raffinate streams. 2-Butene contained in the butene feedstock is isomerized to 1-butene and recovered. The 1-butene then reacts to form 3-hexene that is isomerized and recovered as 1-hexene. The first step increases 1-butene production by upgrading the 2-butene in the stream. The next steps allow part or all of the 1-butene to be upgraded to 1-hexene. Comonomer grade 1-butene can be co-produced with the 1-hexene to address a full range of comonomer requirements in a single unit.

The CPT Process is based on a combination of isomerization and metathesis technologies first developed for the OCT process. In the OCT process, isomerization and metathesis are combined. In the CPT 1-hexene process, these catalytic functions are separated to promote the ideal reactions for 1-hexene production. Butene feedstock containing any amount of 1- and 2-butenes, is isomerized to maximize 1-butene content. The 1-butene is then recovered by super-fractionation to produce either 1-butene comonomer and/or 1-butene fed to metathesis for hexene production. The 1-butene fed to metathesis reacts with itself (autometathesis) to form ethylene and 3-hexene. The 3-hexene is recovered and then fed to its own isomerization unit, where 3-hexene is converted to 1-hexene. The 1-hexene is then recovered by super-fractionation. For smaller capacities, the unit can be operated in campaign mode, where the super-fractionator is alternately used for 1-butene and 1-hexene to match the polymer unit requirements.

Using proven isomerization and metathesis catalysts, combined with a recovery system customized to the product range, 1-hexene and 1-butene comonomer can be economically produced from even low-value C_4 feedstocks (raffinate-2 from MTBE, TBA production, or isobutene recovery). The CPT process does not consume valuable ethylene, as do competing trimerization and dimerization processes, and it uses environmentally friendly catalysts.

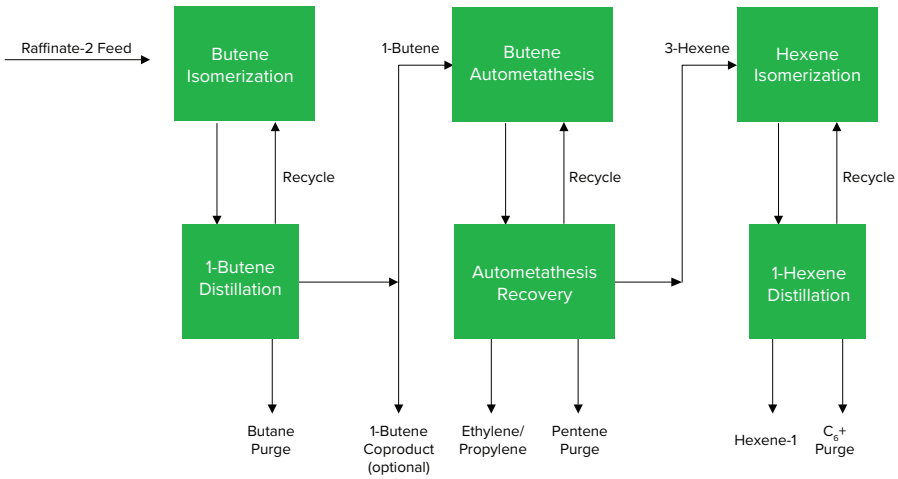
Advantages

Process Features	Process Benefits
Low feedstock cost	Uses low-cost C_4 feed rather than high-cost ethylene. Regardless of the 1-butene content of the raffinates, can be economically processed to produce 1-hexene and/or 1-butene
High value by-product	The small amount of byproducts CPT produces are mainly ethylene and propylene with minimal production of heavies. Heavies are recoverable as gasoline.
Simple catalyst systems	CPT uses a proven solid catalyst system. The catalyst has long life and no make-up or addition of catalyst is required. Catalyst is non-hazardous and is regenerated in-situ to maintain conversion throughout its life.
Vapor phase reaction system	The catalyst is contained in the fixed-bed reactor and does not leave with the reactor effluent so no fouling of downstream equipment or the reactors is experienced. No cleaning or maintenance operations are required.
Environmentally friendly catalyst	CPT fixed-bed catalyst is non-toxic, environmentally inert and easily disposed of.

Performance Characteristics

COMPONENT	
1-Hexene - 98 wt % min.	Heavier than C_6 - 0.1 wt % max.
2- & 3-Hexenes - 1.5 wt % max.	Total Dienes - 200 ppmw max.
Branched C_6 - 0.5 wt % max.	Water - 25 ppmw max.
Mono Olefin - 99 wt % min.	Carbonyls - 5 ppmw max.
Lighter than C_6 - 0.1 wt % max.	Peroxide - 1 ppmw max.

Block Flow Diagram



Process Description

The CPT process for 1-hexene production has three sections: butene isomerization and fractionation, autometathesis and fractionation, hexene isomerization and fractionation.

In the butene isomerization and fractionation section, raffinate-2 feed from OSBL is mixed with butene recycle and vaporized. The combined vapor stream is preheated and fed to the Butene Isomerization Reactor, where 2-butene is isomerized to 1-butene over a fixed bed of proprietary isomerization catalyst. The reaction is driven by equilibrium, so the reactor effluent contains both 1-butene and 2-butene. Reactor effluent is cooled, condensed, and sent to the Butene Fractionator. In the Butene Fractionator, reactor effluent is separated into 1-butene product and recycle 2-butene. The 1-butene product is recovered overhead and the bottoms contains the recycle 2-butene and butane. The column can be stand-alone, use a heat-pump system, or use the hexene splitter-condenser to heat the reboiler. By using the hexene fractionator condenser, the heat input to the hexene splitter can be used in an efficient, multi-effect fashion. A portion of the bottoms is withdrawn as raffinate-3 to maintain butane concentration in the feed before the remaining bottoms is recycled to the isomerization reactor.

In the autometathesis and fractionation section, 1-butene is mixed with 1-butene recycle and vaporized. The combined vapor stream is preheated and fed to the autometathesis reactor, where 1-butene reacts with 1-butene over a fixed bed of proprietary metathesis catalyst. The reaction is driven by equilibrium, so the reactor effluent contains 3-hexene, 1-butene, and ethylene. The reactor effluent is then cooled, condensed, and sent to the depentanizer for recovery of any C_5+ fraction. The overhead flows to the depropylenizer to recover the ethylene and any propylene formed. The bottom 3-hexene stream flows to hexene isomerization.

In the hexene isomerization and fractionation section, 3-hexene feed is mixed with hexene recycle and vaporized. The combined vapor stream is preheated and fed to the hexene isomerization reactor, where 3-hexene is isomerized to 1 and 2-hexene over a fixed bed of proprietary isomerization catalyst. The reaction is driven by equilibrium, so the reactor effluent contains a mix of 1, 2 and 3-hexene. The reactor effluent is cooled, condensed, and sent to the hexene fractionator. There, 1-hexene product is separated from recycle 2 and 3-hexene. The column can be stand-alone or integrated by using the butene fractionator reboiler as a condenser in an efficient, multi-effect fashion.

Lummus Technology offers a number of options for upstream processing of C_4 feed including Butadiene Extraction, Selective C_4 hydrogenation, MTBE production, isobutene skeletal isomerization to n-butene or isobutene/ isobutane removal so that raw C_4s, raffinate-1 or raffinate-2 can be processed to make 1-hexene.

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