Lummus Technology
a CB&I company

Olefins Conversion Technology

Overview

Lummus Technology's Olefins Conversion Technology (OCT) is used to combine n-butenes with ethylene to produce polymer-grade propylene. Two chemical reactions take place: propylene is formed by the metathesis of ethylene and butene-2; and butene-1 is isomerized to butene-2 as butene-2 is consumed in the metathesis reaction.

This technology can be used with a variety of C_4 streams including the mixed C_4s produced in steam cracking, raffinate C_4s from MTBE or butadiene extraction, and C_4s produced in FCC units.

Advantages

Process Features	Process Benefits
Converts pyrolysis C_4s to propylene	Greatly improves C_4 processing economics
High conversion at moderate operating conditions	Lowest capital for incremental propylene production
The OCT can be integrated with a steam cracker	Permits an increase in propylene-to-ethylene production ratio to above 1.0, a 50% increase
The OCT can be integrated with a fluid catalytic cracker (FCC)	Ethylene and butylene produced in the FCC are upgraded to propylene, improving FCC operating economics
Easier propylene purification	Reduced capital since superfractionator not required
Has a fixed bed catalyst system with *in situ* regeneration	Simple operating cycle
Can operate from nameplate to zero propylene production	Allows owner to optimize the product ratio when prices change

Performance Characteristics

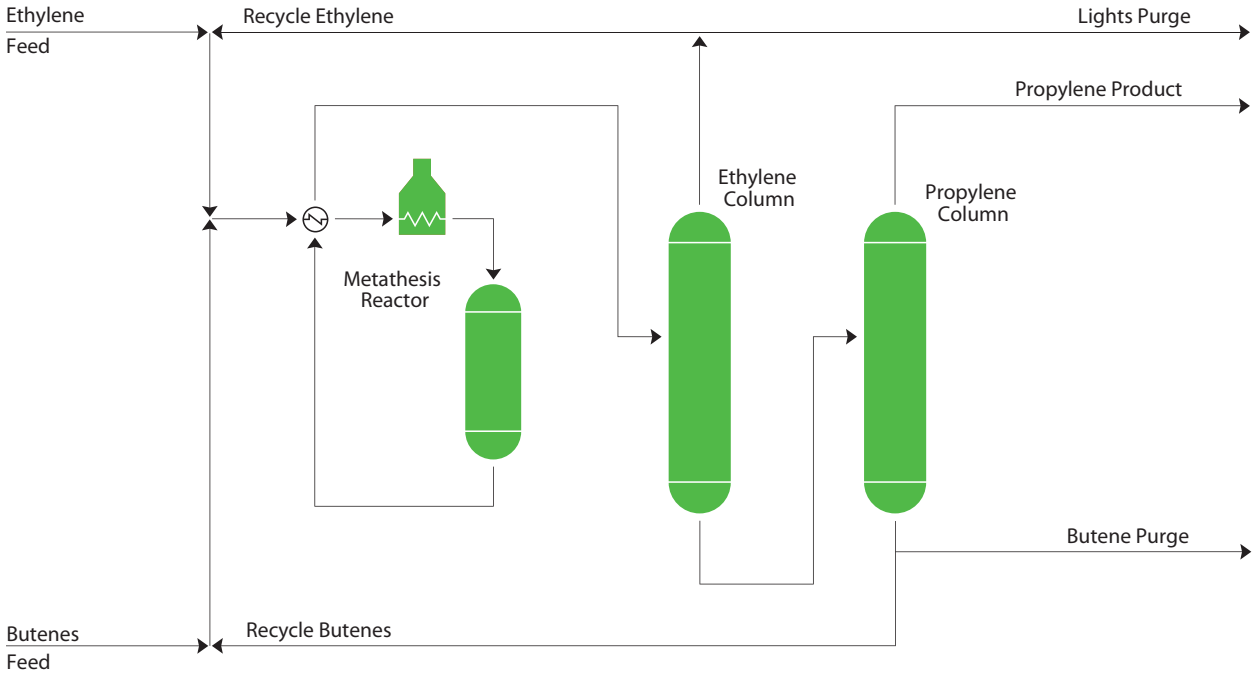
The OCT process can handle a wide range of feedstock compositions, making the unit flexible to take advantage of many lower-value feedstocks. The ethylene stream can vary from dilute ethylene, typical from an FCC, to polymer-grade ethylene. The C_4 stream has similar flexibility because butanes pass through the system as inerts.

Another important characteristic of the process is product purification: the system does not require the superfractionator usually associated with propylene purification. Both C_2 and C_4 feeds generally have only minor quantities of propane, and since the reaction system does not generate any propane, propane/propylene separation is not required.

The propylene produced contains only the propane contained in the ethylene or C_4 feed. This means that the propylene purity usually exceeds the polymer-grade level produced by the majority of steam crackers, without any superfractionators.

When integrated with a grassroots steam cracker, the by-product flexibility of the cracker is greatly enhanced. With high propylene value and demand, the OCT unit can be operated to increase the propylene-to-ethylene ratio to above 1.0. Importing an external C_4 stream can further increase the ratio. Should propylene value fall, the steam cracker is able to produce as much as 115% of its nameplate ethylene capacity while exporting either a mixed C_4 stream or a C_4 stream where the butadiene has been hydrogenated to butenes. Operation can thereby be optimized depending on the relative values of ethylene, propylene, butene, and mixed C_4s. This product flexibility ensures profitable operation as by-product values shift over the 30+ year life-cycle of the facility.

Process Flow Diagram



Process Description

Ethylene feed plus recycle ethylene are mixed with the butenes feed plus butenes recycle and heated prior to entering the fixed-bed metathesis reactor. The catalyst promotes the reaction of ethylene and butene-2 to form propylene, and simultaneously isomerizes butene-1 to butene-2. A small amount of coke is formed on the catalyst, so the beds are periodically regenerated using nitrogen-diluted air. The ethylene-to-butene feed ratio to the reactor is controlled at a value to minimize C_5+ olefin by-products and maintain the per-pass butene conversion above 60%. Typical butene conversions range between 60 to 75%, with greater than 95% selectivity to propylene.

The reactor product is cooled and fractionated to remove ethylene for recycle. A small portion of this recycle stream is purged to remove methane, ethane, and other light impurities from the process. The ethylene column bottoms is fed to the propylene column where butenes are separated for recycle to the reactor and some is purged to remove butanes, isobutylenes, and heavies from the process. The propylene column overhead is high-purity, polymer-grade propylene product.

This process description is for a stand-alone OCT unit that can be added onto any refining/petrochemical complex. The utility requirements – which include cooling water, steam, electricity, fuel gas, nitrogen, and air – are typically integrated with the existing complex.

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