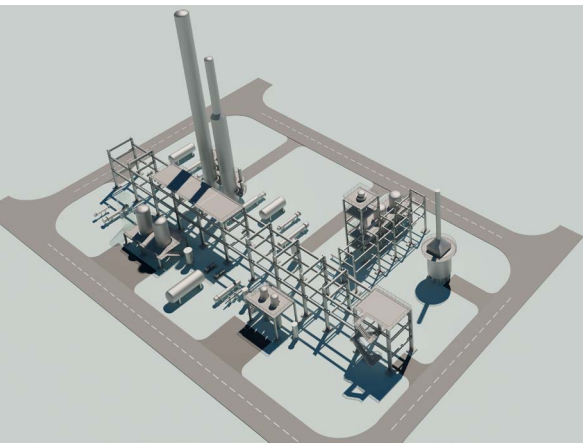
Where energies make tomorrow

Propylene Metathesis using Clariant's MetaMax® Catalyst

Clariant and Technip Energies have been working in close partnership to offer the exclusive use of the MetaMax® catalyst in a licensed process to produce propylene.



CAD model

Compared to other propylene production methods, our metathesis process has major advantages, including the direct production of polymer-grade propylene (> 99 mol percent), with very low by-products, valorizing C4 cut feedstock. When integrated with an ethylene steam cracker or refinery, it offers a very low investment cost per ton of olefin product.

The main metathesis reaction is the reaction of butene-2 with ethylene to produce propylene. The best propylene yields are provided by a C4 feed with a high butene-2/butene-1 ratio.

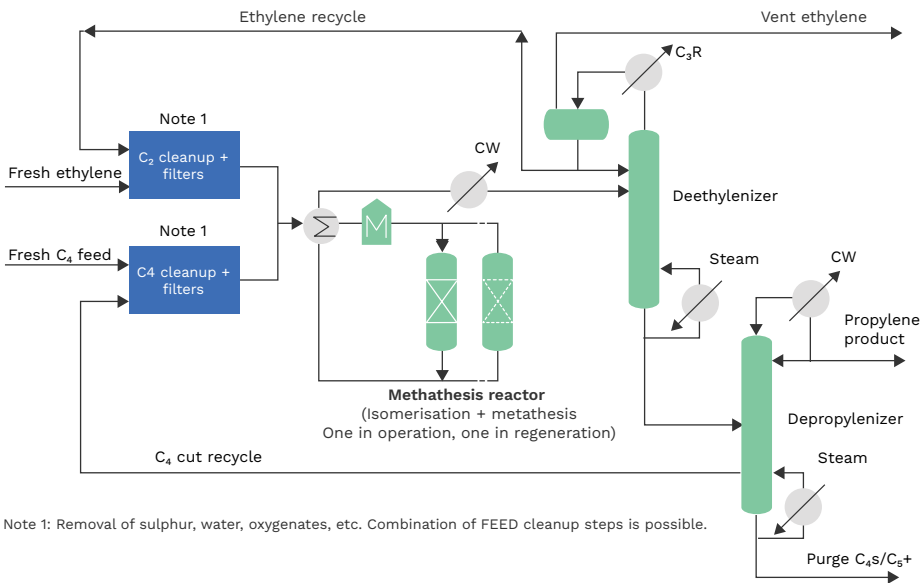
How the process works

Downstream of impurities removal beds (which remove poisons, such as oxygenates, water, sulfur), the combined ethylene and C4 feed is heated before it enters the metathesis reactor, which operates at the following typical conditions:

Main operating parameters

Reaction temperature	300–350°C
Reaction pressure	30–35 bar(g)
Regeneration	Nitrogen/air/hydrogen

Typical process flow description



Note 1: Removal of sulphur, water, oxygenates, etc. Combination of FEED cleanup steps is possible.

The butene once-through conversion is limited by equilibrium, while here an excellent ATE (approach to equilibrium) of >98 % will be achieved. The metathesis catalyst exhibits a selectivity towards propylene of >96 %, while the variations depend of the feedstocks applied.

The effluent from the metathesis reactor contains mainly unreacted ethylene, propylene, butenes, paraffinic C4, C5 and heavier components. This stream is cooled before being fractionated in two distillation columns (deethylenizer/depropylenizer) to produce polymer-grade propylene. No super-fractionation column is required, since no propane is present within the process.

The overhead stream from the deethylenizer is recycled to the reactor. The cryogenic conditions at the top of this column require the use of a refrigerant fluid (commonly propylene). It is convenient to integrate this refrigerant loop with the main loop of the steam cracker.

The depropylenizer is fully condensed against cooling water. A C4 side-draw dedicated to recycling unconverted butenes to the metathesis reactor is extracted in the lower part of the column. The bottom product, which purges the system, forms the heaviest product and the components that cannot react (mainly the paraffinic C4). It is convenient to route this by-product stream to a steam cracker or to send it to the gasoline pool of the refinery.

About the catalyst

The catalyst tailored to metathesis reaction developed by Clariant is a mixture of a tungsten oxide catalyst (dedicated to metathesis) and a magnesium oxide catalyst (dedicated to isomerization of 1-butene to 2-butene). Benefits of the Clariant MetaMax® catalyst solution include:

- High feed flexibility — applications include steam cracker, FCC off-gas, MTO and C5s
- High tolerance to butadiene
- Nearly no effect from i-butene
- High propylene yields and selectivity
- Low C5+ byproduct make
- Outstanding stability and long operating cycles
- Good mechanical resistance prevents dust and related pressure drop
- Robust to multiple regeneration cycles.

Integration with an ethylene cracker or refinery

Since polymer-grade ethylene feed is required, the metathesis process is fully utilized when integrated in a steam cracker plant. The integration of the two units into one relies on synergies, which lower the investment cost per ton of olefins produced. Integration with refineries, in combination with an ethylene recovery unit, can significantly increase the value of refinery streams by production of olefins.

About our alliance

Clariant and Technip Energies have been working in close partnership since 2010 to offer the exclusive use of the MetaMax® catalyst in a licensed process. This alliance combines Clariant's expertise in catalyst formulation with Technip Energies' knowledge in process optimization and engineering.

Several years of extensive experiments in Technip Energies' research center in Weymouth, Massachusetts have been completed to test, under commercial conditions (including pressure, temperature and feedstock), the catalyst formulated by Clariant. Due to the extensive testing, strong and reliable catalyst performances were demonstrated, and a robust model able to predict process performances for various types of feed was established.

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