KBR Catalytic Olefins Technology (K-COT™)

Case Study: Improving the profitability of liquid crackers through olefinic streams recycle

PROBLEM DESCRIPTION

High crude oil prices have driven up the operating costs of steam crackers that utilize naphtha and other liquid feeds. Price and availability of light feeds such as ethane from US shale formations put additional pressure on liquid cracker operators.

Despite their high cost, liquid will continue to play a significant role in ethylene production, remaining as the most used feedstock worldwide even with the number of ethane crackers expected to come on-stream over the next 10 years.

Problem

Liquid crackers have become the high cost ethylene producers, but comprise 50% of the world's capacity.

Question

How can liquid crackers improve cost of production of ethylene and profitability in this environment?

The challenge is to improve the profitability of liquid crackers to compensate for their raw material price disadvantage.

THE SOLUTION

KBR Catalytic Olefins Technology (K-COT™) is a commercially proven technology for converting low-value olefinic, paraffinic or mixed streams into high-value propylene and ethylene. K-COT is an engineering process and service that builds on KBR's experience in developing catalytic olefins technology for various feed types, and combines the know-how into one technology offering. This technology can be implemented as a stand-alone olefin production unit or be readily integrated into a refinery or petrochemical complex to enhance profitability, operational flexibility and to meet market-driven product demand.

UPGRADE LOW-VALUE STREAMS

K-COT can be used to produce propylene from a variety of C4-C10 feeds. The technology effectively upgrades a variety of processes and feeds, including olefin-rich streams such as:

- Mixed C4s from refineries and conventional steam crackers
- Amylenes, TAME raffinate and mixed C5s from conventional steam crackers
- Cracked naphtha from FCCs, steam crackers, cokers and visbreakers
- Oxygenates, such as methanol and ethanol
- Other low-value olefinic streams

SELL, RECYCLE OR CONVERT?

Typical liquid crackers produce several low-value C4+ streams in the process of producing ethylene, propylene and butadiene. C4 raffinate, C5's and C6-C8 non-aromatics represent about 20% of the fresh feed.

Some producers have the option to sell these streams per market demand: C4 raffinate can be sold for recovery of other components contained in the stream (such as iso-butylene), or can be added to LPG stream after hydrogenation. C5's and C6-C8 non-aromatics can be added to the gasoline pool. Prices of these streams tend to be low and don't compensate for the final product yield loss.

Recycle Cracking

Producers have the option to recycle these streams as feed material to the steam cracker. However, C4 raffinate and C5's is typically fully hydrogenated before being fed to the steam cracker to avoid yield penalty and operational issues caused by olefins in the feed stream.

Economics of selling these streams (compared to recycling them) are dependent upon the price ratio between naphtha and sellable streams.

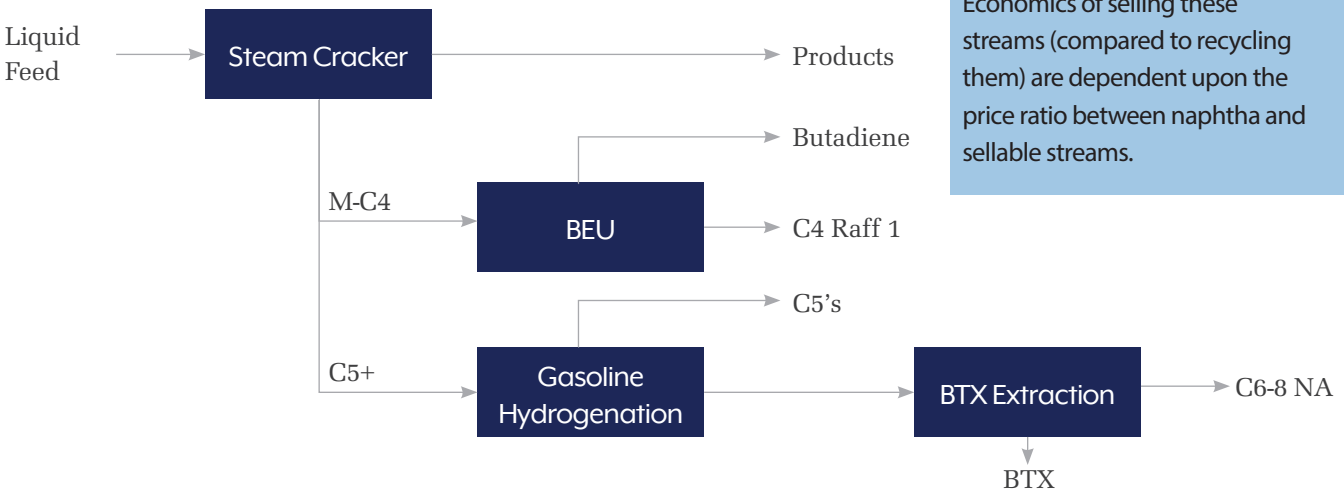

Figure 1: Typical liquid cracker configuration

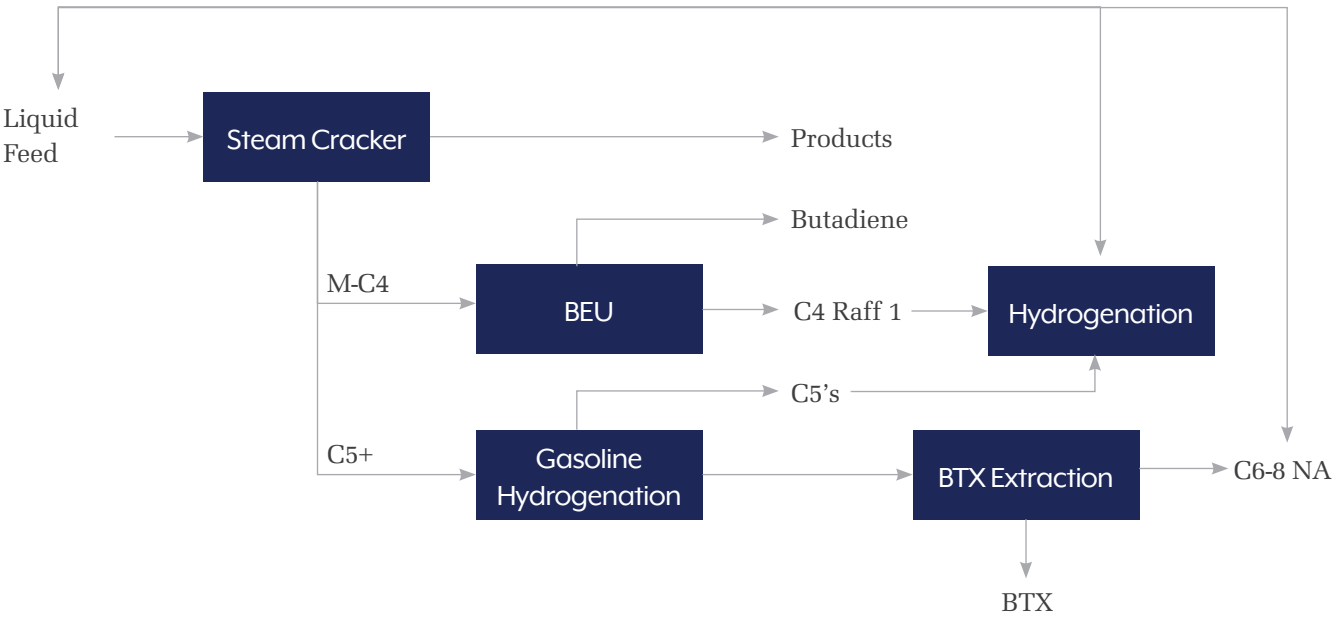

Figure 2: Liquid cracker configuration for C4+ streams recycle

CATALYTIC CONVERSION – THE OPTIMAL CHOICE

Instead of hydrogenating the olefinic or mixed streams (just to have them cracked again in the steam cracker), an efficient option is to convert those streams to ethylene and propylene using a catalytic olefin converter.

K-COT can convert C4 raffinate, C5's and C6-C8 non-aromatic streams into light olefins, which can then be separated in the steam cracker along with steam-cracked products. C4 raffinates and C6-C8 non-aromatics can be fed into the converter "as-is", and C5's can be fed after the first stage hydrogenation to convert diolefins to olefins. This mode of operation results in higher propylene + ethylene + BTX yields, as well as higher P:E ratio. It also produces less fuel gas and eliminates potential tube coking issues.

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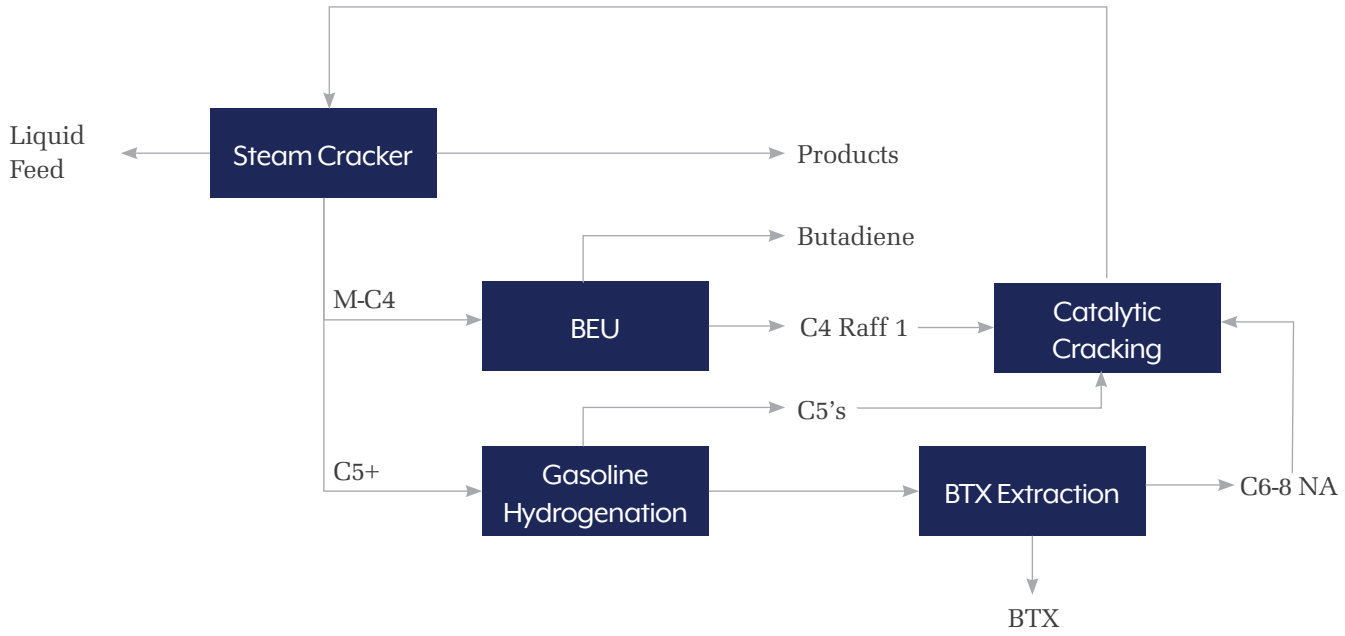

Figure 3: K-COT unit addition for direct conversion of C4+ streams

Based on actual economic figures for naphtha feed and various by-products over the past six years, this option can lower the cost of production of ethylene by $55 to $70/ton, significantly improving the liquid cracker profitability.

EASY INTEGRATION, MAXIMUM RESULTS

K-COT can be easily integrated into a liquid cracker plant, resulting in immediate impact on cracker margins.

K-COT increases propylene yields, reduces energy consumption and improves liquid crackers' cost of production when compared to steam cracking

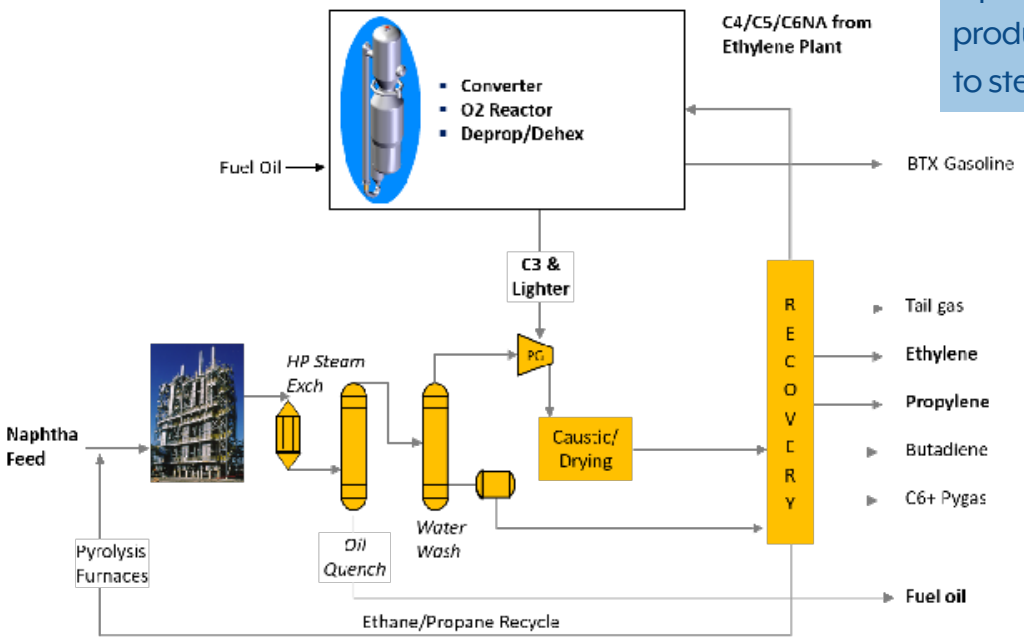

Figure 4: K-COT integration in liquid cracker plant

Based on actual market prices of ethylene, propylene and other feed and product streams, K-COT results in a positive impact in the cost of production of ethylene of at least $55/ton of ethylene averaged over the period of 2006 and 2012.

FLEXIBILITY

K-COT is a very flexible technology that can accommodate other, nontraditional ethylene feeds such as refinery cracked naphtha (from FCC or coker units), potentially providing another degree of flexibility to the liquid-cracking ethylene producer.