Butadiene Extraction Technology

LUMMUS TECHNOLOGY

Overview

The BASF NMP-based butadiene extraction process, licensed by Lummus Technology since 1990, is the preferred technology for the production of high purity 1,3-butadiene from crude C_4 cuts. The technology is successfully applied in 38 plants worldwide, with a total capacity exceeding four million tons per year.

The NMP-based butadiene process uses n-methyl-pyrrolidone (NMP) as solvent. Unlike the other solvents used for butadiene extraction, the aqueous mixtures of NMP are not corrosive, thereby allowing the use of carbon steel as construction material without the addition of corrosion inhibitors. This process is particularly suitable for C_4 streams from high severity cracking where the acetylene levels may be high (>3%). It produces a 1,3-butadiene product of 99.7 wt% purity while recovering more than 99% of the 1,3-butadiene contained in the feed. It also produces a raffinate-1 product that consists of a mixture of butanes and butenes with a butadiene content as low as 40 ppm wt.

Advantages

Process Features	Process Benefits
NMP and its water mixtures are non-corrosive and low-fouling. Carbon steel construction is used throughout the entire unit, plus a dividing wall column and packing are used in the extractive distillation section	Low investment costs
Efficient heat recovery systems and optimal process design	Low operating cost
Operating periods exceeding five years between turnarounds can be achieved due to high solvent stability, an effective solvent regeneration system, and an effective fouling inhibitor system	Fewer shutdowns • lower maintenance cost
NMP is the least toxic solvent that is easily treated by conventional biological degradation	Environmentally friendly design
Low solvent losses due to NMP's stability to hydrolysis and thermal decomposition as well as its high boiling point	Low operating cost
All industrial C_4 feeds can be processed, regardless of their 1,3-butadiene content, to obtain a high-purity butadiene product	High value product

Performance Characteristics

Feed

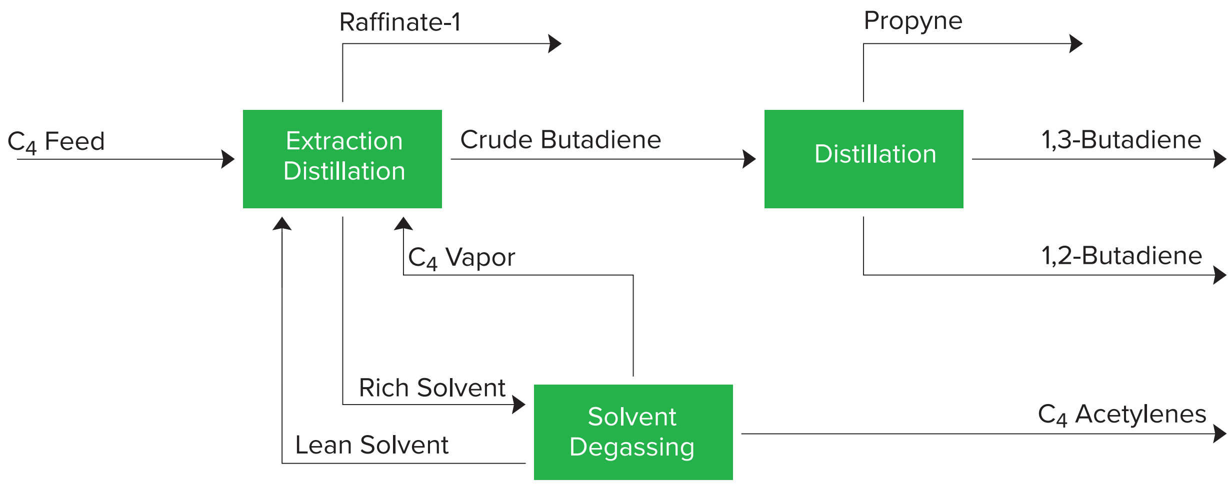
Feedstock Composition (typical)	*wt%*
1,3-Butadiene	35-55
Butanes	<14
Butenes	40-51
Total acetylenes	<2

Product

Butadiene Composition (typical)	
1,3-Butadiene	99.7 wt%
Methyl Acetylene	<10 ppm wt
1,2-Butadiene	<20 ppm wt
Total acetylenes	<40 ppm wt
C_5 hydrocarbons	<5 ppm wt
VCH	<50 ppm wt
NMP	<5 ppm wt

Raffinate Composition (typical)	
1,3-Butadiene	<2000 ppm wt
NMP	<5 ppm wt

Process Flow Diagram



Process Description

A typical butadiene extraction plant consists of four basic process sections: extractive distillation, conventional distillation, solvent degassing, and solvent regeneration.

The C_4 feed is sent to the extractive distillation section where it is vaporized and separated using two extractive distillation columns. The overhead product from the first column consists of a mixture of butenes and butanes and is designated as raffinate-1. The second column is a dividing wall column consisting of a rectifier and an afterwasher. The overhead from the afterwasher is a crude butadiene product that is sent to the conventional distillation system for further purification. Rich solvent is removed from the bottom of the second column and sent to the solvent degassing system.

Crude butadiene is fed to the propyne column, which is the first of two columns in the conventional distillation section. Propyne is removed as overhead from this column and the bottoms is sent to the butadiene column. The butadiene product is withdrawn from the top of this column and the C_5s as well as the 1,2-butadiene are rejected in the bottoms.

The rich solvent from the extractive distillation section is fed to the solvent degassing section. The solvent is stripped free of C_4s in the degassing column and recycled to the extractive distillation section. C_4 acetylenes are removed as a side stream and can be hydrogenated, used as fuel gas or as cracker feed, or burned in a flare system. The vapor leaving the degassing column is cooled in a separate cooling column, compressed, and sent back to the extractive distillation section. A sophisticated heat recovery system utilizes most of the sensible heat of the solvent, resulting in extremely low energy consumption.

A small solvent stream is continuously fed to the NMP regeneration section. The solvent is heated with steam under vacuum conditions in a regeneration vessel. Vaporized NMP is condensed and recycled to the extractive distillation section. The remaining residue is usually incinerated.

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