Lummus Technology
a CB&I company

# Butadiene Extraction 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 more than 30 plants worldwide, with a total capacity exceeding three 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 is non toxic, non carcinogenic and can be treated by conventional biological waste water treatment | Environmentally sound design |
| NMP and water mixtures are non-corrosive allowing carbon steel equipment to be used without the need for a corrosion inhibitor | Low investment and operating costs |
| Low solvent losses due to NMP's remarkable resistance to hydrolysis and thermal decomposition as well as its high boiling point | Low operating costs • Less fouling |
| High yield (>99%) as well as high purity (>99.7%), regardless of the feed concentration | High value product |
| Low energy consumption due to an efficient heat recovery system and optimal process design | Low operating costs |
| Operating periods exceeding four years without cleaning due to effective fouling inhibitor system | Longer on stream time • Low maintenance costs |

## Performance Characteristics

| Feed | | Product | |
|---|---|---|---|
| *Feedstock Composition (typical) wt%* | | *Butadiene Composition (typical)* | |
| 1,3-Butadiene | 40-55 | 1,3-Butadiene | 99.7 wt% |
| Butanes | <14 | Propadiene | <10 ppm wt |
| Butenes | 40-51 | 1,2-Butadiene | <20 ppm wt |
| Total acetylenes | <2 | 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 | <10 ppm wt |

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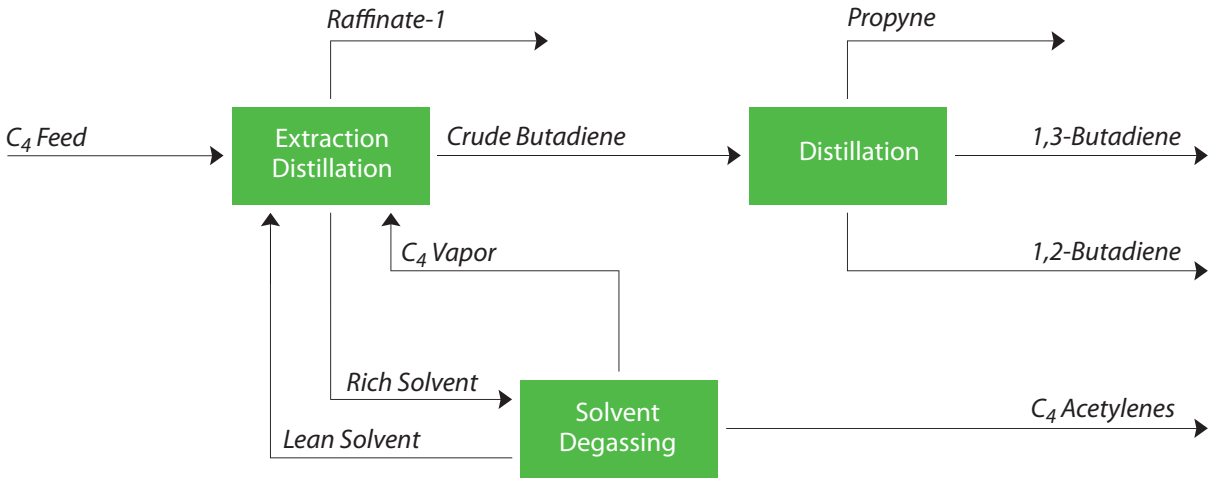
## Block Flow Diagram




## 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 three 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 overhead from the third column 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 $C_5$s 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 $C_4$s 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 or heat exchanger, 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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