Low Pressure Recovery (LPR)

Overview

Lummus Technology's Low Pressure Recovery (LPR) technology is used to recover valuable ethylene from refinery offgases which normally are disposed of as fuel. Further value upgrade can be obtained by recovery of ethane which can be sent to an adjacent ethylene plant for cracking to valuable olefins. In addition, propylene can be recovered from the heavy end components of refinery offgas. This technology can either be a stand-alone or can be easily integrated with an ethylene plant for recovery of olefins and paraffins or with Olefins Conversion Technology (OCT) to produce propylene.

Advantages

Process Features	Process Benefits
Recovers ethylene from low value refinery offgas	Improves refinery processing economics
Processes a large range of refinery off gas compositions	Adds flexibility to refinery operation
High recovery of ethylene	Better operating margin
Can produce polymer grade ethylene	High value product from low value fuel gas
Process operating conditions are inherently safe	Safe operation
Eliminates offgas compressor, separation at low pressure	Lowers investment
Easy integration with an ethylene plant	Lowers overall CAPEX, offers refrigeration synergy and improves ultimate olefins yield

Performance Characteristics

Refinery offgas composition (typical)

	mol % or vol %
Nitrogen	4 - 13
Hydrogen	15 - 36
Methane	20 - 32
Ethylene	12 - 26
Ethane	10 - 13
Propylene	1 - 3
Propane	0.1 - 0.4
Oxygen	0.04 - 0.25
CO	0.7 - 3.6
CO_2	0.3 - 1.5
H_2S, mppm or vppm	8 - 150
C_4+	balance

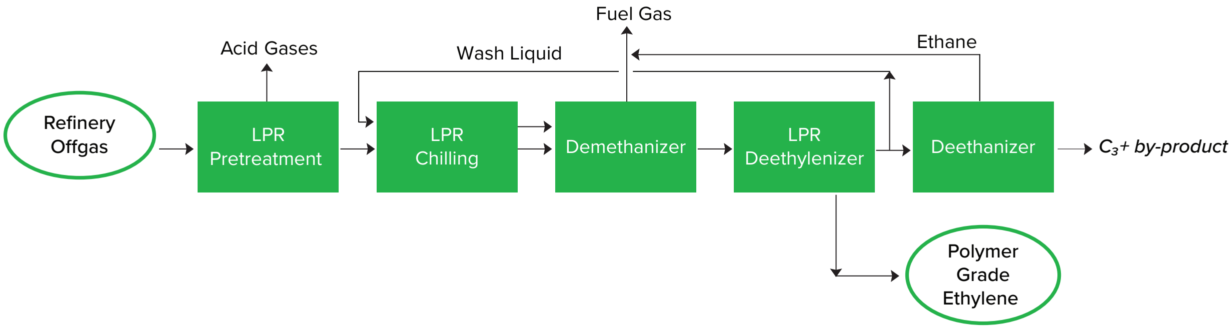
Ethylene product composition (polymer grade)

	mol % or vol %
Ethylene	99.95
Methane + Ethane, mppm or vppm	500

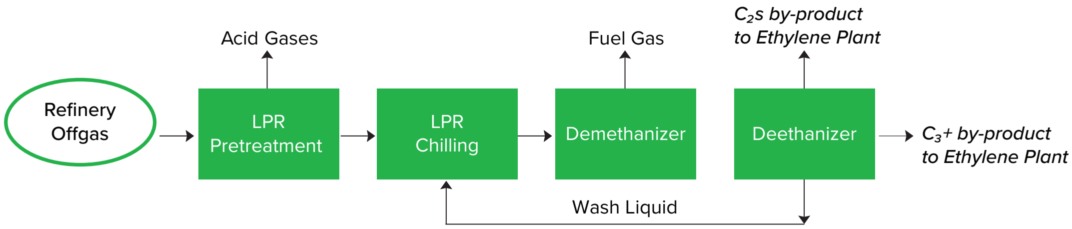
Ethylene product composition (dilute)

	mol % or vol %
Ethylene	86
Methane, mppm or vppm	50
Ethane	balance

Process Flow Diagram



With Ethylene Plant Integration



Process Description

Refinery offgas is first treated in a pretreatment section to a remove a broad range of impurities from the offgases. Impurities typically present in the refinery offgases are oxygen, NOx, CO_2, mercaptans, sulfides/disulfides, ammonia, amines, nitriles, cyanides, COS and metals such as arsine, phosphine and mercury. Oxygen and NOx impurities are first removed in the pretreatment section to very low ppm levels to prevent formation of unsafe NOx compounds potentially leading to formation of explosive gums and salts in the downstream cryogenic chilling section. The pretreatment section can include a caustic tower with or without amine treatment for removal of acid gases. The wet offgases from the caustic tower are then partially cooled and sent to a dryer/treater to achieve a dew point target and remove all the final trace nitrogen, oxygenate and sulfur impurities prior to transfer to the chilling section. Normally, a metals treater is provided downstream of the dryer/treater before the treated offfgas is sent to the chilling section.

In the chilling section, the treated offgas and the wash liquid are chilled to about -90°C. Chilling is typically achieved by cold recovery from the spent refinery offgas stream and a binary refrigeration unit provided as a part of the ISBL equipment. Operating conditions of the chilling section are selected to mitigate the risk of gum formation. Chilled offgas is then sent to the demethanizer for removal of lighter components such as nitrogen, hydrogen and methane. A high recovery of ethylene is achieved by the wash liquid. Recovered ethylene from refinery offgas is then distilled in the deethylenizer to produce either a polymer grade ethylene product or dilute ethylene product, depending upon client requirements. Deethylenizer bottoms can be distilled in a deethanizer to produce overhead ethane product. The bottoms C_3 + stream can be sent to the refinery for recovery of valuable propylene. Choice of wash liquid (schematic shows wash from the deethylenizer tower as C_2 wash) would depend upon whether ethane recovery is required for the project or not. If ethane recovery is required, the choice of wash liquid is from the deethanizer bottoms, C_3 wash. The wash liquid is an internally accumulated stream and does not require an outside source.

LPR units in a number of plants are integrated with an ethylene plant, where olefins and paraffins such as ethylene, ethane, propylene, and propane are recovered from LPR and further processed. In such units, the deethylenizer is replaced with a deethanizer. The column overhead, which is primarily ethylene and ethane, and bottoms C_3+ is sent to the cracker for further recovery. Olefins from the LPR unit are distilled in the ethylene plant to achieve polymer-grade quality products and adds on to the olefins production. Paraffins are cracked in fired heaters of the ethylene plant to further boost olefins production and increase operating margin. LPR integration lowers the overall ethylene complex CAPEX, due to synergies such as refrigeration integration, and improves overall olefin yield from the cracker complex, which benefits operating margin.

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