

## Overview

The I-FCC<sup>SM</sup> process is a breakthrough in FCC technology for converting heavy feeds, including residue, selectively to propylene and other light olefins (ethylene and butylenes). It combines Lummus Technology's FCC process with the proprietary Indmax<sup>(1)</sup> catalyst formulation and process conditions developed by Indian Oil Corporation Limited's Research and Development Center. Lummus Technology is responsible for the design and licensing of I-FCC units globally.

The I-FCC unit selectively produces propylene and other light olefins with very high feedstock conversion: up to 45% of the feed can be converted to light olefins, with propylene in LPG (i.e., the combined C<sub>3</sub>/C<sub>4</sub> products) or ethylene in dry gas as high as 50%. It is designed for and operated at Indmax process conditions: riser reactor temperature from 560° to 600°C, catalyst-to-oil ratio from 12 to 20, and lower hydrocarbon

partial pressure compared to conventional FCC operations. The Indmax catalyst is a multi-component, proprietary formulation that is specifically tailored for each facility depending on the feedstock and product objectives. It is highly metals-tolerant and produces low delta coke and dry gas – properties that are particularly important when processing residue to make light olefins.

Like a typical FCC unit, the I-FCC process uses only short-contact-time riser cracking, but is inherently more flexible than a typical FCC unit because the product slate can be easily adjusted to maximize propylene, maximize gasoline, or produce combinations such as propylene plus ethylene or propylene plus gasoline. This process flexibility is a key variable in maximizing profitability in a given market scenario.

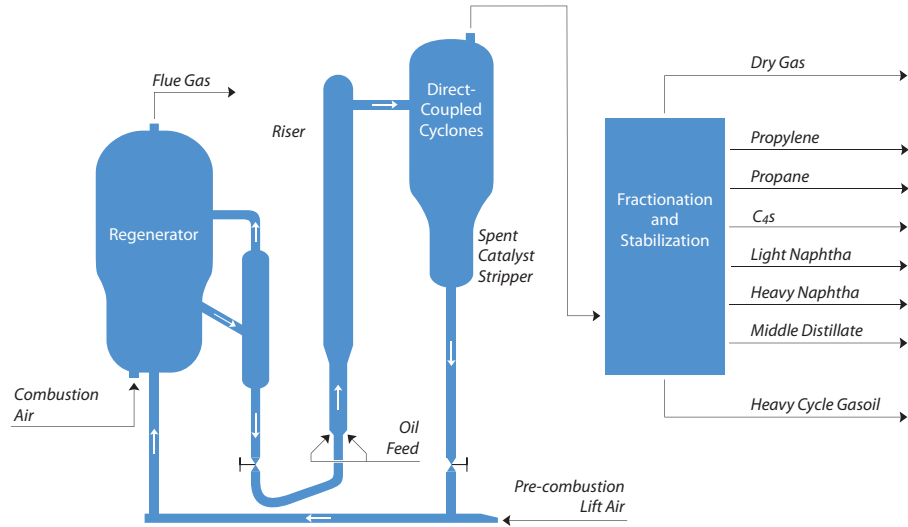
## Advantages

Process Features	Process Benefits
Multi-component Indmax catalyst	Formulation can be adjusted in response to changes in feedstock properties and/or product objectives
<i>Micro-Jet</i> <sup>TM</sup> feed injectors	Uniformly contacts feed with catalyst, maximizing catalytic cracking (i.e., high liquid yields and selectivity) • Minimal erosion and catalyst attrition • Minimal thermal cracking (i.e., less dry gas and coke) • Low pressure drop
Short contact time reactor	Minimal backmixing and erosion • Efficient catalyst/oil contacting • Reduced hydrogen transfer • High yield selectivity
Patented direct-coupled cyclones at the end of the riser reactor for quick and efficient recovery of product vapors	Minimal after-cracking • Low dry gas yield and delta coke • High liquid and light olefin yields retained • Minimal hydrocarbon loading in the stripper
Modular Grid ( <b>MG</b> ) catalyst stripper design	Highly efficient removal/recovery of hydrocarbon product vapors from the catalyst • Reduced delta coke • Low stripping steam requirement • High catalyst mass flux/lower stripper vessel size
Dual diameter catalyst regenerator and turbulent bed combustion	Low carbon on regenerated catalyst • Minimal catalyst deactivation • Efficient use of combustion air • Reduced after-burning and NOx emissions
Regenerated catalyst standpipe with external hopper	Smooth, stable catalyst flow over a wide operating range • Insensitive to unit upsets • Low erosion/catalyst attrition

(1)Indmax is a service mark of Indian Oil Corporation Limited

# Fluid Catalytic Cracking for Maximum Olefins

## Process Flow Diagram



## Process Description

The I-FCC process operates in a dynamic heat balance with hot regenerated catalyst supplying the net heat demand required by the reaction system. Finely sized solid catalyst continuously circulates in a closed loop between the reaction system and the catalyst regeneration system. The feed and catalyst are intimately contacted in the riser reactor in the proper ratio, and with the proper residence time and temperature, to achieve the desired level of conversion. The reaction products are disengaged from the spent catalyst using a patented riser/reaction termination device. The catalyst passes through a highly efficient, patented, spent catalyst stripper where any hydrocarbon product vapors entrained with the catalyst are removed and recovered. The regeneration system restores the catalytic activity of the coke-laden spent catalyst by combustion with air. It also provides heat of reaction and heat of feed vaporization by returning hot, freshly regenerated catalyst back to the reaction system.

Hot regenerated catalyst flows to the base of the reaction system riser where it is contacted with feed supplied through feed injectors. Vaporized feed and catalyst travel up the riser where catalytic reactions occur. The reacted vapor is rapidly disengaged from the spent catalyst in direct-coupled riser cyclones and routed directly to product fractionation, minimizing time for non-selective, post-riser

cracking. Reactor vapors are quenched and fractionated in the product recovery system, which yields dry gas, LPG, naphtha, and middle distillate products.

The spent catalyst separated by the riser cyclones is degassed of most of the reaction vapor while flowing via diplegs into the catalyst stripper. In the stripper, hydrocarbons are effectively removed from the catalyst by efficient contacting with steam.

The spent catalyst is transported from the stripper into the regenerator. The hydrogen-rich portion of the coke deposits reacts with the lift air at a lower combustion temperature relative to the regenerator dense bed temperature, which reduces catalyst hydrothermal deactivation. The carbon-rich portion of the coke deposits is burned off in the turbulent dense phase of the regenerator. Regeneration flue gasses are first routed through cyclones to minimize catalyst losses and then sent to energy recovery and environmental treatment before being ejected from the stack.

Hot regenerated catalyst overflows into an external catalyst hopper where it is aerated to the proper density before flowing back to the base of the riser.