

KMG Rompetrol & Grace: Increase FCC Profitability by Operating in Propylene Maximization Mode

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- **European refineries which are integrated with petrochemical facilities will be better positioned for the future market challenges.**
 - a) True**
 - b) False**
 - c) It depends**



Refining and petrochemicals is one of the main business units of KMG International

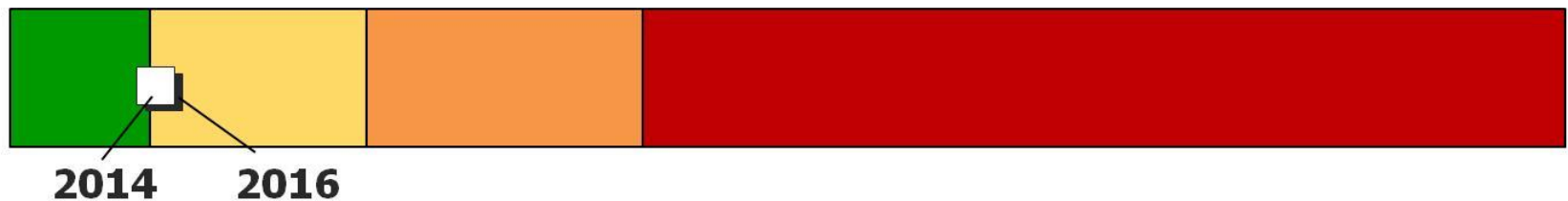
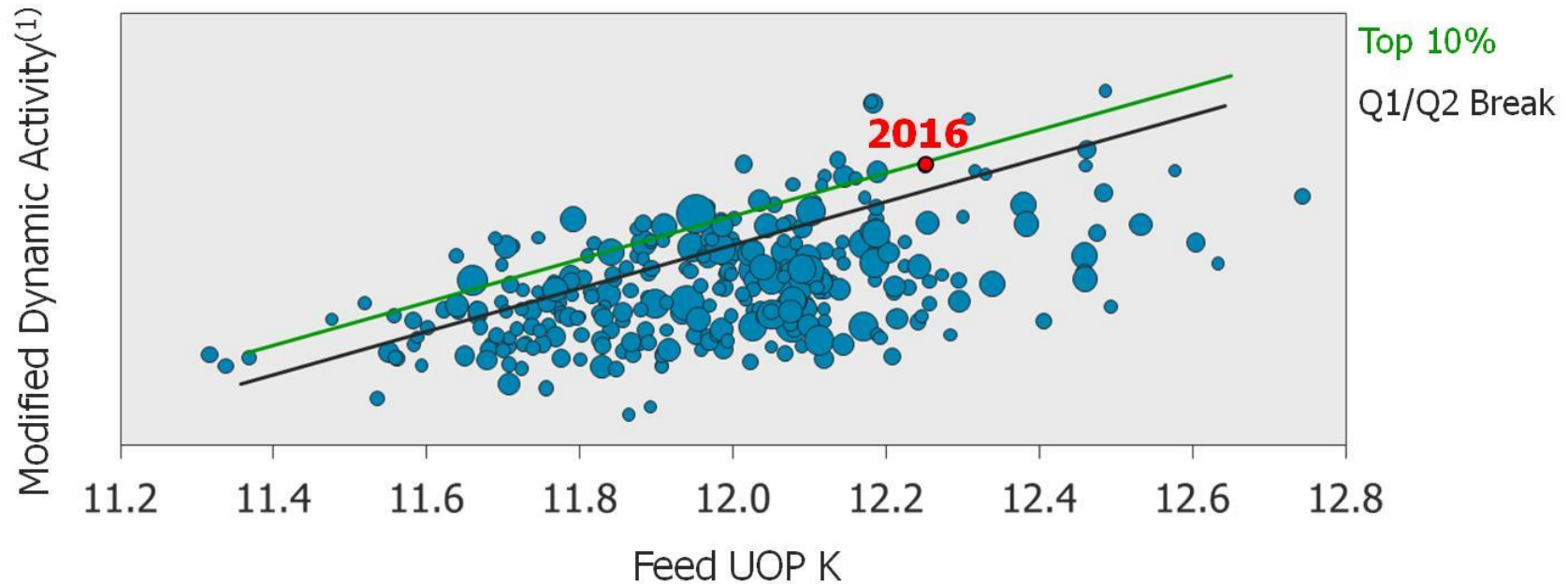
- It has two Production facilities: Petromida consisting of a Refinery and Petrochemical Complex and Vega Refinery.
- The refinery operates integrated petrochemical production facilities, making propylene a key product for the refinery
- The fluid catalytic cracking (FCC) unit is the main contributor to the refinery's production of light olefins, especially propylene.



Nelson Complexity Index	10.5
Crude processed are typically URAL with blend to other opportunity crudes like Kirkuk, Azeri, Siberian, CPC	
Unit design	UOP SBS
Unit capacity, bbl/day	24100
FCCU unit process 100 % hydrotreated feed	

FCC Yield Gaps

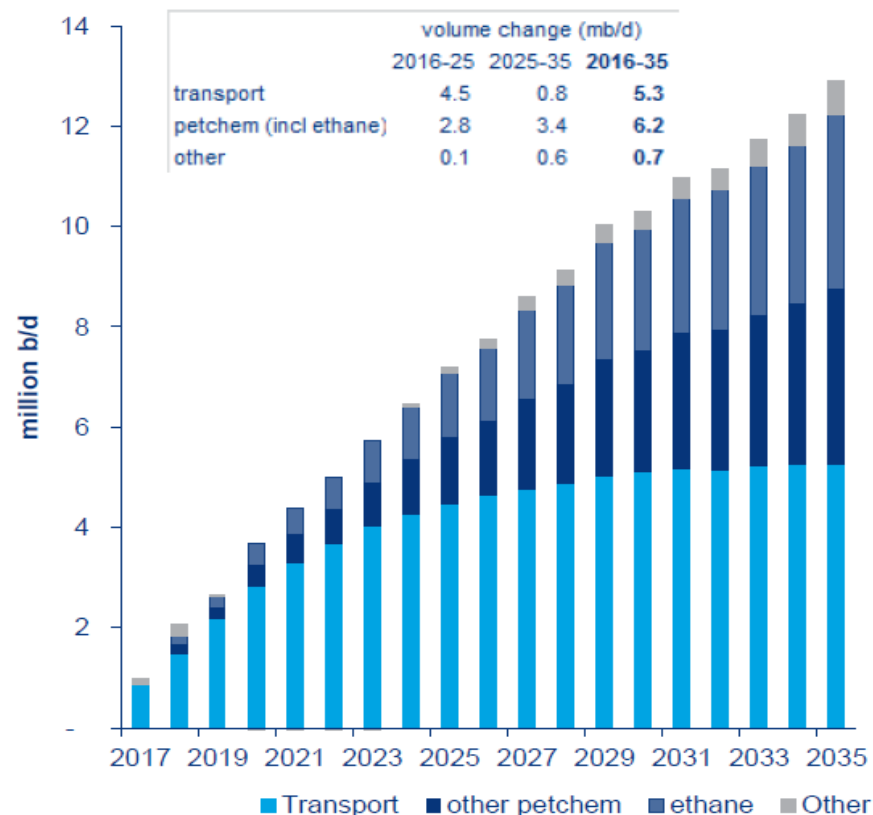
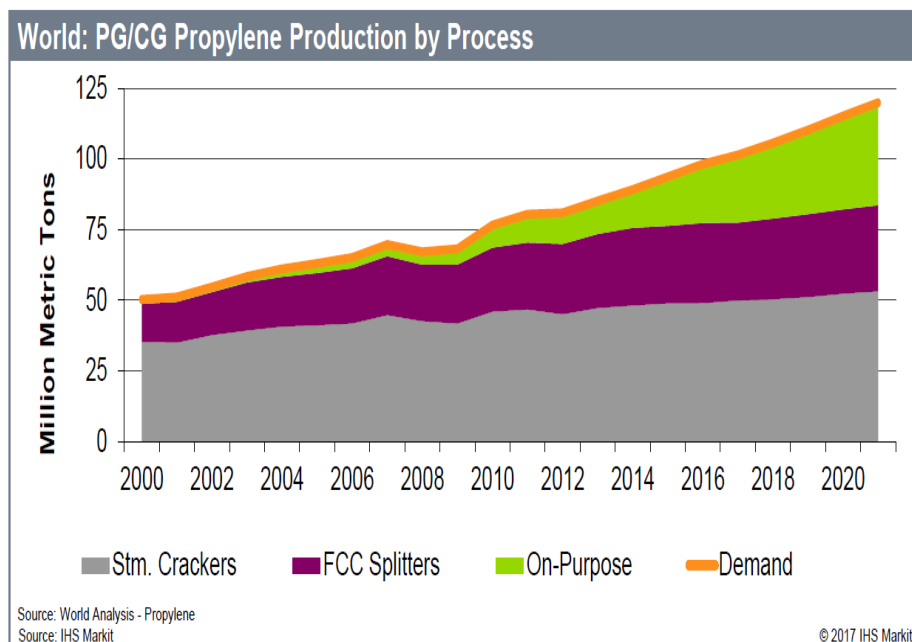
2016 Study – Worldwide, 303 Units



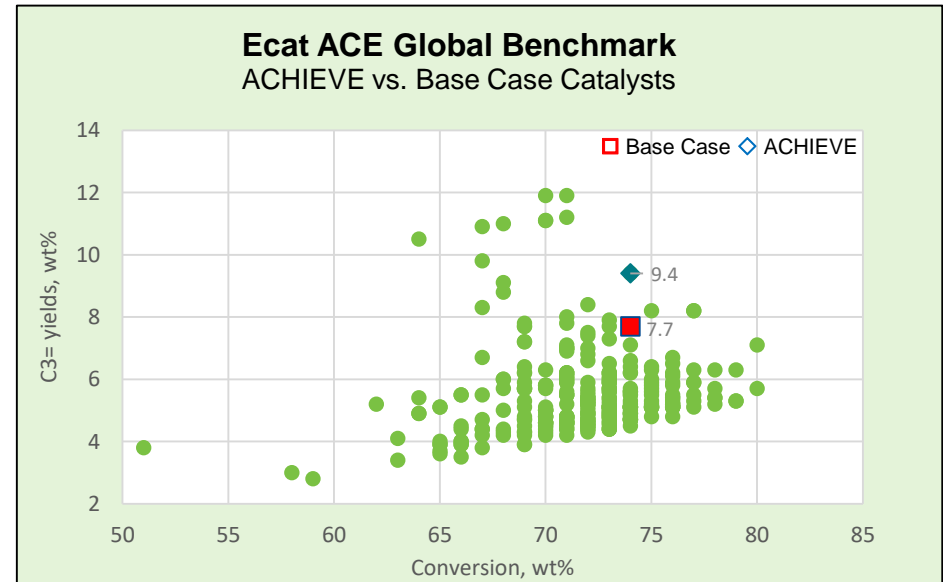
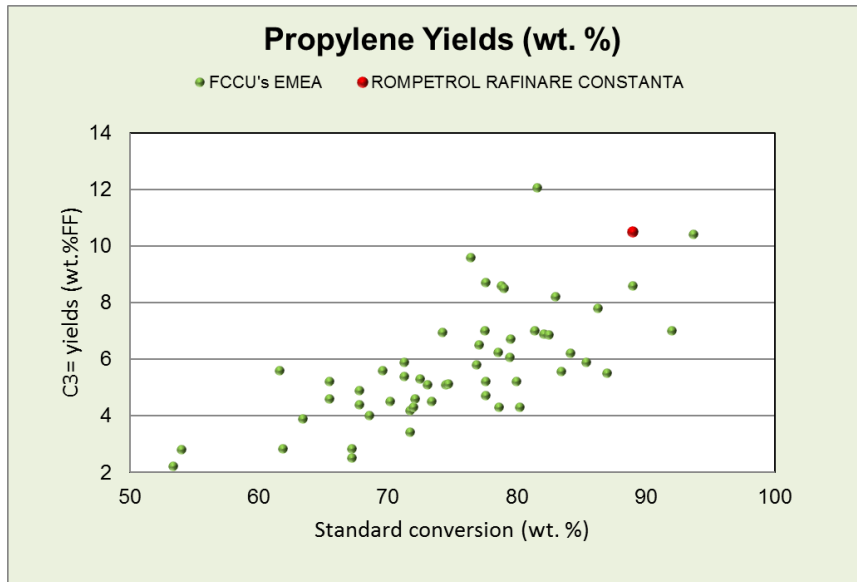
(1) $0.15 \times \text{Log}(\text{feed N}/10) + \text{Second Order Conversion} \div (\text{wt \% coke} - 0.84 \times \text{feed wt \% ConCarbon})$
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- 2016 - Petchem make up 12% of crude oil market.
- 2035 - Petchem will make up almost 50% demand of crude oil growth



- Yields of over 12 wt% have been achieved with Grace's latest generation of propylene maximization technology.
- KMG Rompetrol is among the 5 highest FCCU propylene yields in EMEA



**Refineries in EMEA are utilising Grace solutions
to achieve excellent propylene yields**



Internal screening by Grace before offering ACHIEVE - screening study using the ACE® pilot plant to identify most suitable formulation – July 2015

New technology proposed – September 2015

Grace Management of Change presented and discussed – September/December 2015

First delivery of new catalyst to KMG Rompetrol refinery – July 2016

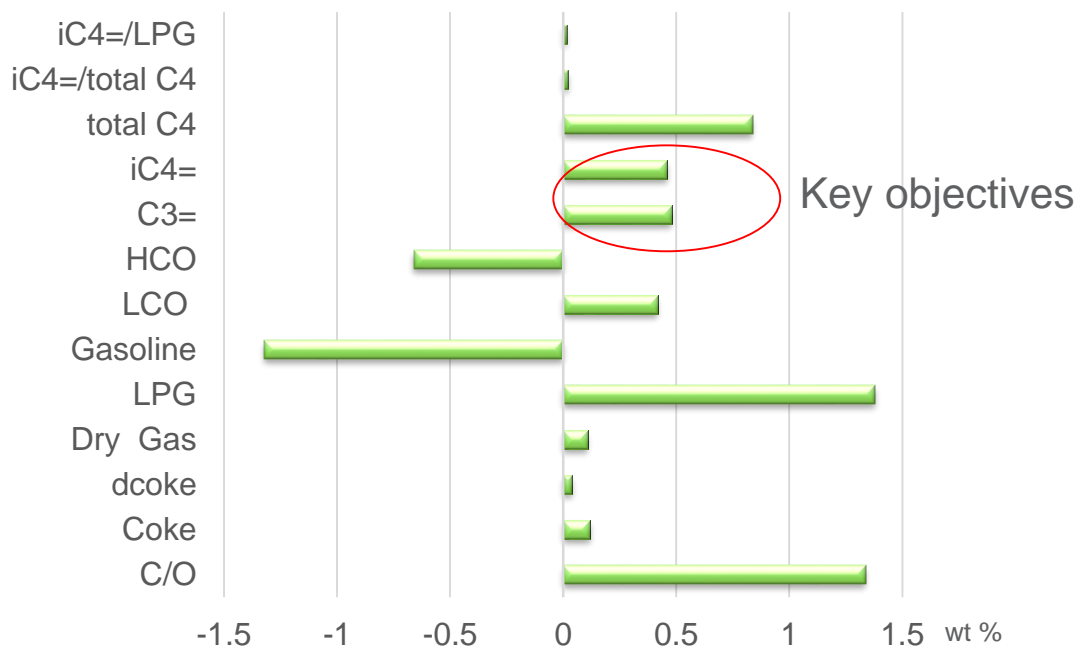
ACHIEVE results are showing the expected benefits in propylene yield and C4's selectivity – test run January 2017

Continuous analysis of ACHIEVE is being conducted to validate the increased profitability of the KMG Rompetrol FCCU.

Key Unit Objectives

- Maximum Propylene Yield (min.10 wt% of FF)
- Maximum Iso-Butylene Yield
- Maximize LCO
- High RON
- Higher dcoke
- Minimize dry gas

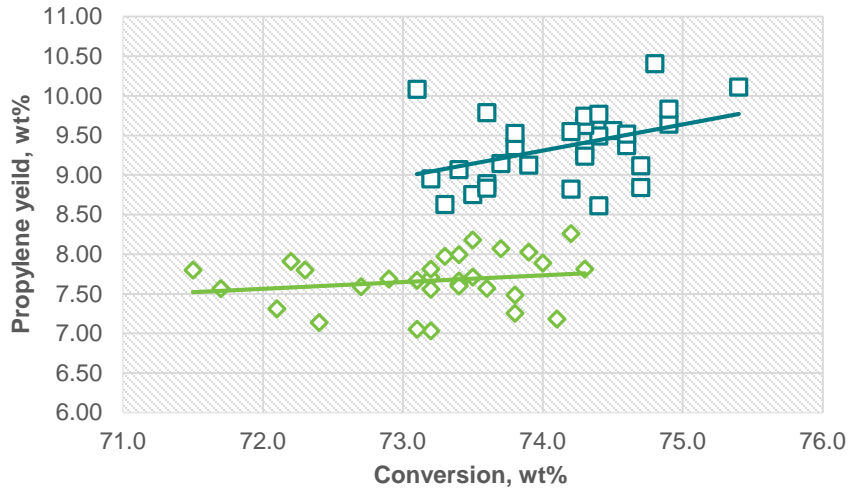
ACE Performance Deltas



Improved performance with selected FCC catalyst tested by Grace's pilot plant

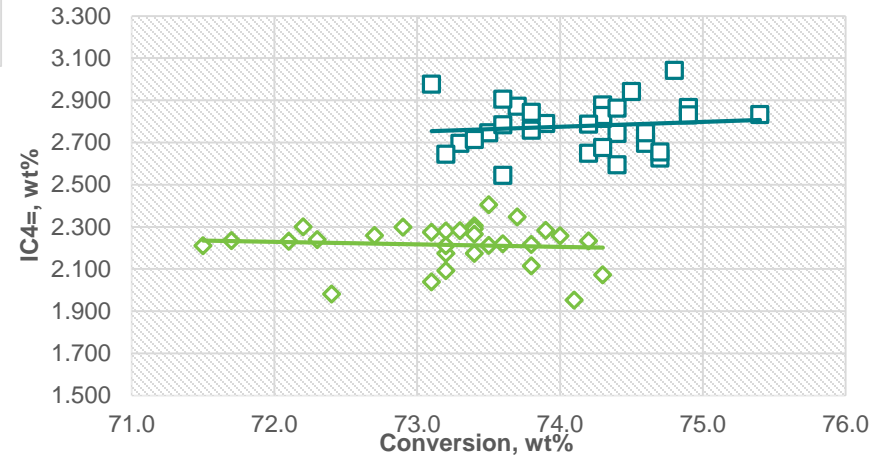


ECAT Propylene Yields (wt%)

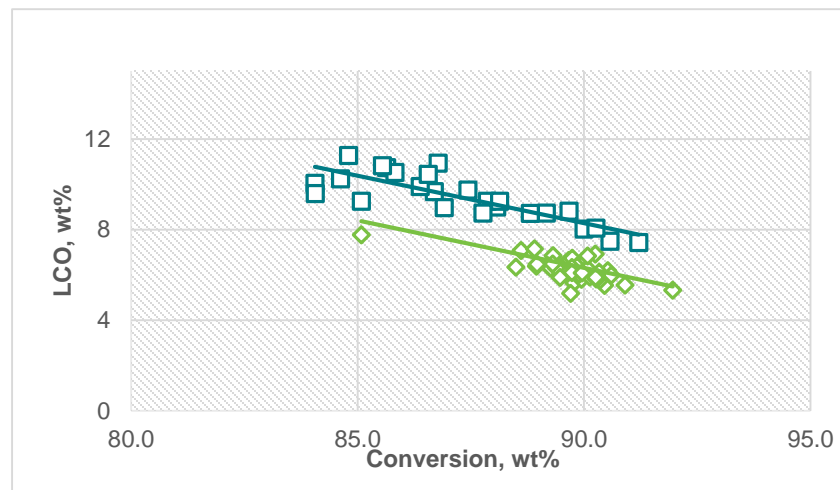
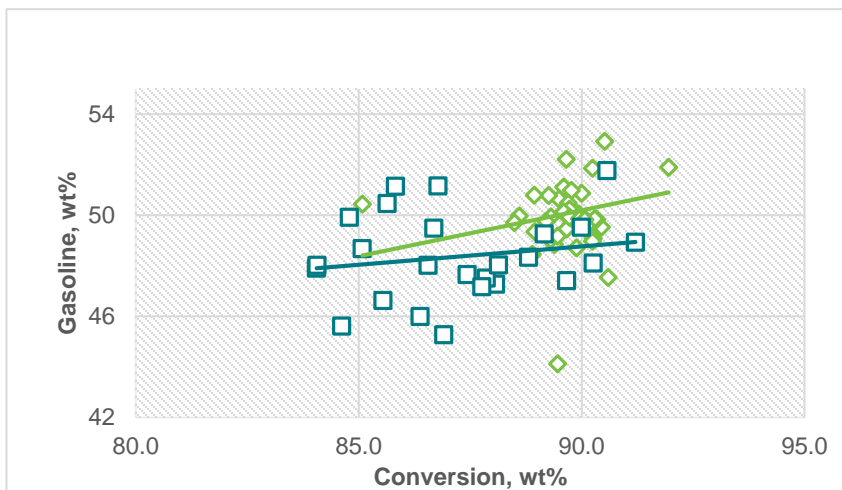
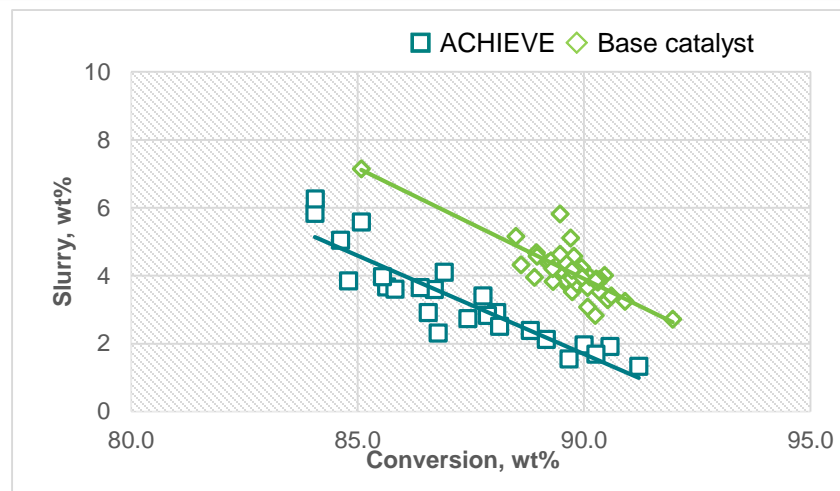
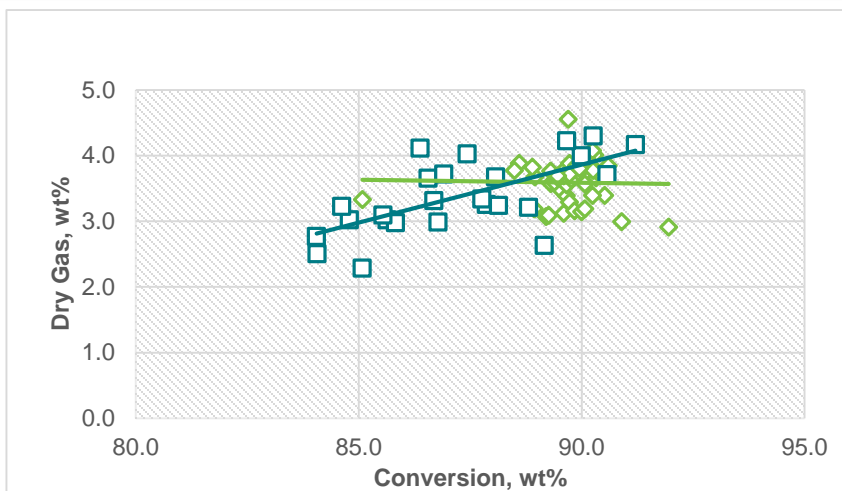


■ ACHIEVE ◇ Base catalyst

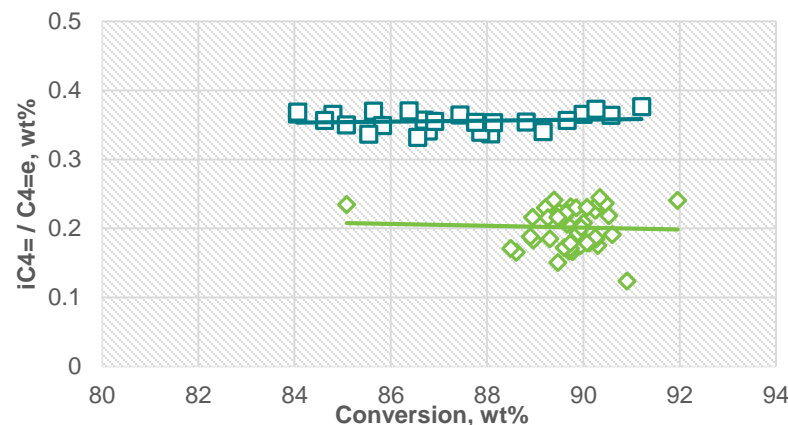
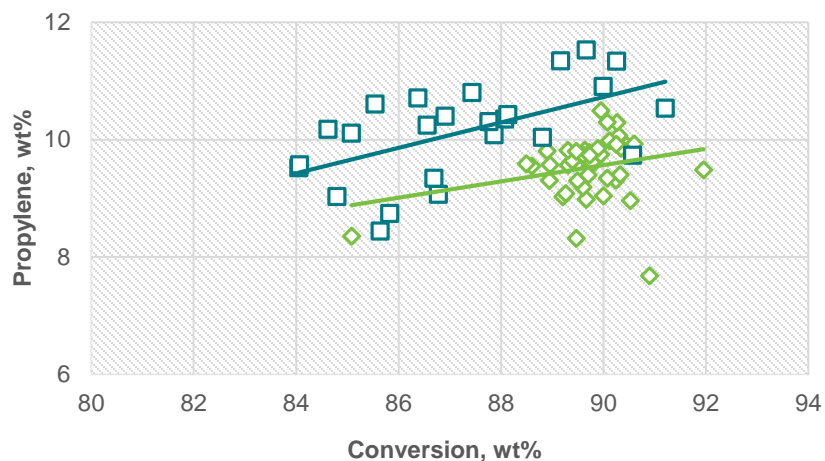
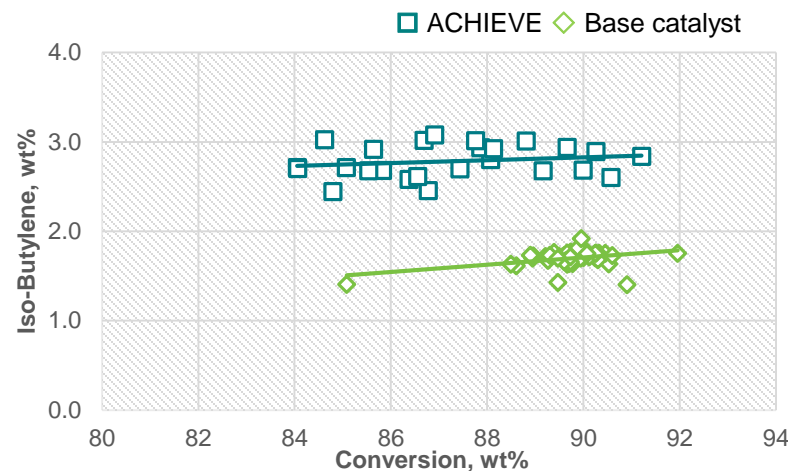
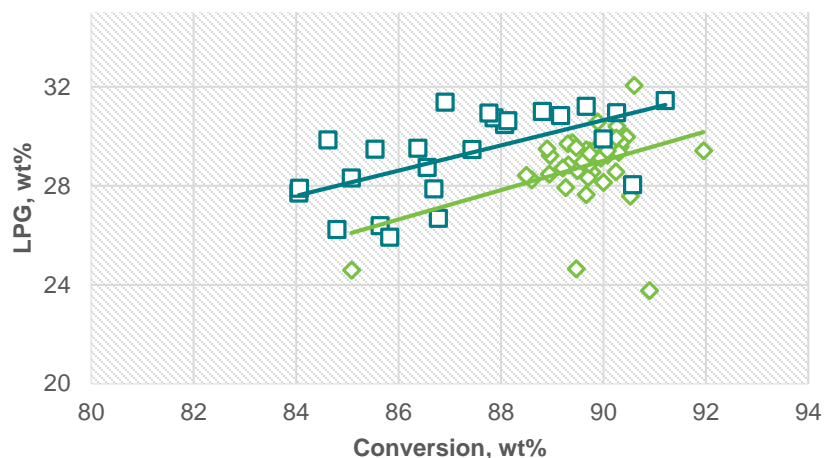
ECAT Iso-butylene, wt%



ACE Ecat results confirm improved olefins yields



ACHIEVE catalyst formulation provides significant bottoms upgrading



Key refinery objectives of increased propylene and isobutylene yields have been achieved



Compared to the Base catalyst system,

the ACHIEVE catalyst:

- provided higher iso-butylene and propylene yields as expected.
- 11.0 wt% propylene yield is achieved

Performance	ACHIEVE vs. Base
Dry Gas, wt%	0.29
C ₃ =, wt%	1.26
iC ₄ =, wt%	1.05
LPG, wt%	1.68
Total Naphta, wt%	-1.77
LCO, wt%	2.03
Slurry, wt%	-2.10
Coke, wt%	-0.13

Operating conditions:	
Unit throughput, t/h	142
ROT, ° C	541
FPH temperature, ° C	215
Specific Gravity	0.885
ZSM- Additive (OlefinsUltra HZ), %	7
Operation Mode	Full Burn

ECAT Properties:	
Activity, wt%	73.5 -75.0
UCS, Å	24.26
SA, m2/g	182 - 192

ACHIEVE test run results at maximum unit throughput and max. severity demonstrate higher refinery profitability for 2.3 M\$/y



- The most profitable refineries are the ones that leverage their flexibility to capture market opportunities.
- Increased profit of 2.3M \$/y is calculated using refinery PIMS model.
- Rompetrol could even further optimize performance and improve profitability through additions of Grace's latest generation ZSM-5 additive, OlefinsUltra[®] XZ.
- Refinery plan is to increase downstream petrochemical unit capacity for additional 15-20% to further increase LPG production.

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