CRUDE TO CHEMICALS
DIRECT CRACKING FOR LIGHT OLEFINS FROM CRUDE OIL (LOCO)

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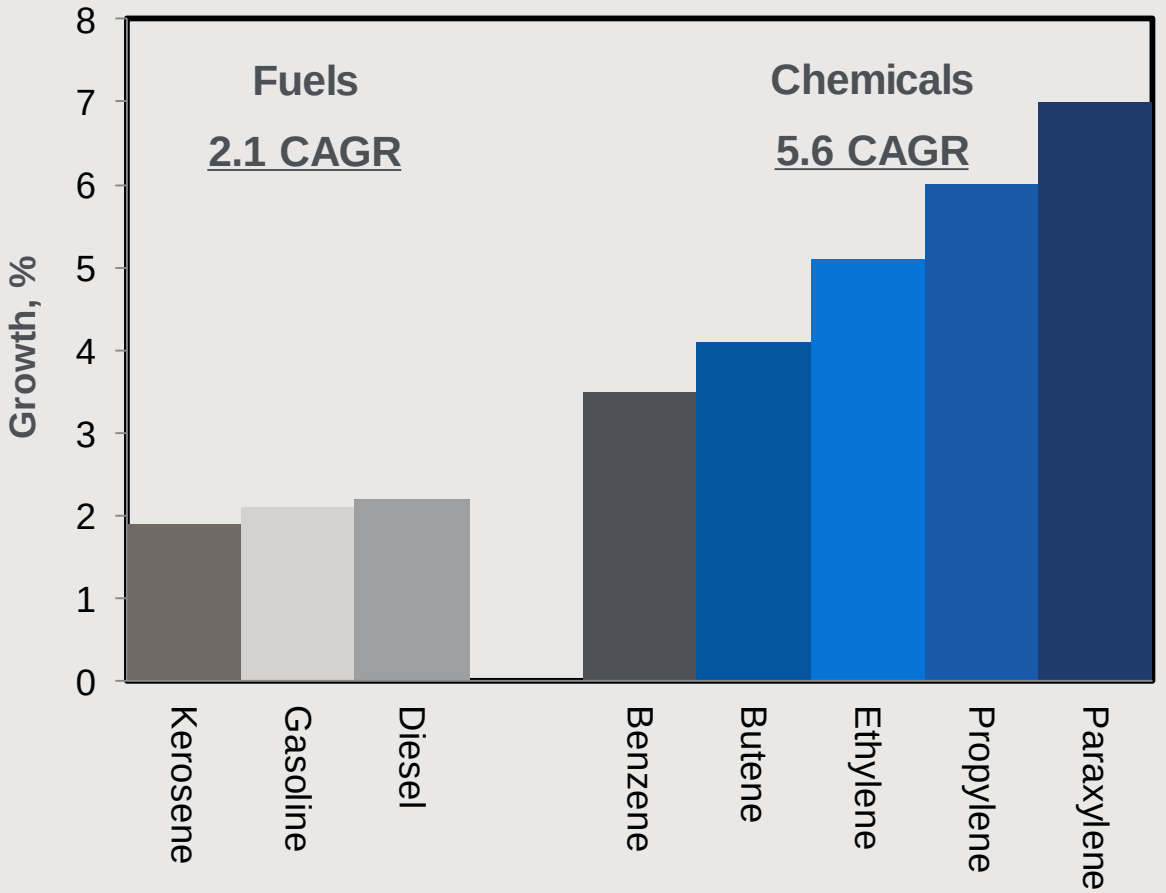
INTRODUCTION

GROWTH AND DEMAND

An objective assessment and detailed technological analysis of the activities directed towards Crude to chemicals.

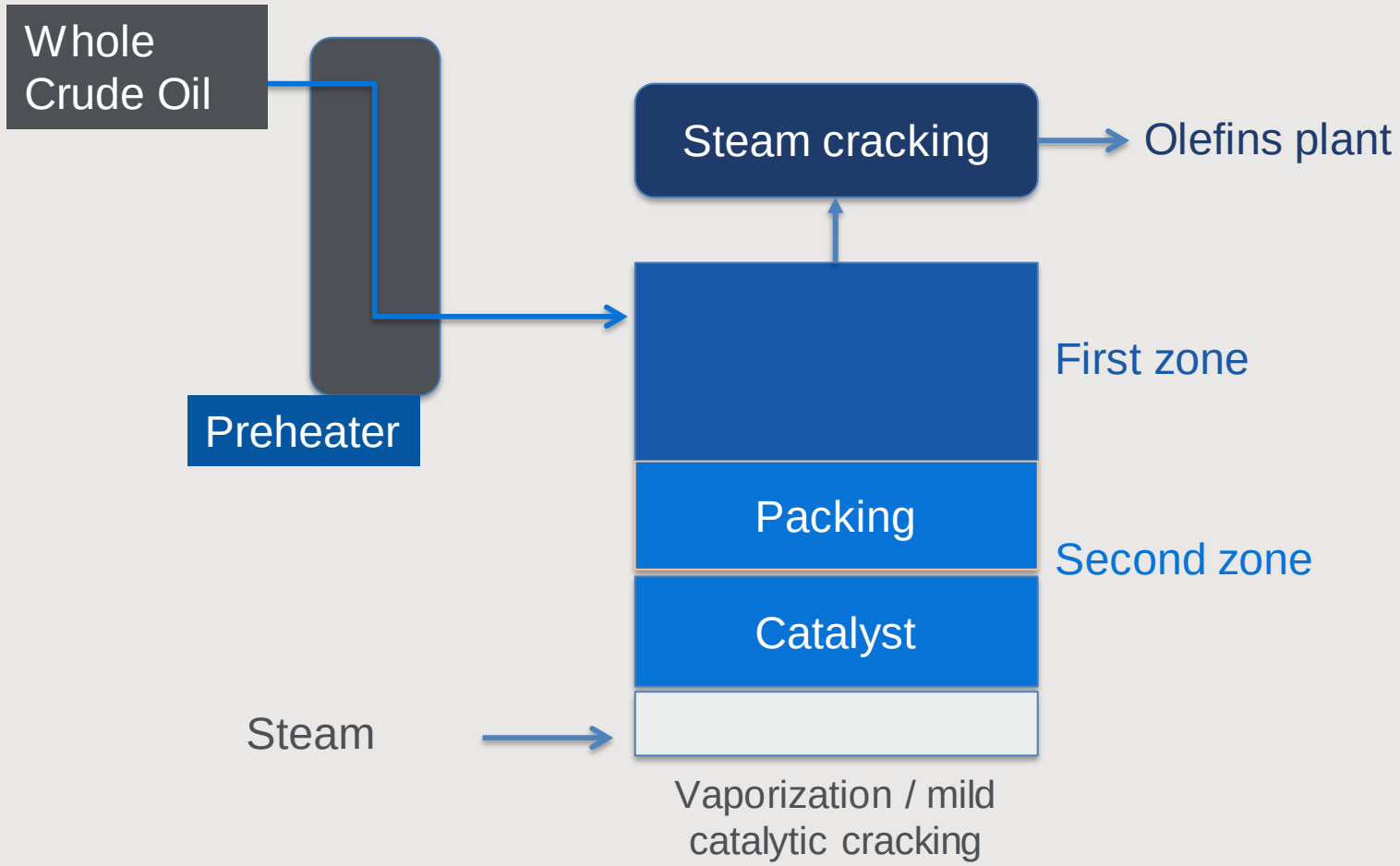
The CAGR for chemicals is higher than Fuels

Numerous independent technology developers like UOP/Honeywell, Axens, CB&I and other majors like SABIC are working towards combinations of technologies



Sources: OPEC 2016, IEA 2016, IHS 2016, Platts 2016, and TCGR 2016

REFINING STRATEGY



Steam cracking and Controlled vaporization

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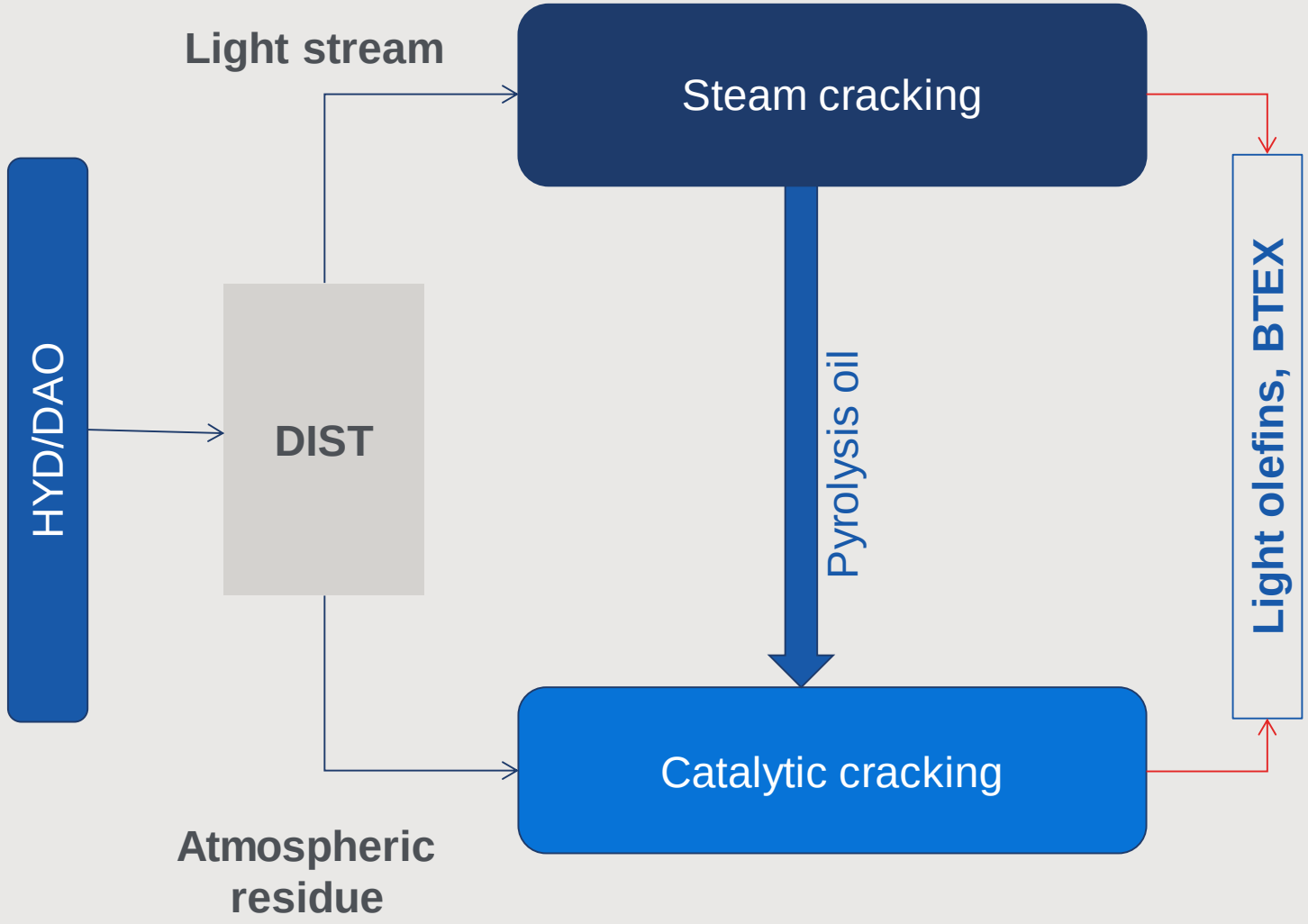

Pre-treatment, Steam cracking, Catalytic Cracking of heavy fraction

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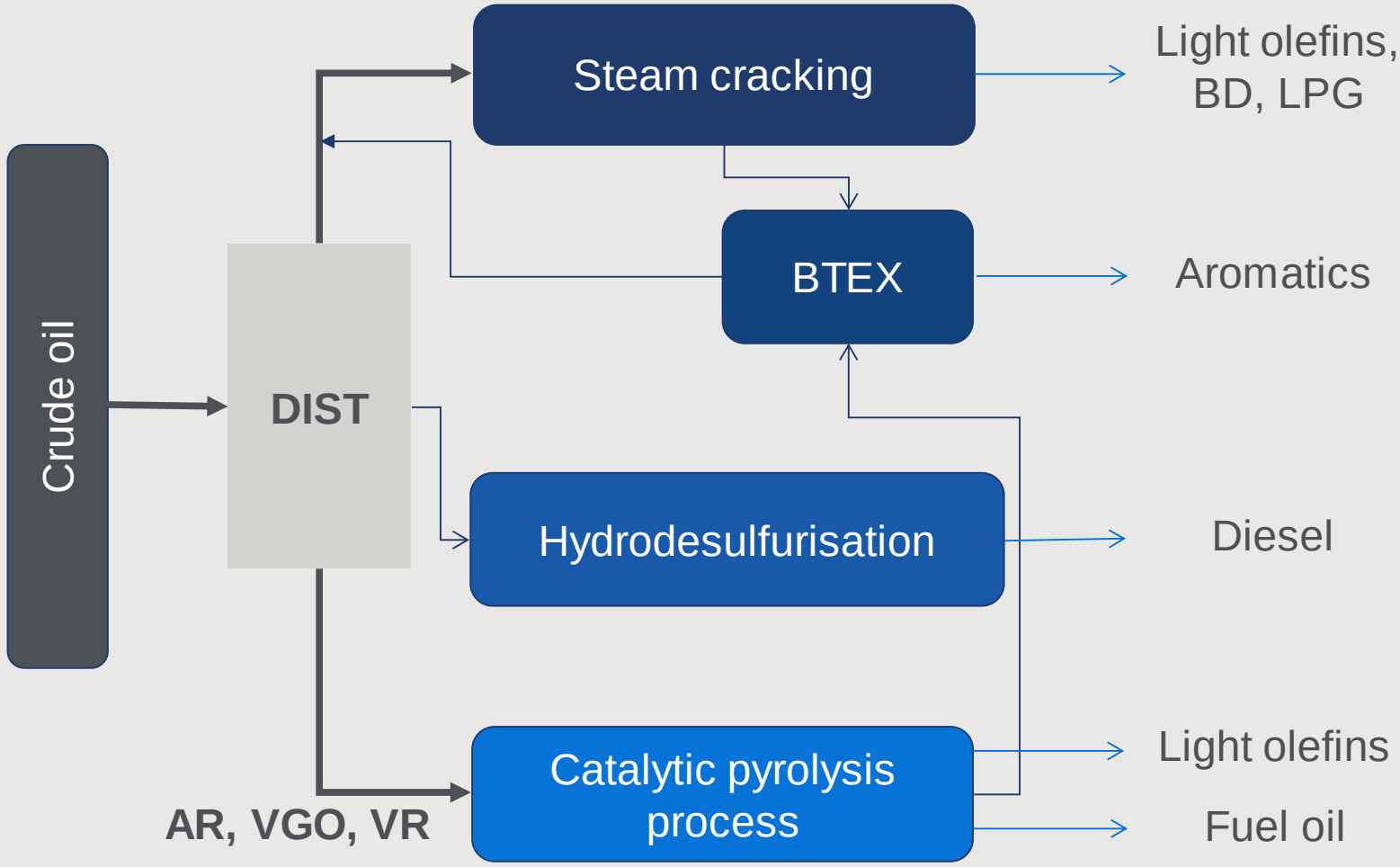
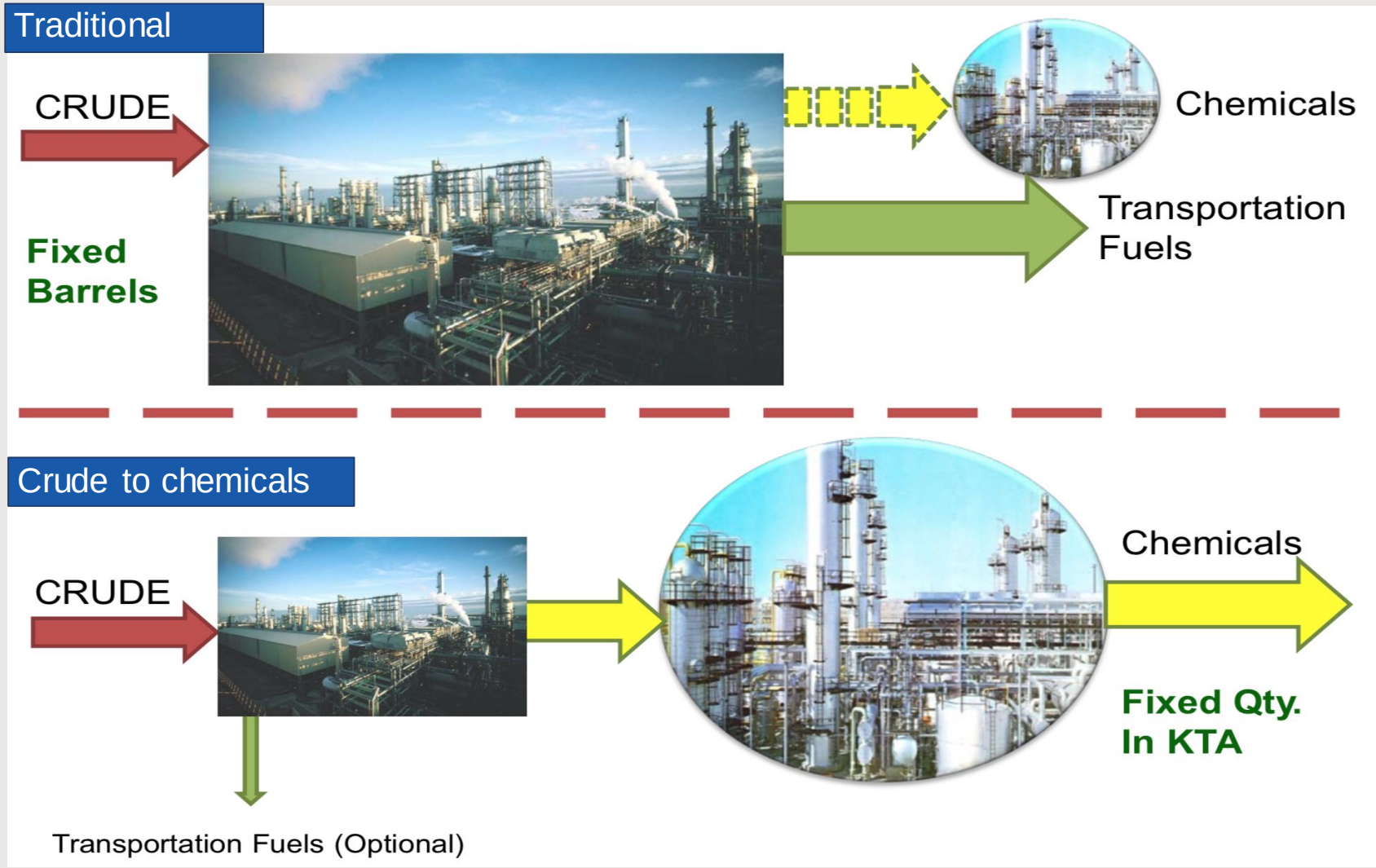
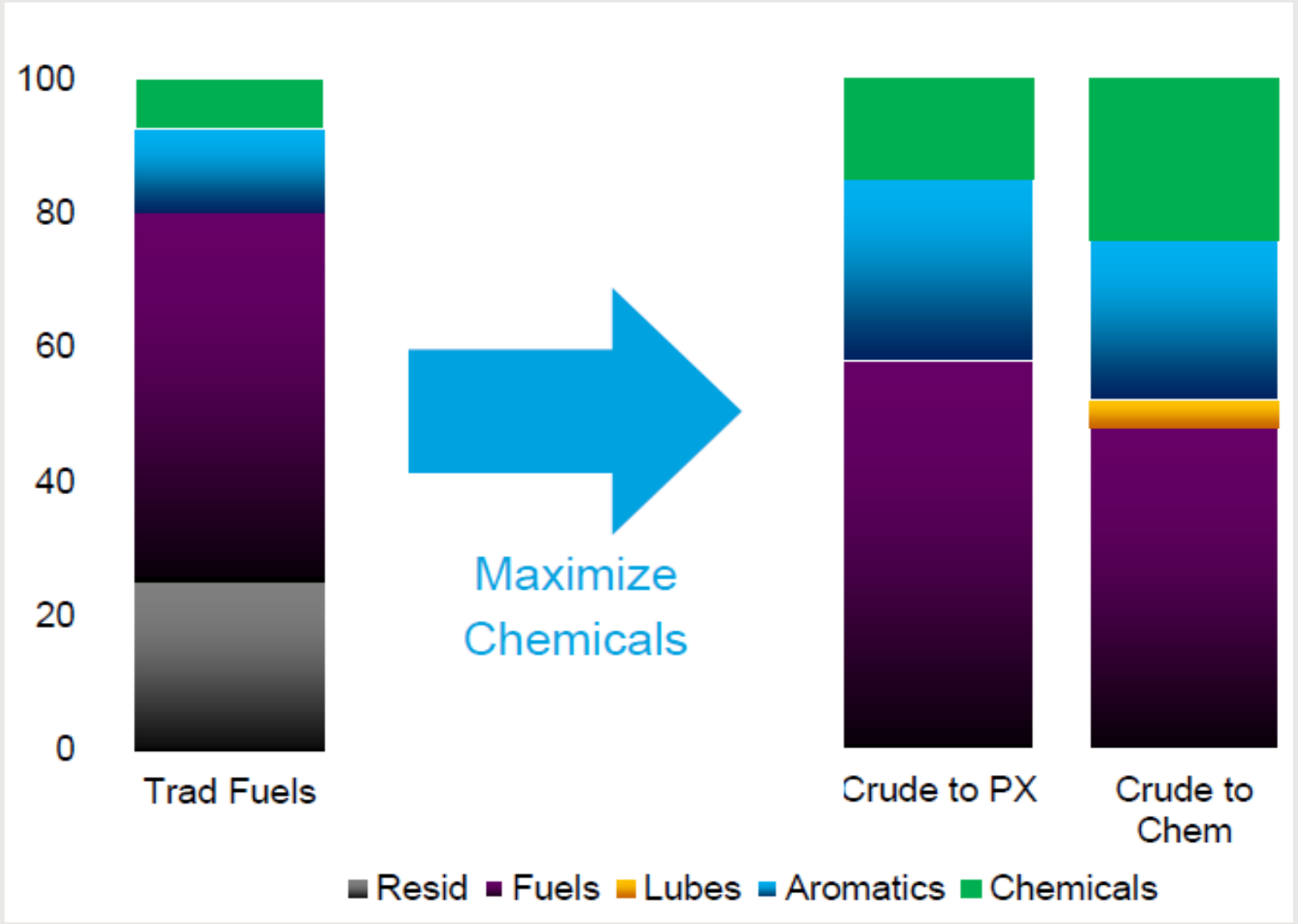


Steam Cracking, bottom upgradation and petro chemistry

CRUDE TO CHEMICALS – CONVENTIONAL VS NEW CONFIGURATION

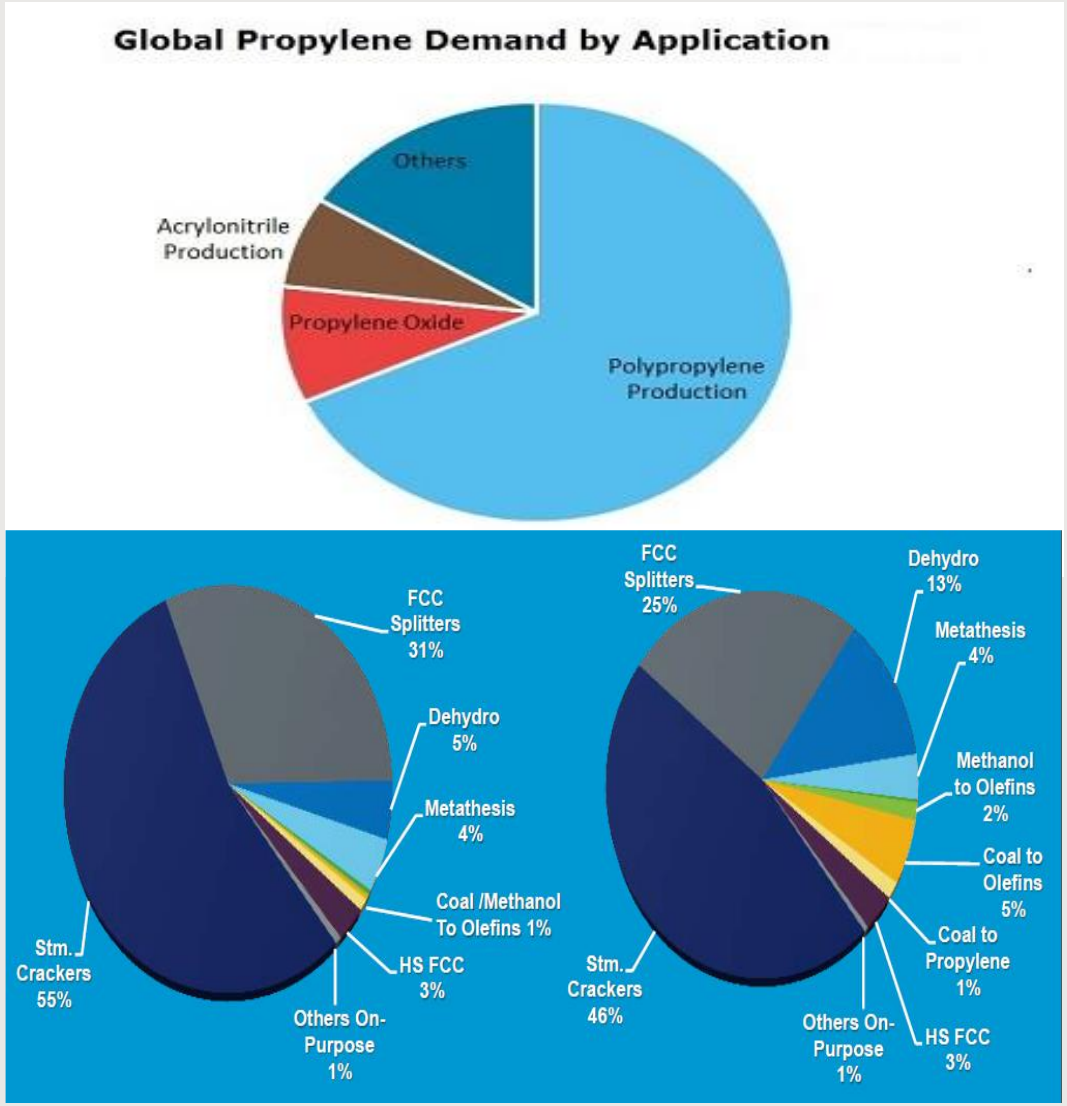


CRUDE TO CHEMICALS

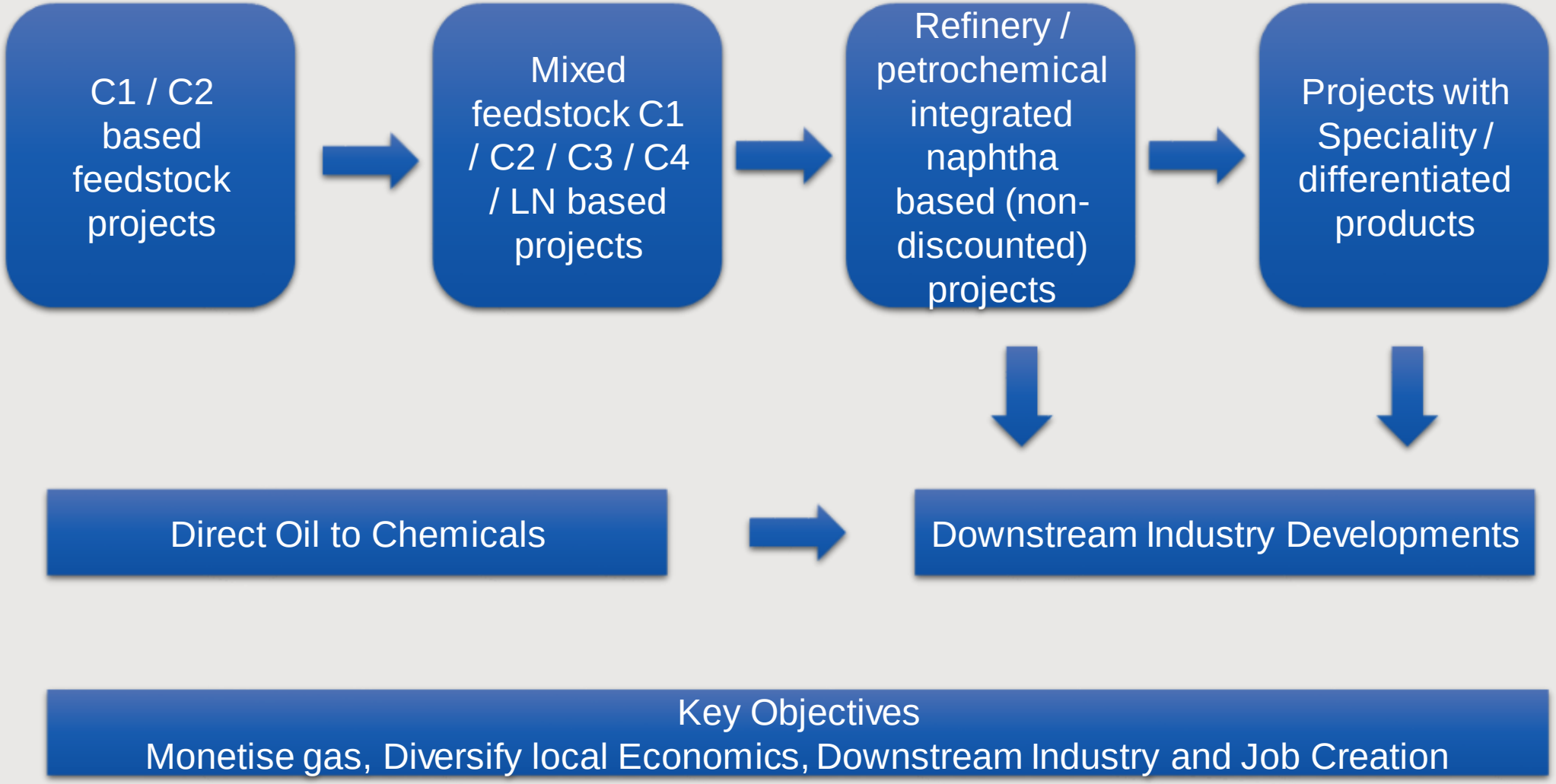


PROPYLENE DEMAND

- Polypropylene (PP) industry consumes about 70% of all propylene produced
- Traditional propylene production methods, new on-purpose technologies have penetrated the market; among them are propane dehydrogenation (PDH), methanol to olefins (MTO), methanol to propylene (MTP) and isobutylene to propylene
- China will introduce considerable on-purpose propylene capacity to become self-sufficient in propylene supply
- Overall propylene market is expected to post good growth rates with Asia Pacific being the leader



MIDDLE EAST- FEEDSTOCK DRIVES NOT THE MARKET



KEY PLAYERS

NEW TECHNOLOGIES

- ExxonMobil has been reported to be cracking crude oil at its Singapore complex since January 2014.
- Saudi Aramco announced an operational demo plant (TC2C)
- SABIC suggested a “Crude Oil to Chemicals” project for Yanbu (KSA)
- Aramco and SABIC announced a JV in 2016.
- Siluria’s OCM technology for ethylene from natural gas.

PROBLEM DEFINITION

- Fluid catalytic cracking (FCC/RFCC) has proven high flexibility in feedstock and product slate, especially for chemicals feedstocks.
- Crude oil cracking in a FCC/RFCC process may appear as an ideal candidate to fulfill chemical producer's needs which usually run on vacuum gas oil (VGO) and vacuum residue (VR) and atmospheric residue (AR).
- All the technologies developed to enhance olefin yield in FCC/RFCC are of high interest for converting crude to chemicals. Such a disruptive technology may probably be based on a conversion unit which can handle the heavy fractions of the crude oil, converting it partially to light olefins and reducing the amount of heavy products to a minimum.

CASE STUDY-FEEDSTOCK

			Crude Oil		Atmospheric Residue	
			Murban	Upper Zakum	Murban	Upper Zakum
Density at 15^{O}C	ASTM D4052	g/cm3	0.8232	0.8539	0.9268	0.9612
Specific Gravity at 60/60 ^{O}C	Calculation		0.8236	0.8544		
Sulphur, Total	ASTM D2622	wt%	0.778	1.95	1.87	3.26
Total Nitrogen	ASTM D5762	wppm	438	890	1300	1400
Concarbon Residue (CCR)	ASTM D4530	wt%	1.43	5.07	4.37	9.89
Nickel	IP 433	wppm	2	12	5	14
Vanadium	IP 433	wppm	2	13	8	20
Iron	AAS	wppm	<1	1	<2	3
Boiling point cuts						
IBP		Mass %	58.0	-	257	328
50%		Mass %	286.8	336.8	475	485
90%		Mass %	528.8	598.4	629	666
95%		Mass %	593.4	659.0	669	707

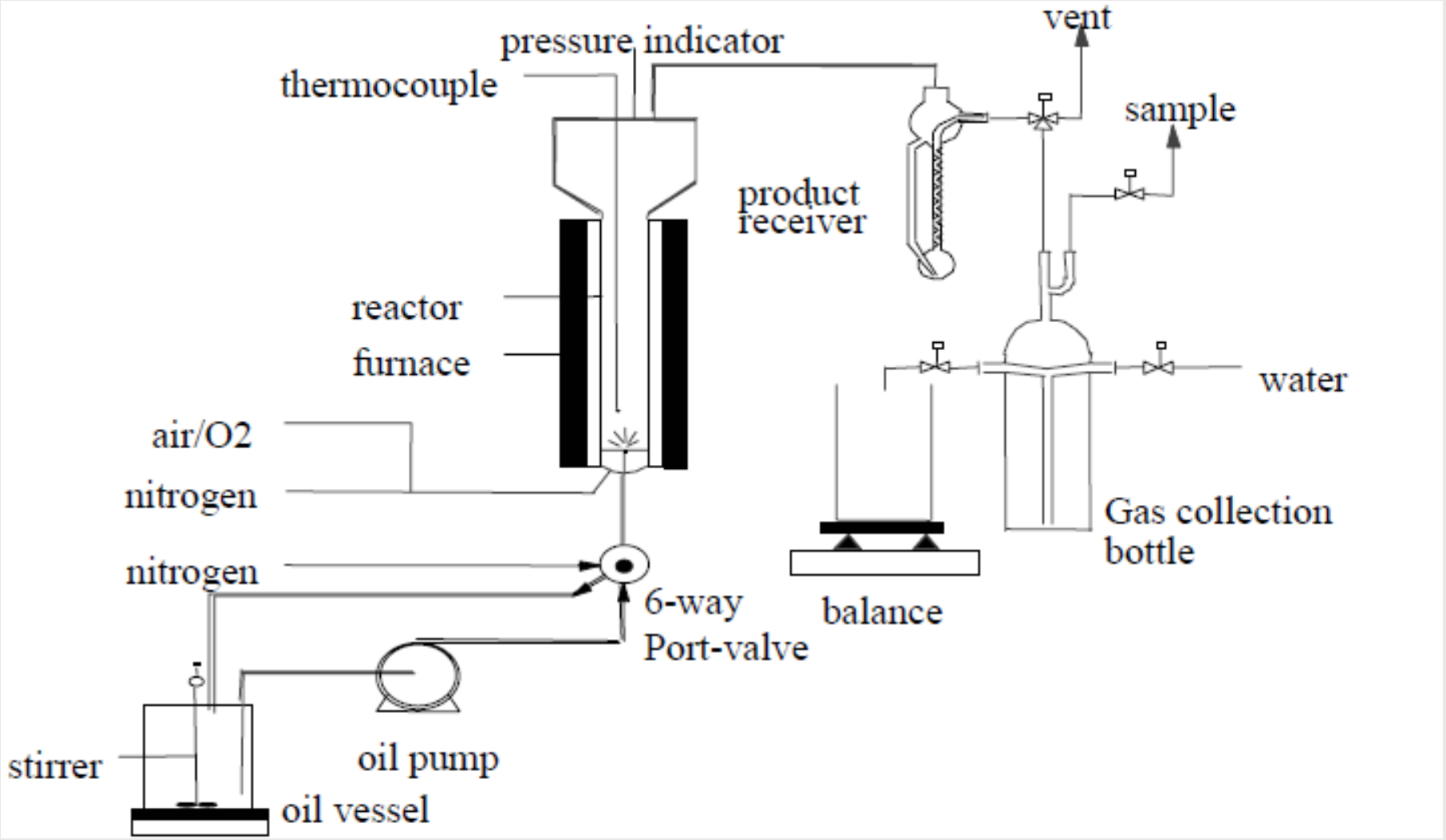
Upper Zakum crude is heavier than Murban in terms of density, CCR, Sulfur etc.,

CASE STUDY- CATALYST & CONDITIONS

Properties	Ecat
TSA (m^2/gm)	183
ABD (gm/cc)	0.76
APS (µm)	78
UCS (Å)	24.32
RE_2O_3 (wt%)	2.61
Ni (ppm)	4000
V (ppm)	4300
Total (Ni+V) (ppm)	8300

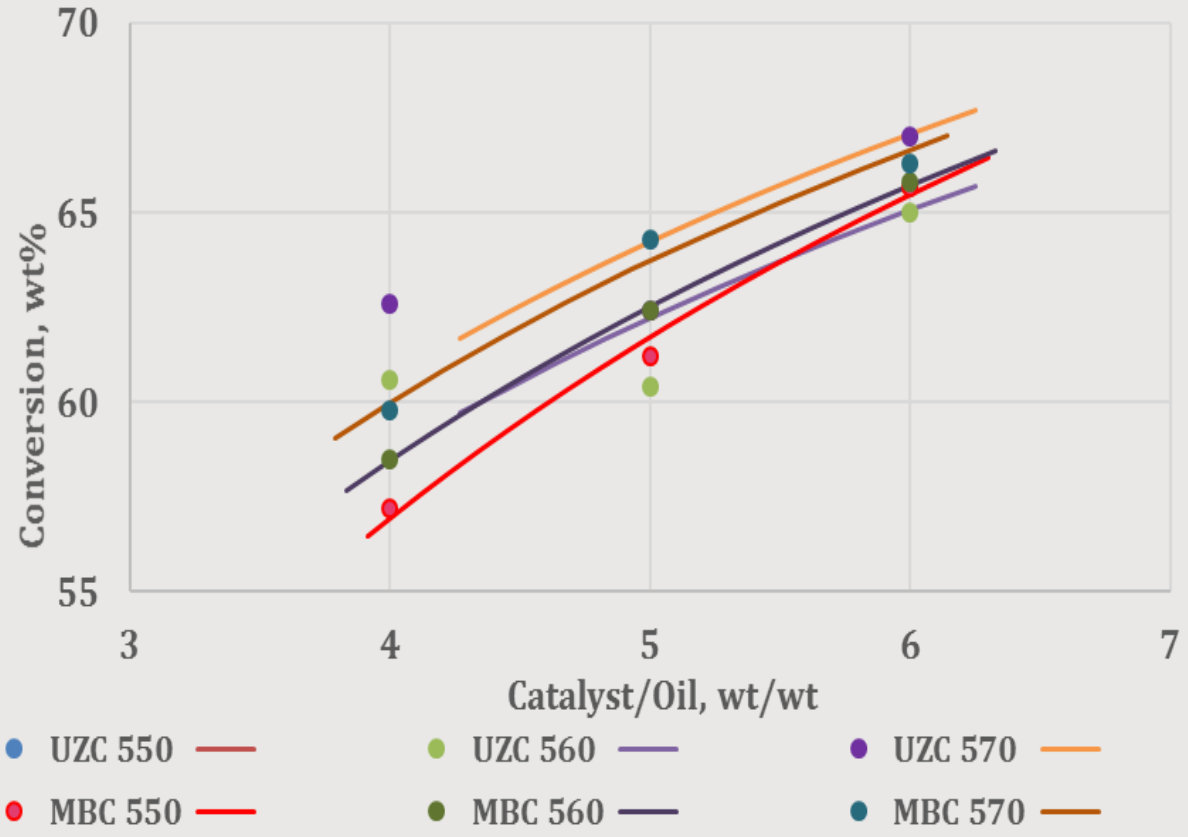
Experimental conditions	Value
Temperature, ^oC	550
Catalyst to oil ratio (CTO)	4-8
Injection time, s	1
Injection quantity, g	3
Catalyst quantity, g	12-24

TESTING UNIT-SHORT CONTACT TIME RISER TEST (SCTRT)



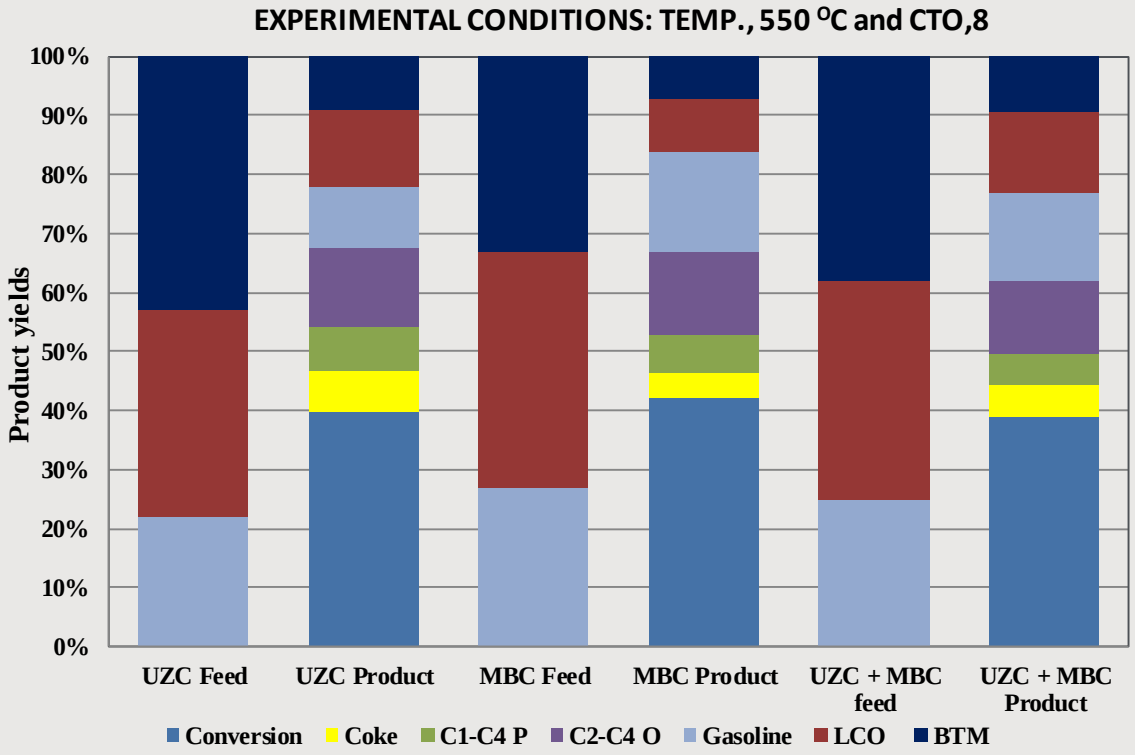
EFFECT OF CATALYST TO OIL RATIO ON CONVERSION

- Conversion increases with increase of catalyst to oil ratio irrespective of feed and temperature. UZC showed lower conversion than MBC due to feed quality.
- At higher CTO and temperature, the delta conversion increases for UZC whereas MBC showed nearly zero delta conversion



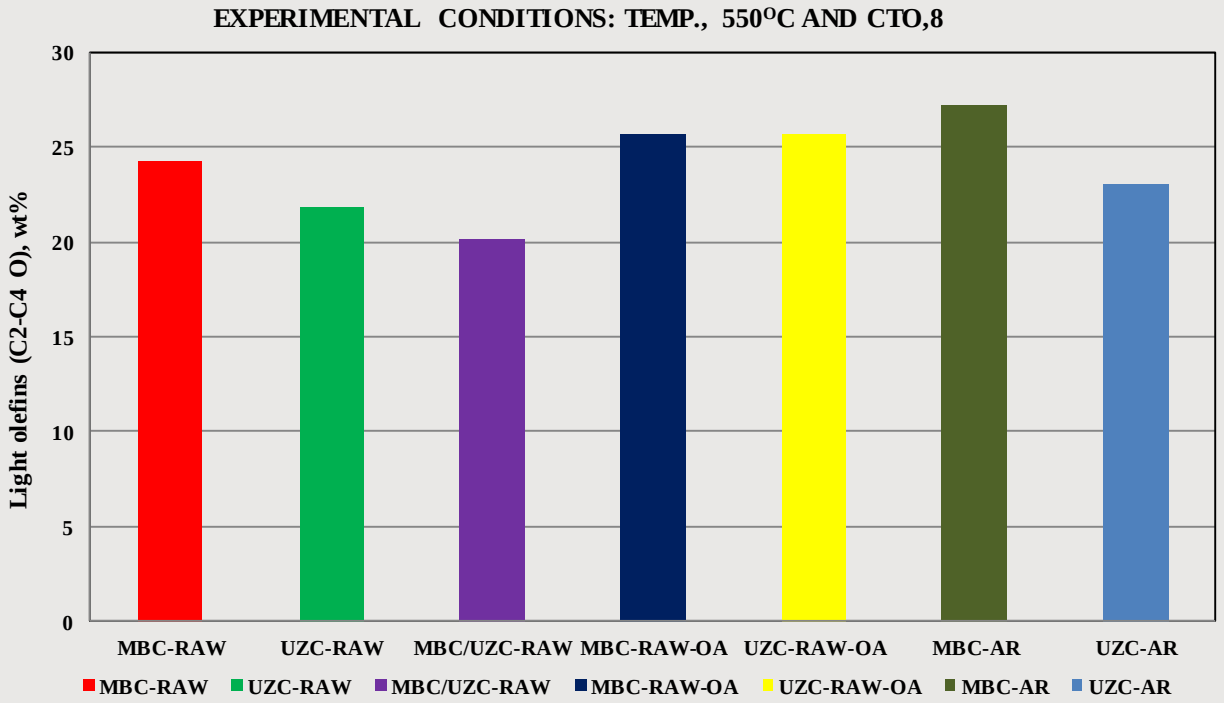
PRODUCT DISTRIBUTION FOR DIFFERENT CRUDES AND MIXTURES

- The product distribution for UZC and MBC crudes showed light olefins and paraffins and reduction in middle distillate and heavier compounds.
- Despite feedstock differences, UZC and MBC crudes are similar in conversion and product yield.



LIGHT OLEFINS CONTENT FROM DIFFERENT CRUDES

- Light olefins production from MBC is higher than UZC and mixture of MBC and UZC.
- Atmospheric residue of MBC produces highest light olefins than UZC.
- Addition of Olefin additive from 10 wt% to higher level produces equal amount of light olefins from both crude oils



SUMMARY

- The use of crude oil as a feedstock to produce olefins and other petrochemicals is attractive economically where naphtha cracking is predominant.
- A central part of such complex could be a catalytic conversion unit such as an FCC/RFCC like process optimized for light olefins.
- The technology already existing in FCC field to boost light olefins production could be extended to process the whole crude oil fraction, propelling the direct petrochemicals production in the 30–50% yield range, which is far beyond the current levels in refinery.
- An important issue in the near future that may impact an olefins oriented catalytic cracker to process feed-stocks with diverse compositions require additional research to obtain processes and catalysts.

REFERENCES

- Corma 2017 ; Crude to Chemicals: Light Olefins from Crude Oil (Catal. Sci. Technol., 2017, 7,12-46)
- CB&I, 2017 ;Crude to Chemicals: Opportunities and Challenges of an Industry Game-Changer, MERTC, Bahrain IEA, 2016
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