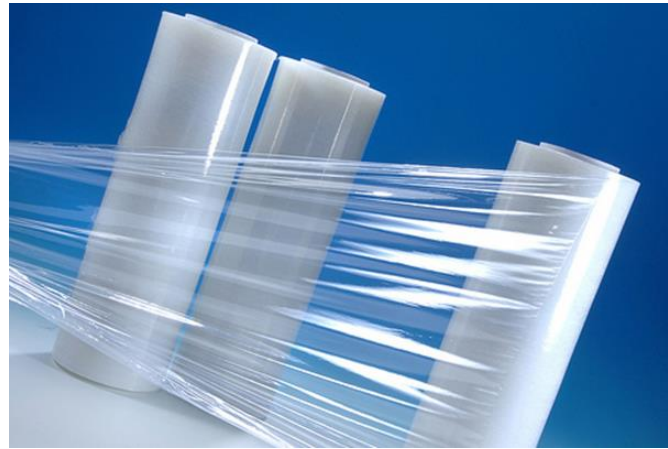
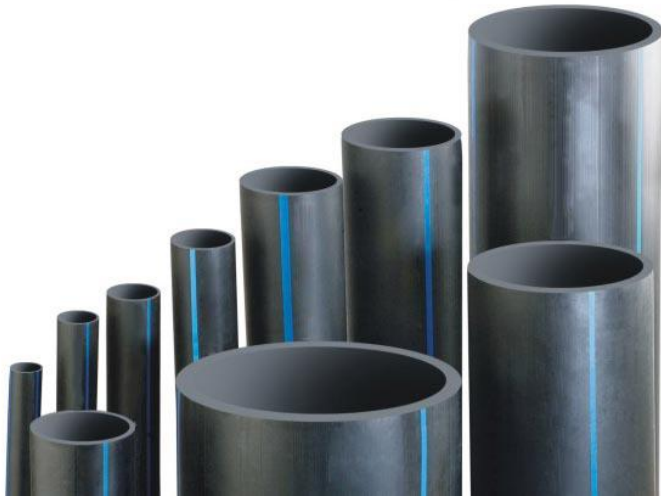


# High Value Niche Products: Octenes, Butene and Hexene Alpha Olefins

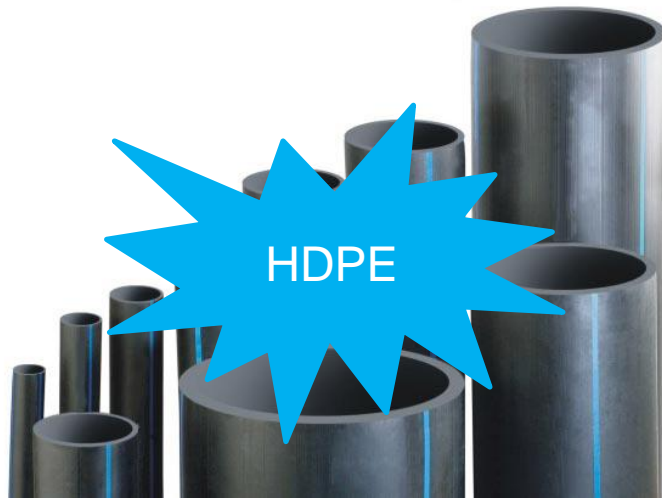


**Xavier LIEGE, Ph.D**

# What Products Can Axens Help You to Produce ?



# ALL OF THEM

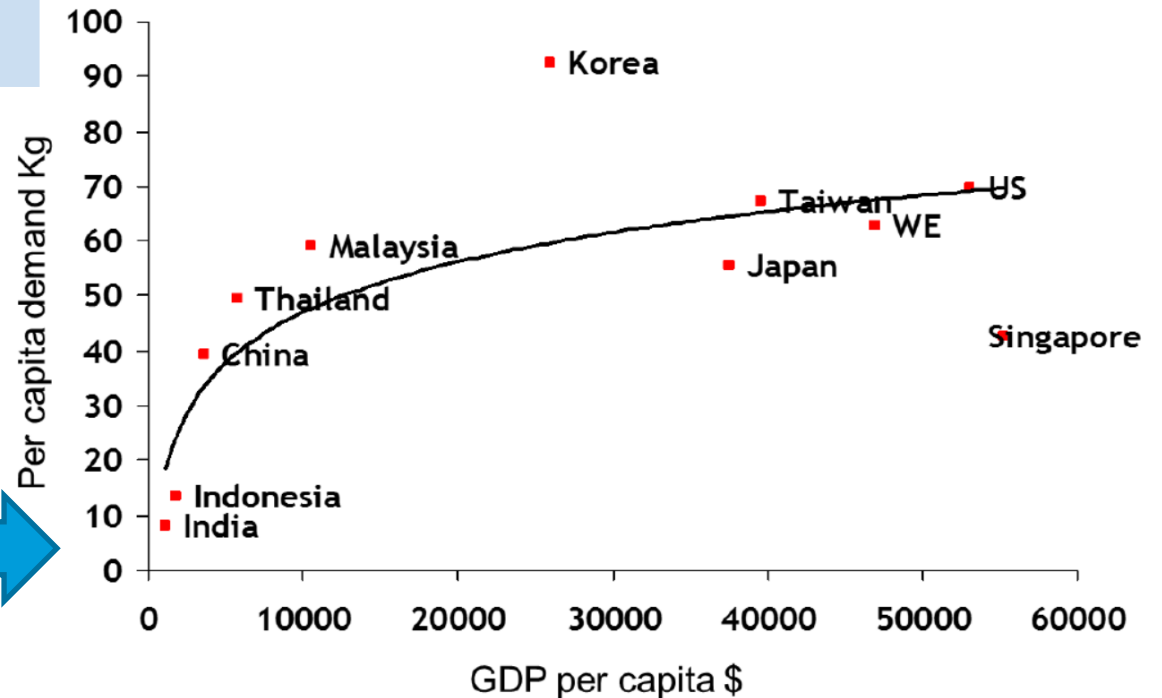


# Polymer Market is Growing Fast in India

In MMT	In 2015	In 2016	In 2017 (exptd)
Production	7.9	9.2	9.8
Demand	10	11.6	12.5
Import	3.3	3.7	4.2

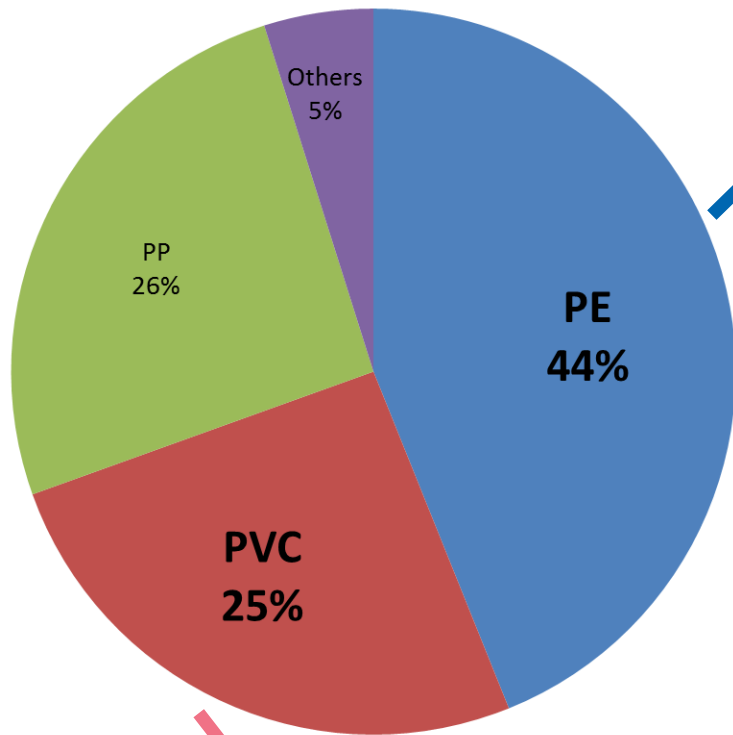
Internal production not satisfying demand

Biggest growth potential in Asia



# Polymer Market is Growing Fast in India

Polymer Production per type in India



**AAGR +10 % by 2022**

**(Expt'd 7.5 MMT/y)**

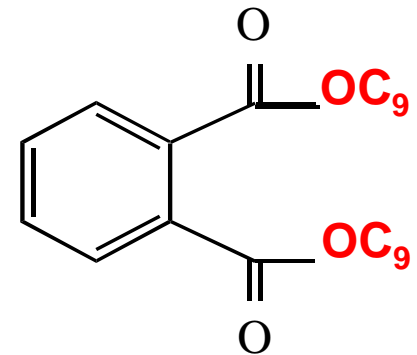
**driver for butene-1 & hexene-1**

**AAGR > +10 % by 2022**

**driver for plasticizer like DINP  
(produced from octenes)**

# Focus on PVC & Phthalates

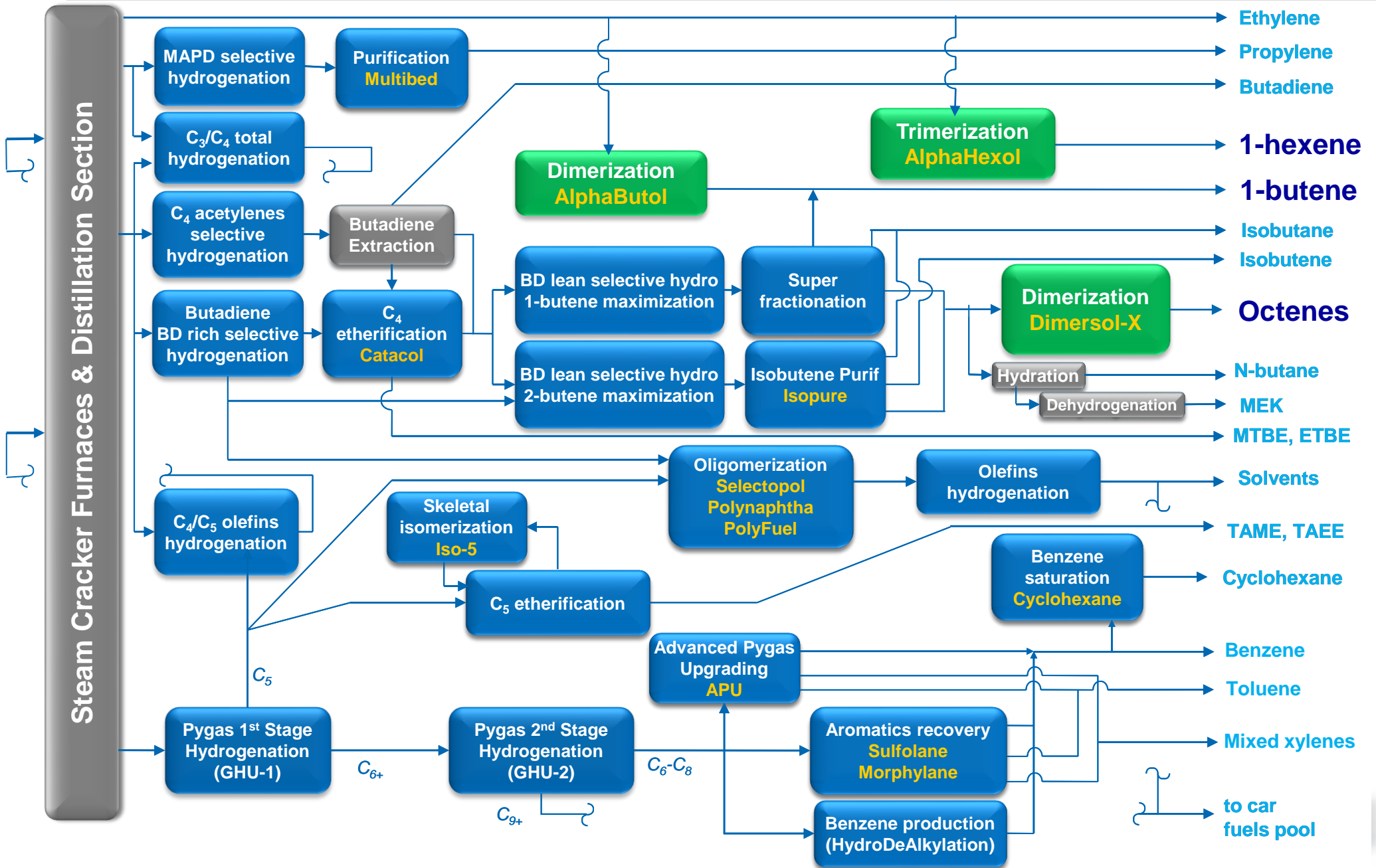
- Plasticizer: Key component to produce soft & flexible PVC
- From 0 % up to 80 % of PVC weight
- 90 % of plasticizer are phthalates
- DINP are raising & replacing DOP



**Phthalates plasticizer**

**AAGR > + 10 %**

# Axens' Technologies for Steam Cracker Complex



# Intermediate Provider for Polymerist since 70's

1976	Cyclohexane for nylon	36 ref
1977	Dimersol™ X for PVC	38 ref <sup>(1)</sup>
1987	AlphaButol® for HDPE/LLDPE	34 ref
2011	AlphaHexol™ for HDPE/LLDPE	2 ref

(1) Including Dimersol™ E and G

**Homogeneous Catalysis family 110 ref**

- **Breakthrough** technology developed in mid 60's
- By Yves Chauvin Nobel prized in 2005
- His team took over his legacy

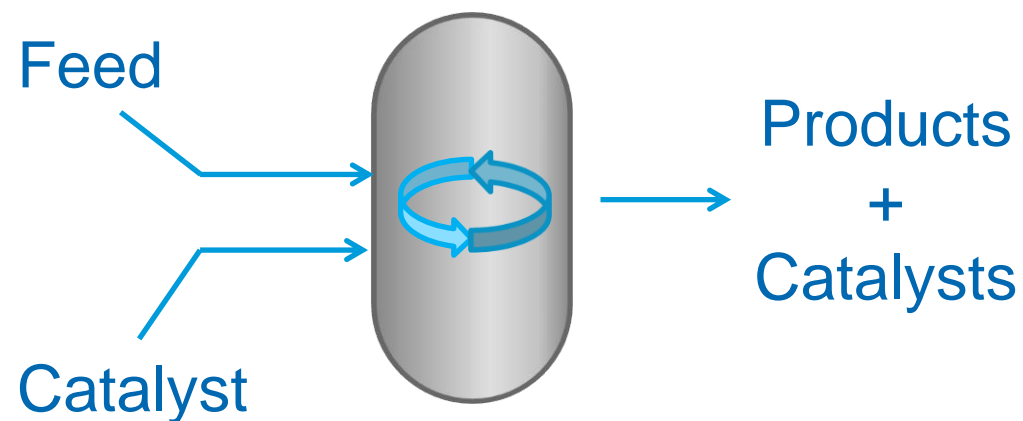


*Laureate Nobel Prize Yves Chauvin*

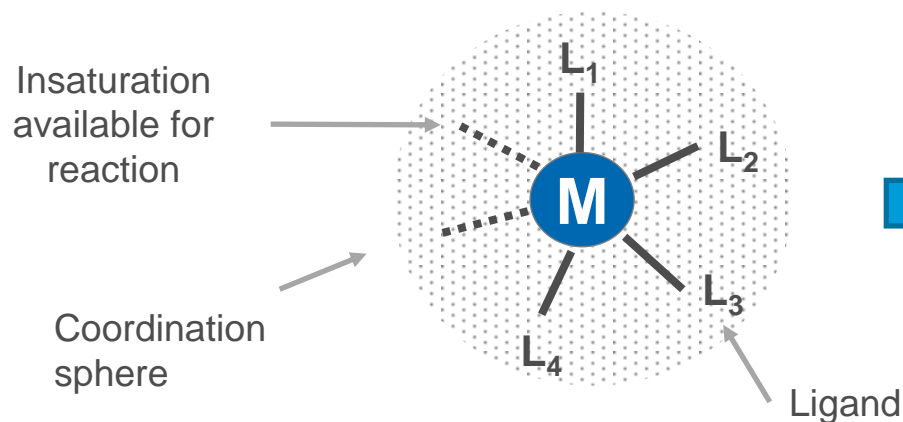


# Chemistry Principles

## Liquid catalyst



## Tailored made catalyst



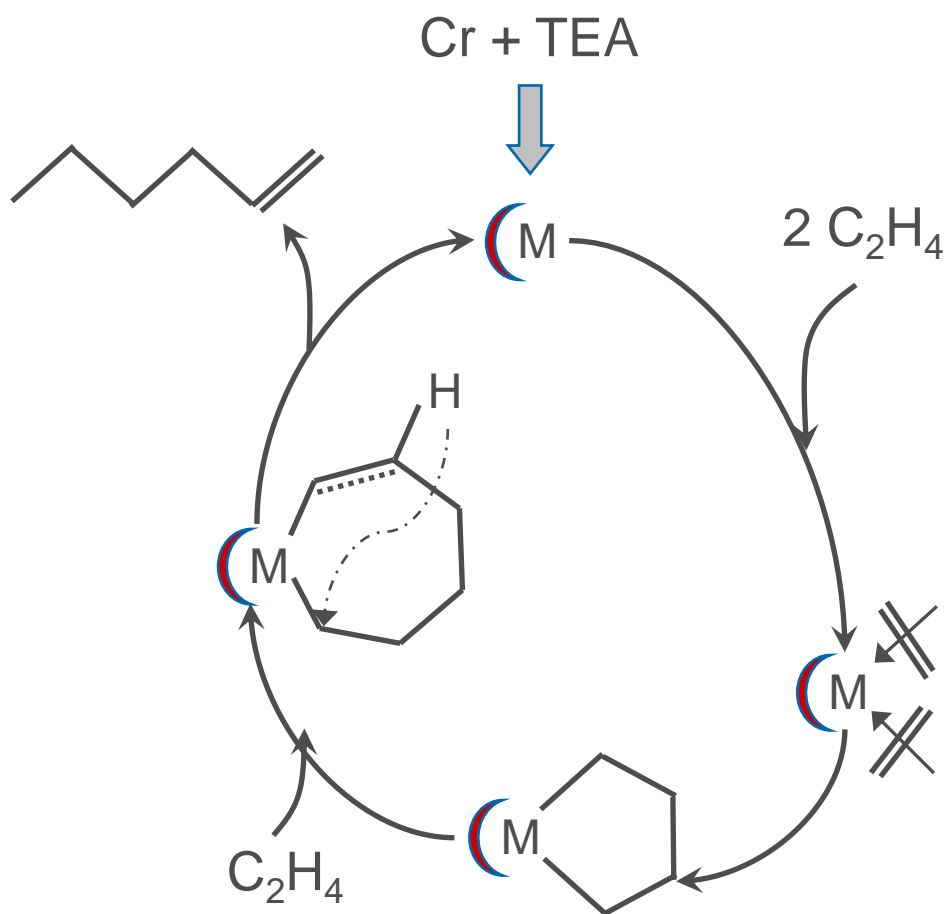
- **Ti for butene-1**
- **Cr for hexene-1**
- **Ni for octenes**

# PE Comonomer Butene-1 & Hexene-1



- Highly selective catalyst
- Simple and proven scheme
- Efficient so popular

# AlphaHexol: Trimerization Mechanism



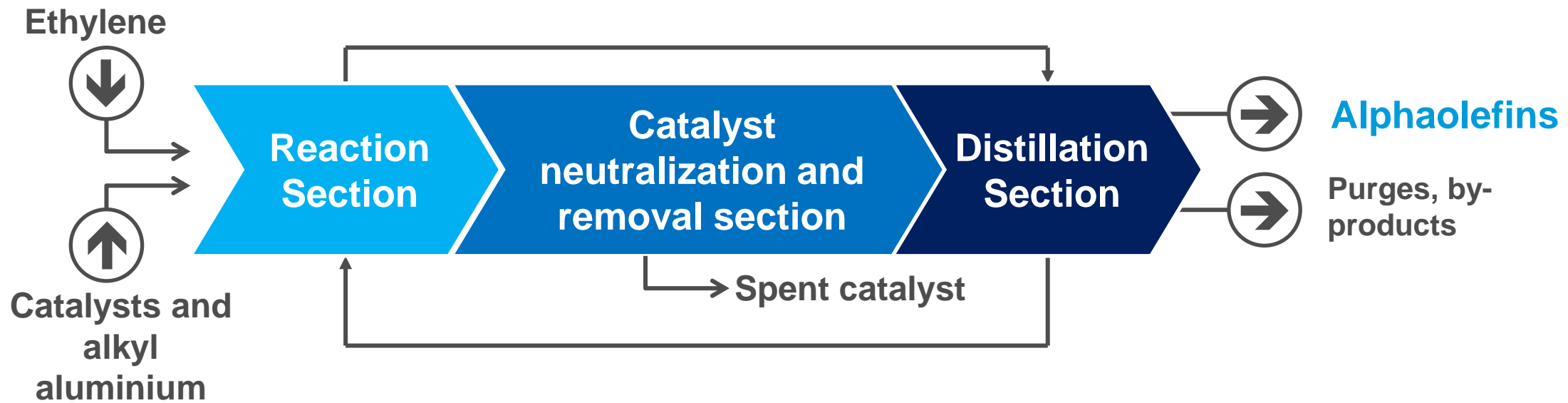
**Unique patented catalytic system**

- Strong IP
- Highly selective
- No Cl & No aromatics

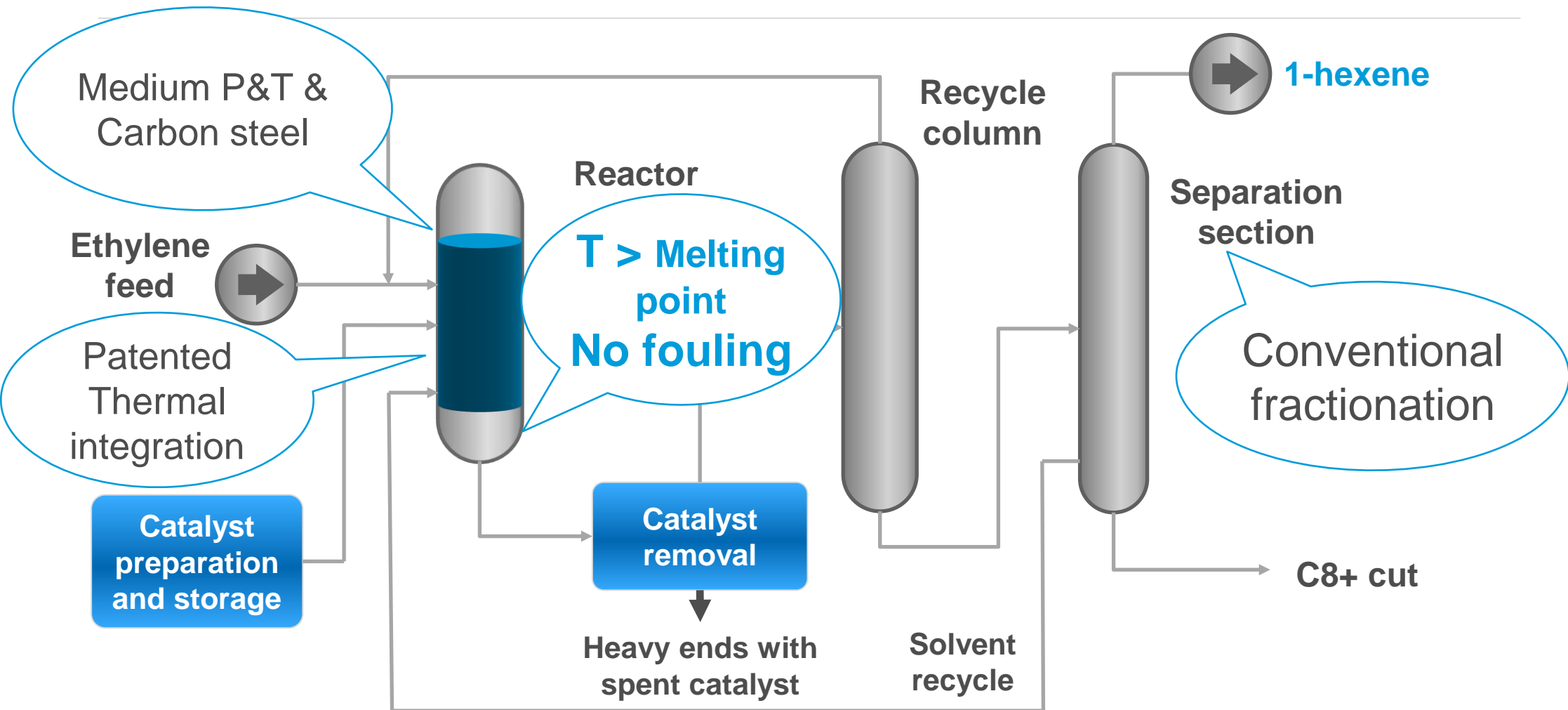
**Same co-catalyst than AlphaButol: TEA**

**Stability of metallacycle leads to selectivity  
= Axens know-how**

# Overall Blockflow



# AlphaHexol: Scheme Simplicity



- Low capex
- Low opex

- Easier to operate

# Efficiency

- Highly efficient ethylene use

Chemical Yield from ethylene to 1-butene/1-hexene

AlphaButol

92%

AlphaHexol

88%

- High quality comonomer

Purity in wt % of 1-butene/1-hexene

> 99.5%

> 99.2%

# AlphaButol in India

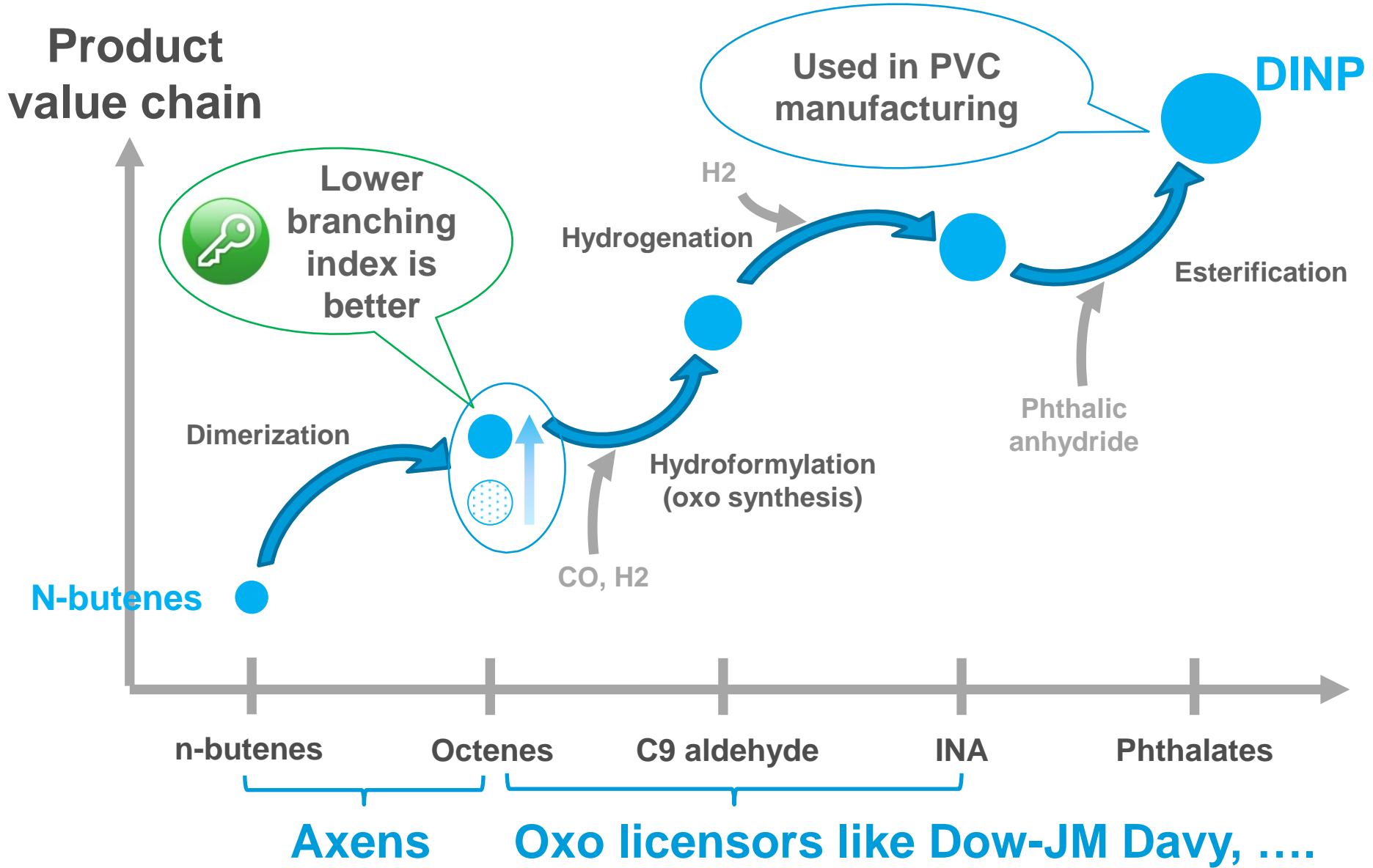
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- **7 references**
- **4 new references since 2011**
- **172 kta of cumulated production**
- **2 references in GAIL PATA**
- **3 successful start-up over the last 3 years**



**AlphaHexol is the next step for India**

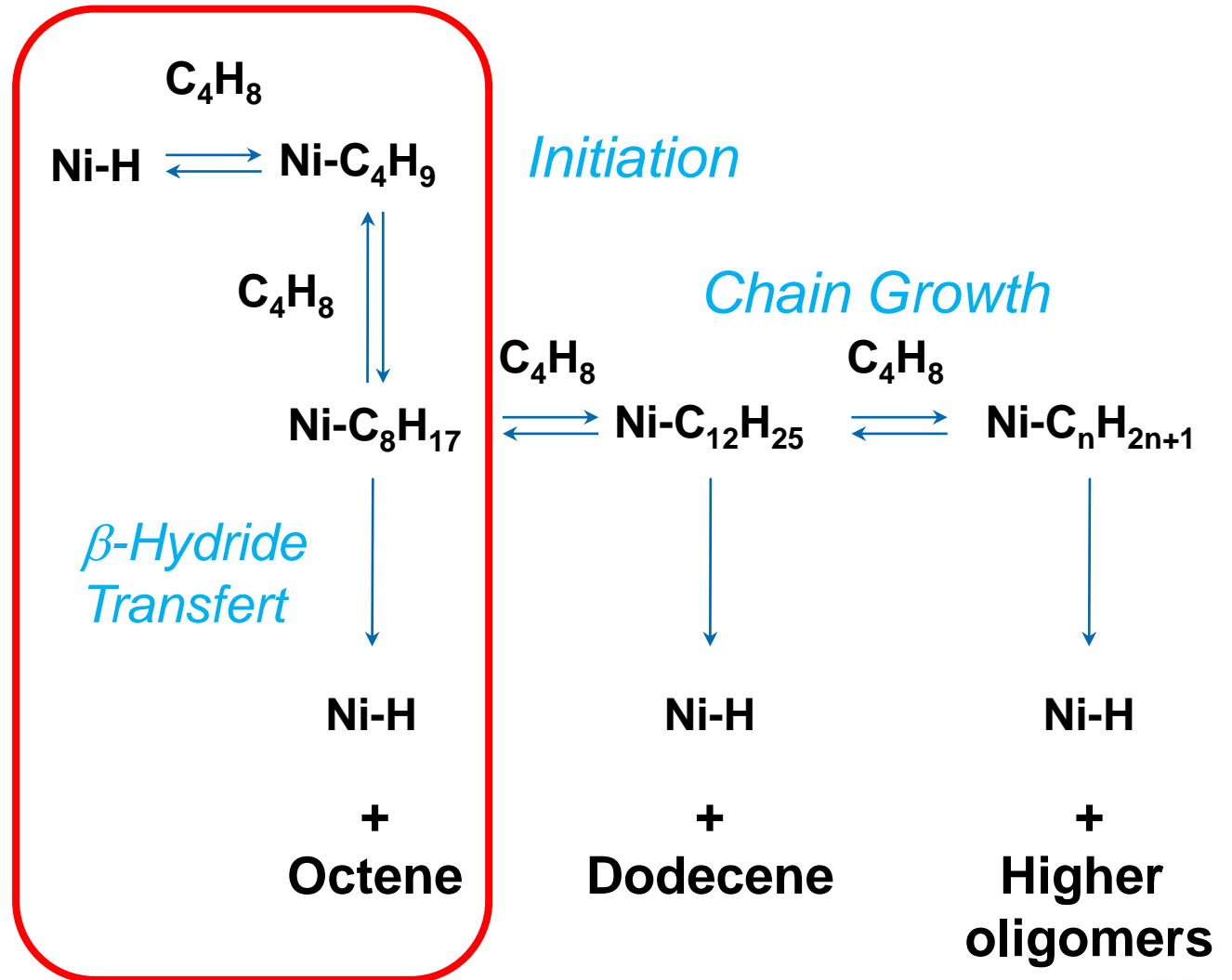
# PVC: From C4 to High Value DINP





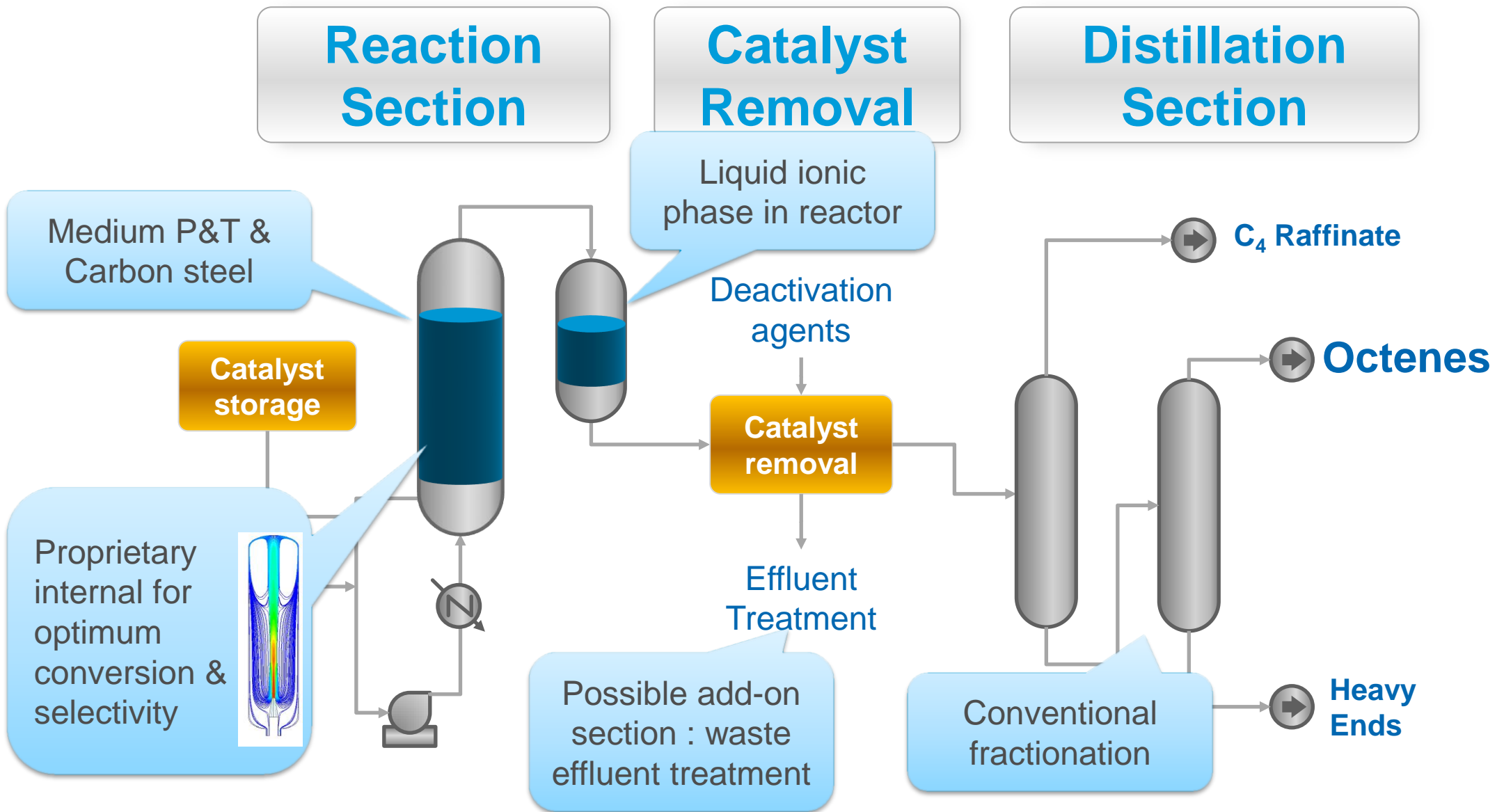
# Mechanism of n-Butene Oligomerization

- Chain growth mechanism



**Main reaction with dedicated catalyst**

# Dimersol-X Technology



# Efficiency

- High n-butene conversion

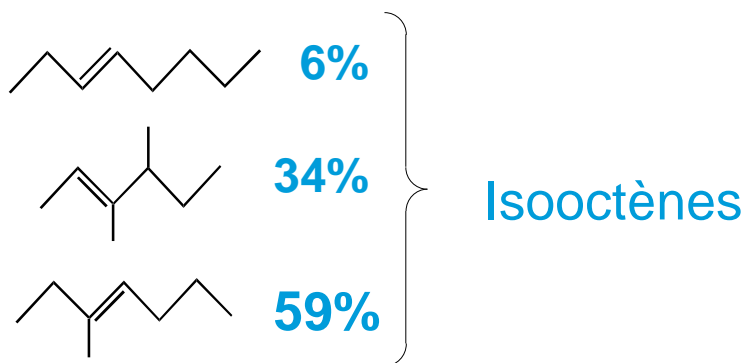
Chemical Yield from n-butene to octenes

up to 80 %

- High quality product

> 99 % wt

With low branching index favoring high quality plasticizer



- Fully proven & compatible with oxo-alcohol technologies

# Axens Technologies for Better Products

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- **High value products**
  - Octenes from petchem C4's for plastizicers industry
  - Butene and hexene alpha olefins for polyethylenes
- **Efficient and simple proven processes**
- **Providing high quality and highly valued products**
- **Long and extensive experience since 40 years**

**Axens' is the right partner to accompany this new step of diversification into chemicals in India**

# Thank you! And see you on Axens' Blog axens.net/blog

