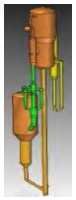
Naphtha Catalytic Cracking for Propylene Production by FCCU



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HIGH Olefins Technology Services LLC

CatCracking.com®

More Production - Less Risk!

Coking and CatCracking Conference
New Delhi, India – October 2013

Purpose (Objective)

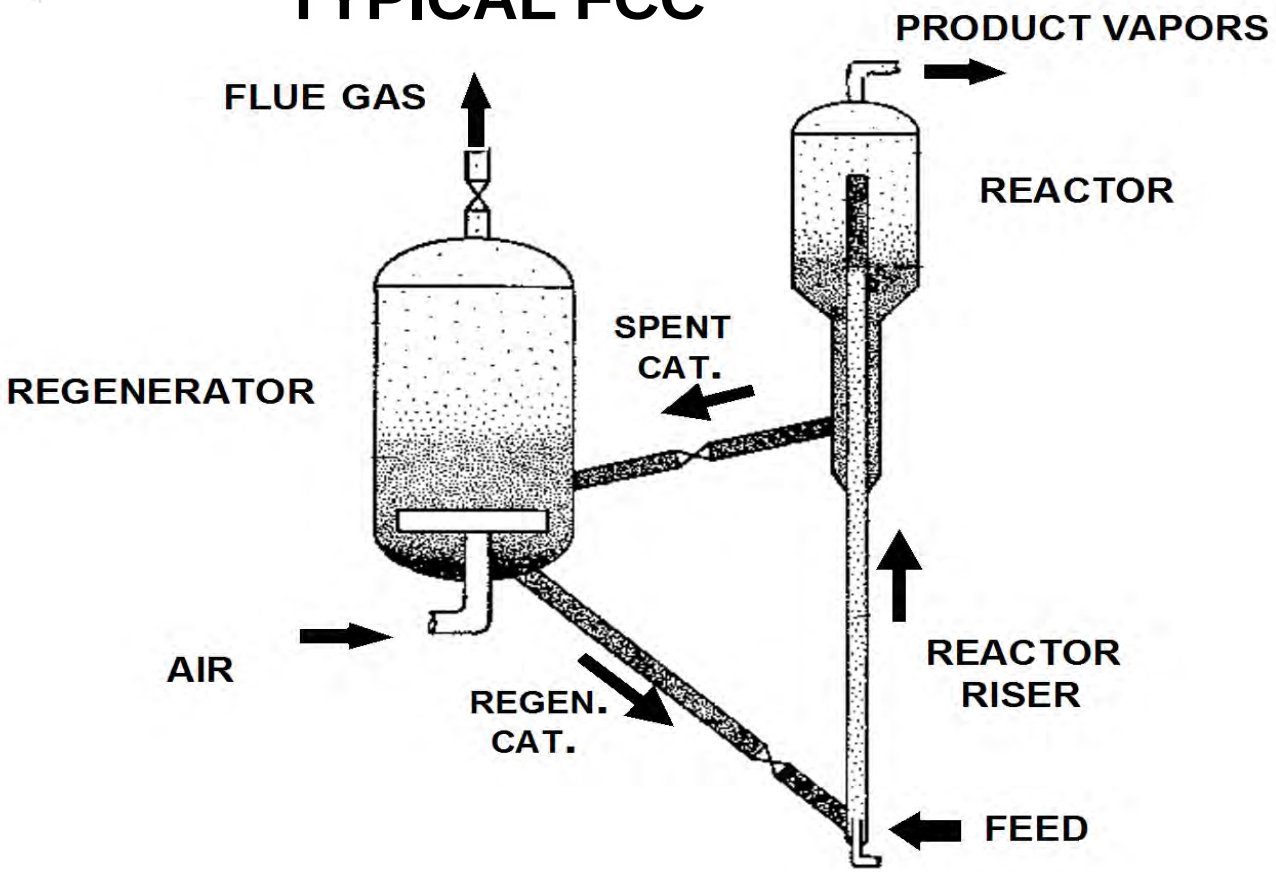
- To present and discuss producing propylene (C3=) by catalytic cracking paraffinic naphtha utilizing Fluid Catalytic Cracking processes

Contents- Covering 3 Points

- Why Propylene from FCCU's ?
- Naphtha Feedstocks – Supply Balances
- Naphtha Catalytic Cracking Processes
  - FCC Catalytic Processes
  - Traditional Steam Cracking (Comparison)

REACTION SECTION

TYPICAL FCC



Paraffinic Naphtha

Benefits

- MOTOR GASOLINE
- PETROCHEMICAL FEEDSTOCKS
  - Propylene (C3=)

TODAY & FUTURE PLANNING

- Minimizing to no gasoline production from FCC
- Additional Focus
  - Light Olefins (Ethylene & Butylenes)
  - Aromatics

Why Propylene from FCCU's ?

- Europe, North America (US) refineries are facing **profitability challenges**
  - Gasoline demand declining both areas
  - Middle Distillates (Diesel) markets increasing both areas
  - European surplus gasoline export markets are declining
  - US lighter shale crudes, "tight oil" use is increasing that produce more naphtha and less diesel
- Asia market is for distillates and petrochemical feedstocks
- Large Middle East, Asia, India and South America are building large integrated Refinery/ Petrochemical Complexes

Petrochemicals Opportunities

Main Building Blocks ← **Produced by Steam Cracking Ethane & Liquid Feeds Naphtha Reformers**

- Olefins - Two Main Blocks
  - Ethylene
  - Propylene ← **Secondary Source Produced by FCC's**
- Aromatics
  - Benzene
  - Paraxylene (other xylenes too)

- High Olefins - FCC (HOFCC) produces C3= and byproducts of other light olefins and aromatics

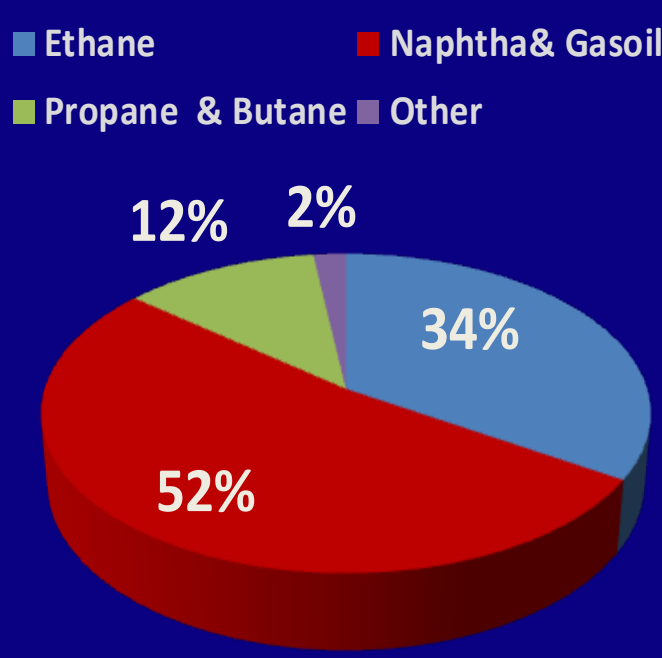
Why Propylene ??

- C3= is the second important raw material after ethylene
- C3= by-product from steam cracking for ethylene with traditional FCC's the other main source
- Ethylene demand is expanding proportionally faster than Propylene demand (Propylene was exceeding ethylene growth up thru 2007-2008 Recession)
- To meet C2= demand new steam crackers are using Ethane as feedstock!
- With new SC, C3= shortages are expected; Existing FCC's can't meet the demand

On Purpose Propylene Processes (OPP) will be developed

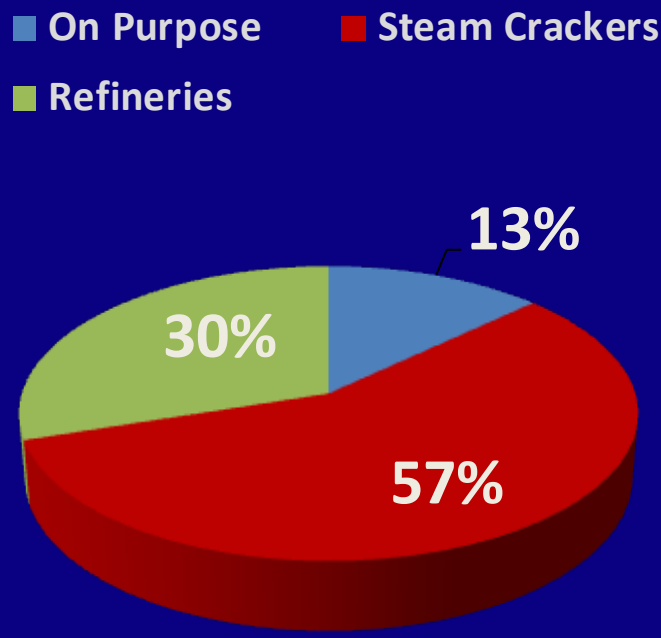
Ethylene & Propylene Supply Sources

Ethylene Supply Sources



127 Million Tons (US) 2011*

Propylene Supply Sources



79 Million Tons (US) 2011*

Data Courtesy of IHS CMAI

Steam Cracking Yields

Propylene/Ethylene(P/E) Ratio indicates propylene selectivity

Typical light olefin yields for steam cracking			
Feedstock	Ethylene, wt%	Propylene, wt%	P/E
Ethane	80	3	0.04 (0.0375)
Propane	44	15	0.34
Naphtha	30	16	0.53
Gas oil	23	15	0.65

Table 1

Meet Future C3= Demand in Asia A P/E Ratio 0.85 is required

WHY NAPHTHA CATALYTIC CRACKING ?

NAPHTHA SUPPLY

Naphtha Supply Balances

Supply is Increasing Globally

- **Steam Cracking**
  - Shifting to Ethane & Lighter Fuels from Naphtha & Gasoil
  - LNG/NGL
- **Increased Byproduct Condensates from Gas Production**
- **Lighter Crude Slates for refiner feedstocks**
  - **Produce more naphtha**
- **Increasing demand for diesel not gasoline**
- **In North America:** Fracking for Natural Gas and Shale Oil (Tight Oil)
- **Aromatics supplies are being squeezed ???**

"Somewhat decoupling" of naphtha pricing from crude"

Naphtha Cracking

Steam Cracking - Thermal

- Not Selective to Propylene makes Ethylene (P/E Ratio)
  - P/E Ratio of 0.55-0.68 (Naphtha & Gasoil Cracking)
- Steam Cracker capacities are world class size > 1000 KTA

Naphtha Cracking - Catalytic

- Propylene Selective not Ethylene
- P/E Ratio of 1.0 to 2.4
- Naphtha FCC capacities 20 MBPD == 64 KTA of ethylene

SC 20 MBPD = 264 KTA

Naphtha Cracking Comparisons

Paraffinic Naphtha Feedstock Driven

Catalytic & Thermal Processes

- ACO (Advanced Catalytic Olefin)
  - KBR License
  - Riser Technology
- HS-FCC (High Severity FCC)
  - Axens/S&W License
  - Downer Reactor
- Steam Cracking
  - Generic

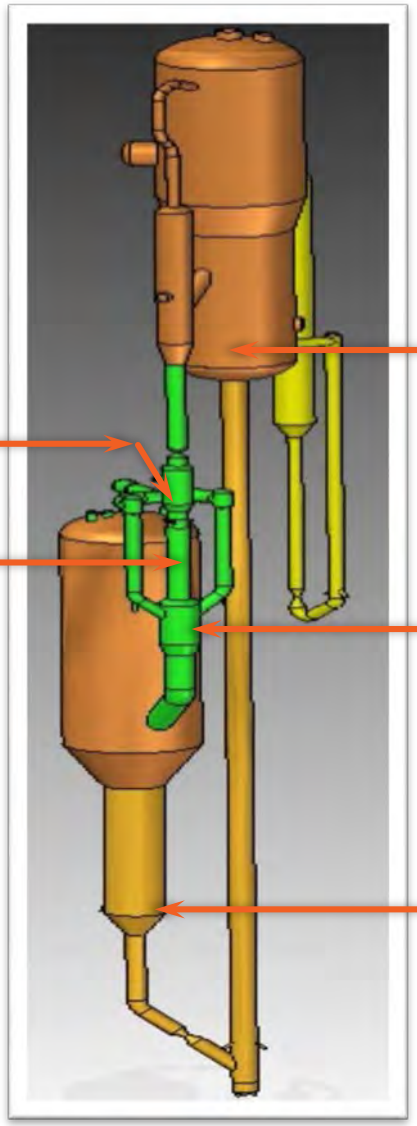
Advanced Catalytic Olefins (ACO)Process

ACO Process Key Features - Reactor

- Proprietary KBR FCC reactor features
- Propylene/ethylene (P/E) Product Ratio ~1/1
- Proprietary catalyst from SK Corporation
- All proven hardware and processes
- Robust and flexible, compared to other processes

KBR

HS-FCC Key Components



Courtesy Axens/TechnipS&W

Features & Advantages of HS-FCC

Features

- Downflow Reactor (Downer)
- High Reactor Temperature
- High Catalyst to Oil Ratio
- Short Contact Time

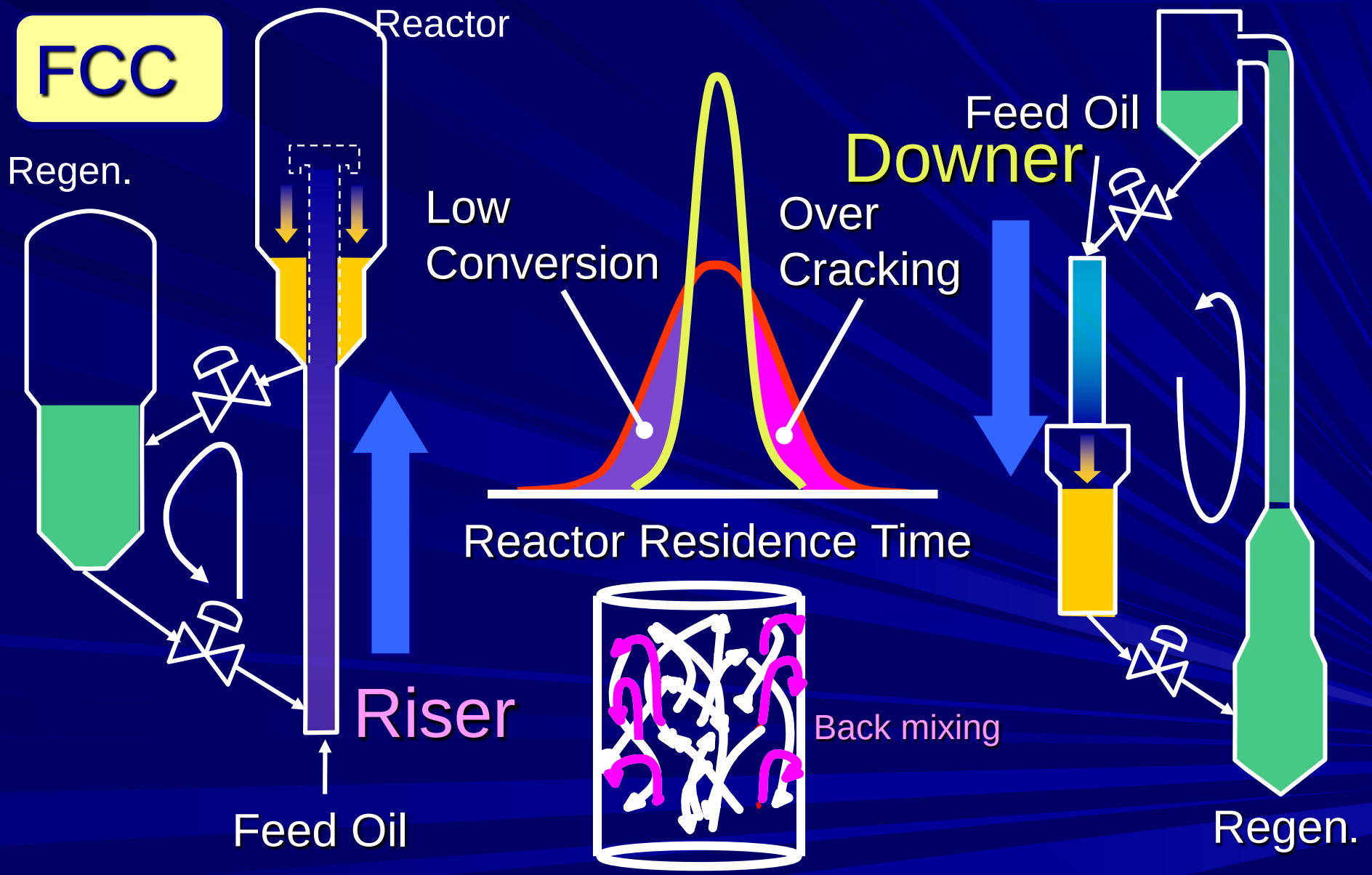
Advantages

- High Propylene Yield
- High Butylene, iso-butylene Yields
- High Gasoline Octane (High Aromatics Content)
- Minimized Dry Gas

CATALYST FLOW

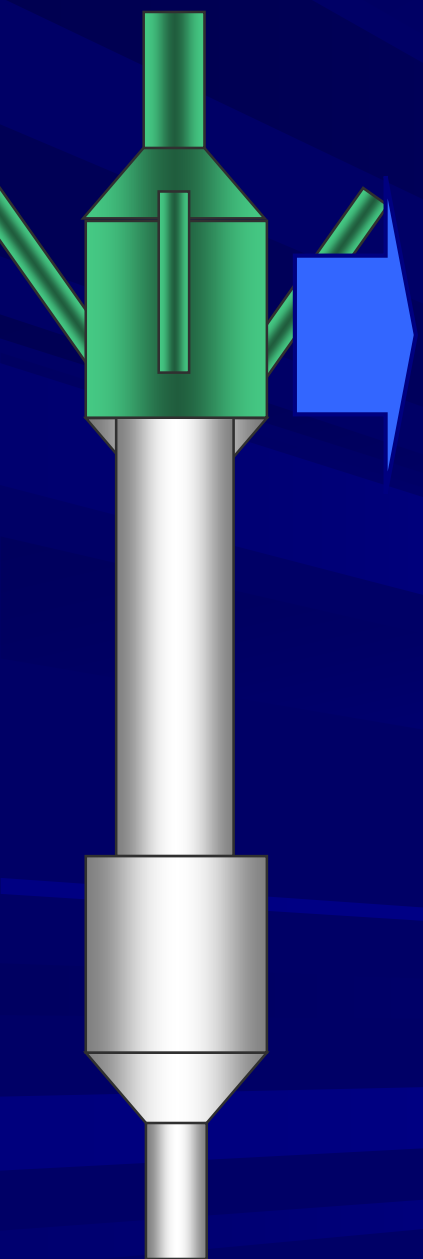
FCC

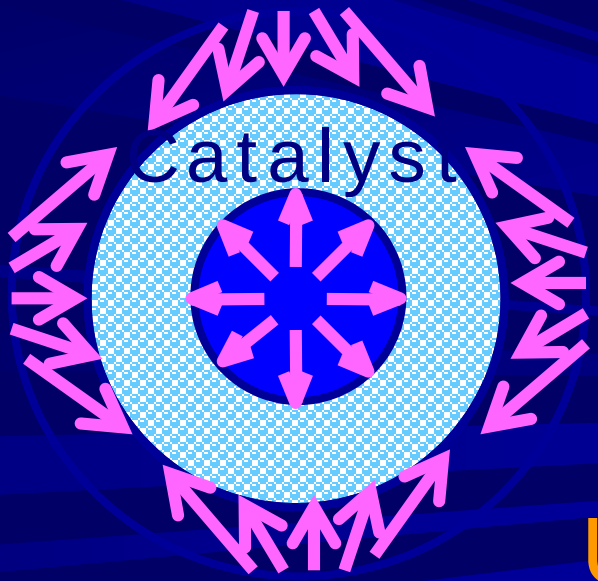
HS-FCC

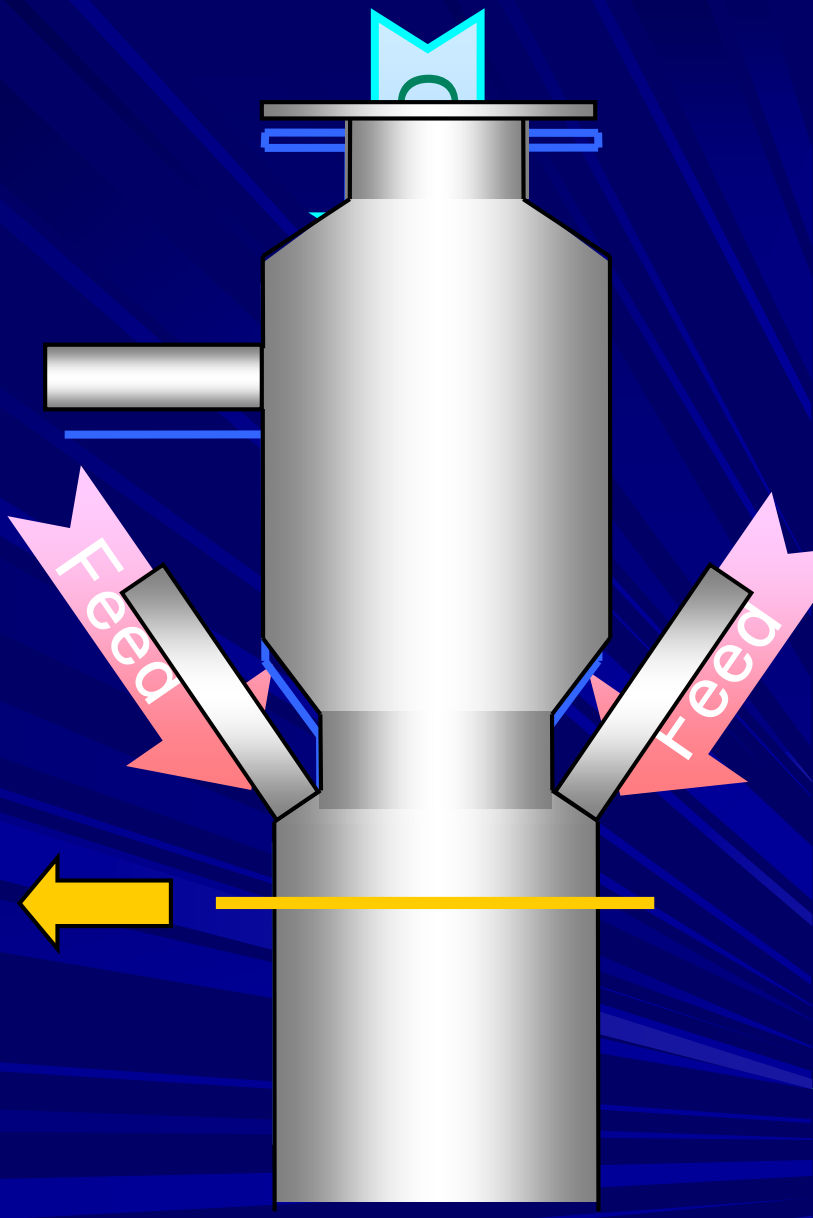


FEED INJECTOR

quick contact
of
feed & catalyst







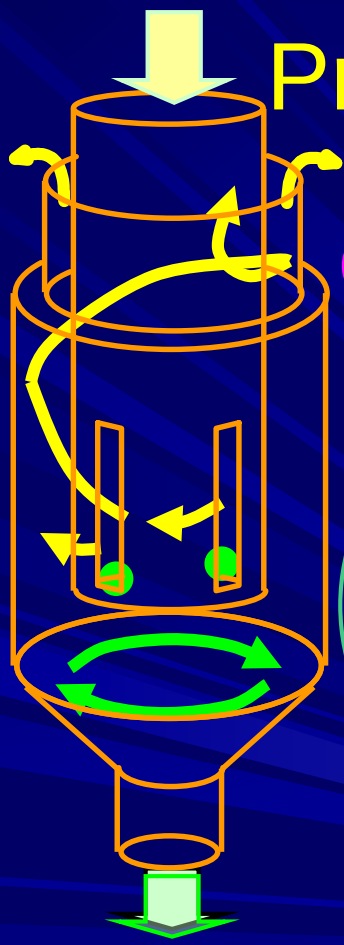
US Patent 6186658

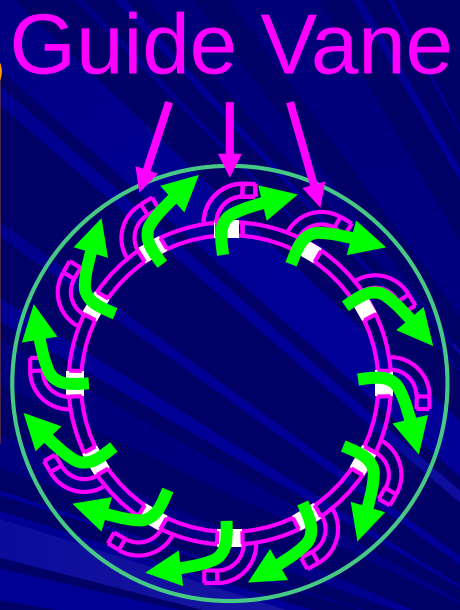
SEPARATOR

US Patent
6146597

Quick separation
Catalyst & Gas

Separator



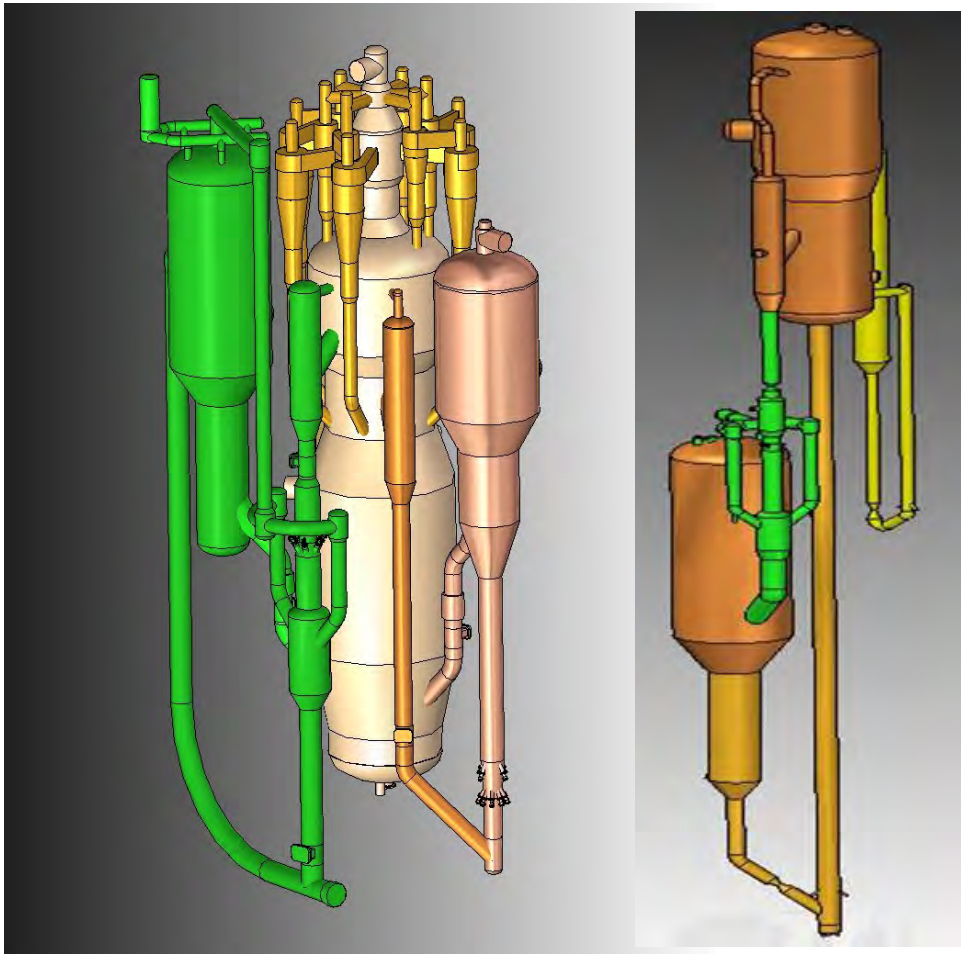


Centrifugal
force

Catalyst

HS-FCC Naphtha Process

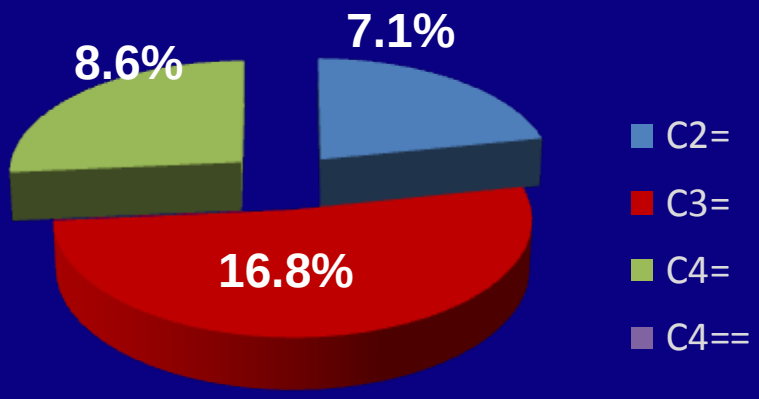
- Retrofit Type to existing FCCU
- Standalone Unit



Full Range Naphtha Yields Olefins wt%

Catalytic Cracking

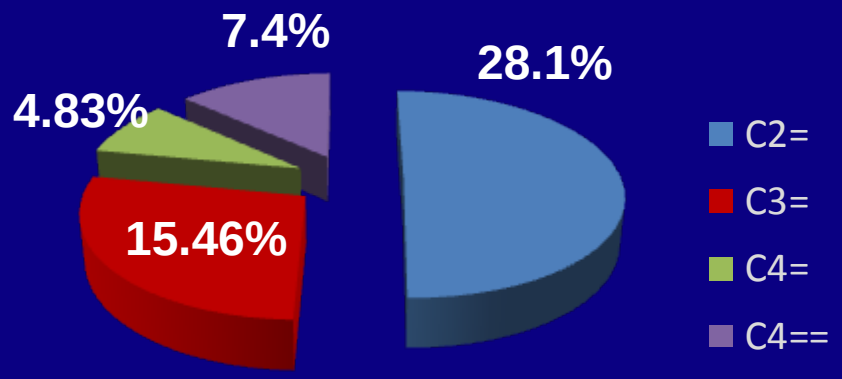
Downer Reactor



P/E of 2.4

Steam Cracking

Furnace Reactor



P/E of 0.55

Naphtha Cracking Fluid Processes

ACO Commercial Demonstration Unit
Ulsan, South Korea

HS-FCC Semi-Commercial Unit
Mizushima, Japan

Conclusions
Petrochemical Opportunities

- Naphtha Fluid Catalytic Cracking is a viable "On Purpose Propylene Process"
- Naphtha Catalytic Cracking produces higher propylene selectivity than Steam Cracking
- Naphtha Catalytic Cracking will help meet future propylene demand
- Naphtha Catalytic Cracking byproducts of other light olefins and aromatics for petrochemicals
- Paraffinic Naphtha Catalytic Cracking processes are in the initial stages of commercialization

THANK YOU

The End

Questions ???