



# Eni Slurry Technology & its commercial Performance

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Confidential



# Presentation outlines

- Eni Slurry technology flow scheme and its main features
- Edge of Eni's catalyst over conventional HCK catalyst
- EST results and operating experience in Sannazzaro refinery
- Topsoe optimal solution in hydroprocessing catalyst & technology
- VGO and Diesel Upgrader performance in Sannazzaro refinery
- Conclusions

# Eni and Topsoe are partners



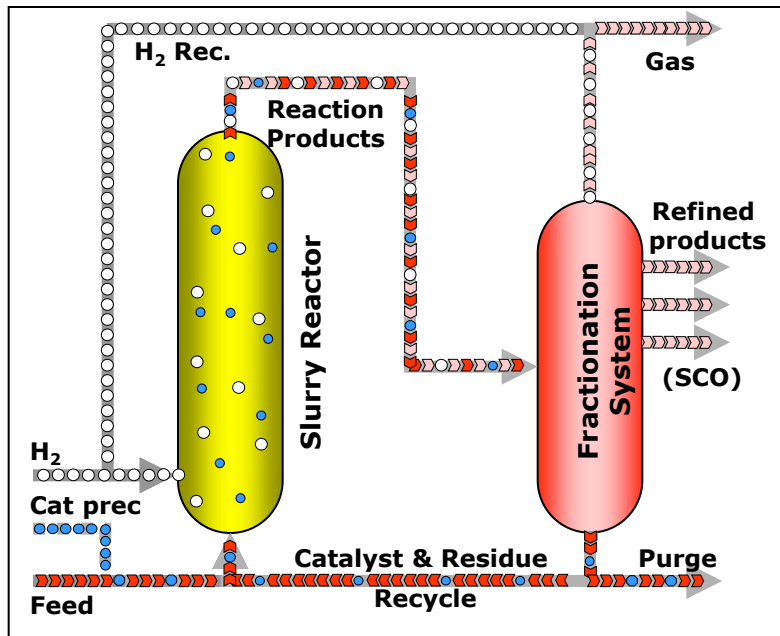
HALDOR TOPSØE 

**“Eni and Topsoe can offer  
a complete solution for Residue Upgradation to produce  
all kind of desired distillate products”**

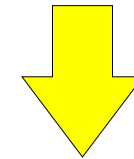
# What is EST ?

**EST is a hydrocracking process based on two unique features:**

- 1. Nanodispersed (slurry) non ageing catalyst**
- 2. Homogeneous & isothermal slurry bubble column reactor**



**The recycle of unconverted heavy ends**



**allows the total conversion of the bottom of the barrel to good quality middle distillates (feedstock conversion >92%)**

**EST can easily handle very heavy feedstock**



# EST main features

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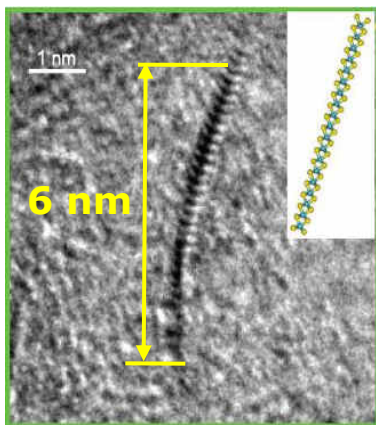
EST  
has overcome  
the main  
problems that  
limit resid  
conversion

Catalyst deactivation/  
life cycle

Limitations due to  
stability problems

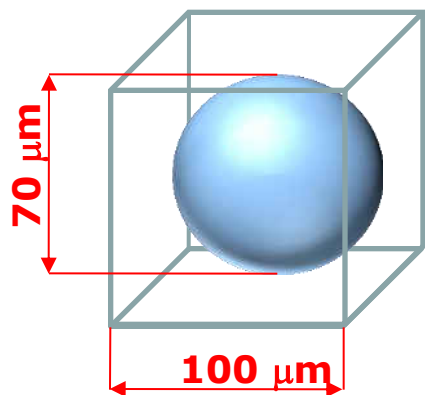


# EST catalyst vs. conventional HCK catalysts

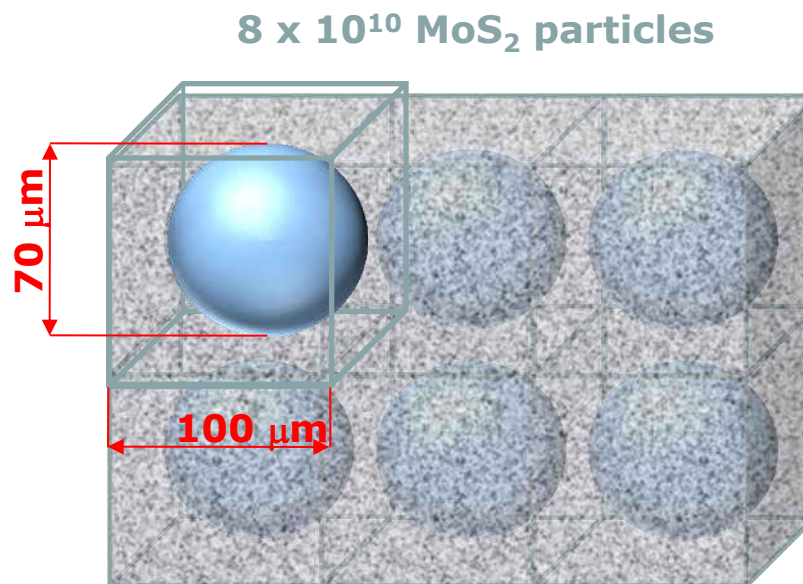


HRTEM of EST catalyst

- The active phase is unsupported molybdenite (MoS<sub>2</sub>) in isolated layers with excellent dispersion
- Generated in situ from oil-soluble precursors
- High surface area
- No plugging from metals and coke deposits

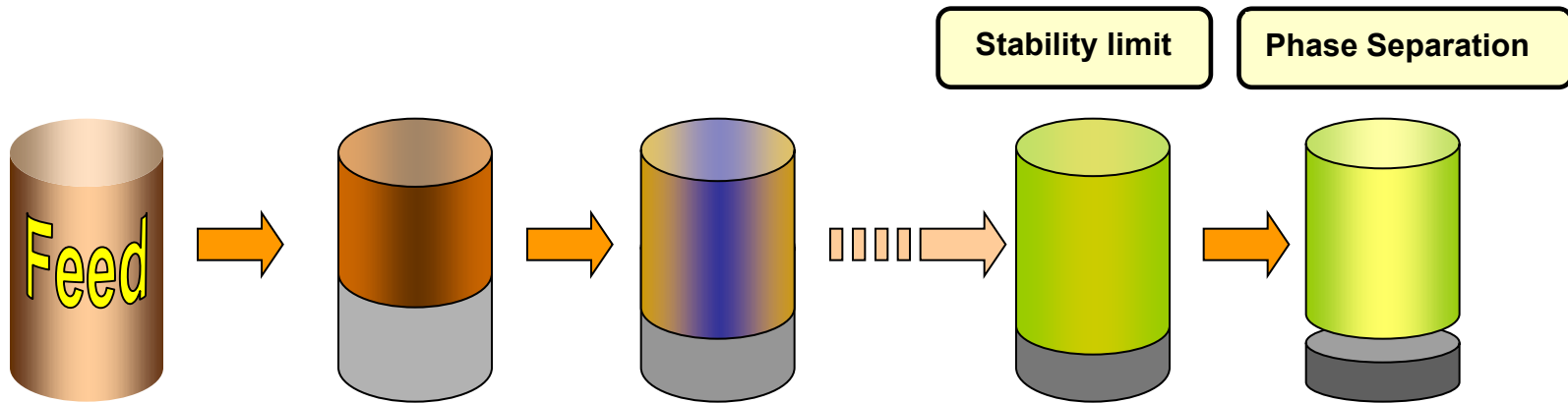


Conventional catalysts



# Limits of Residue conversion

Maximum conversion is limited by the residue stability

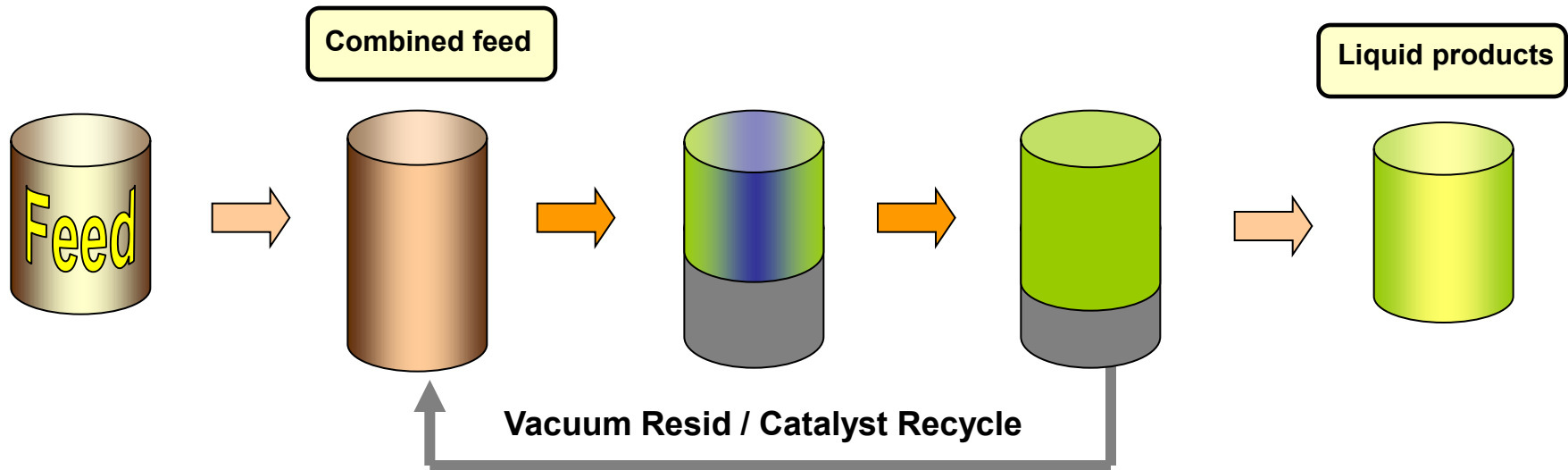


Time course of reaction



# EST towards total feedstock conversion

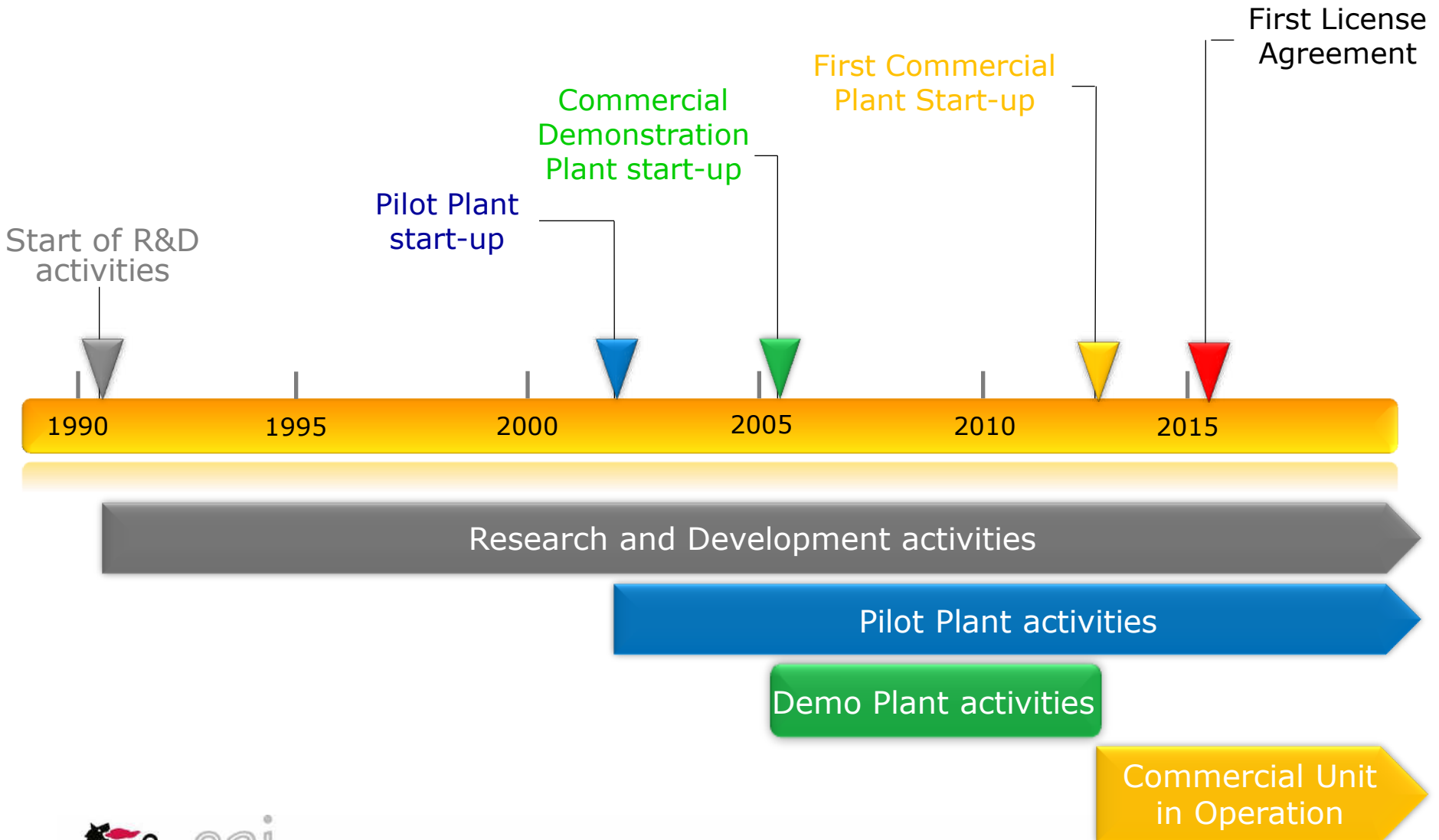
The recycle of unconverted heavy ends allows the almost total conversion of the bottom of the barrel overcoming the stability limit



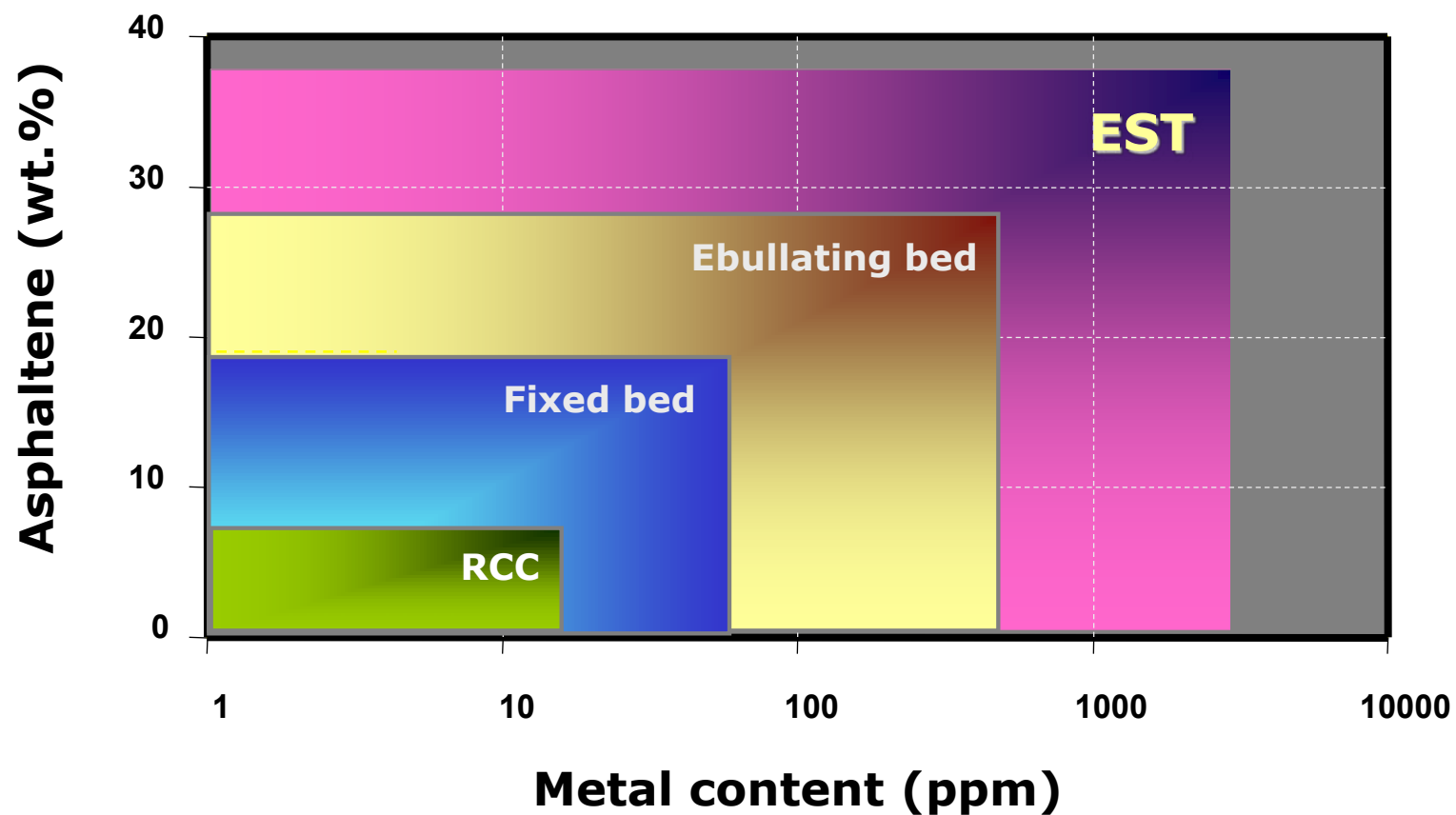
**Time course of reaction**



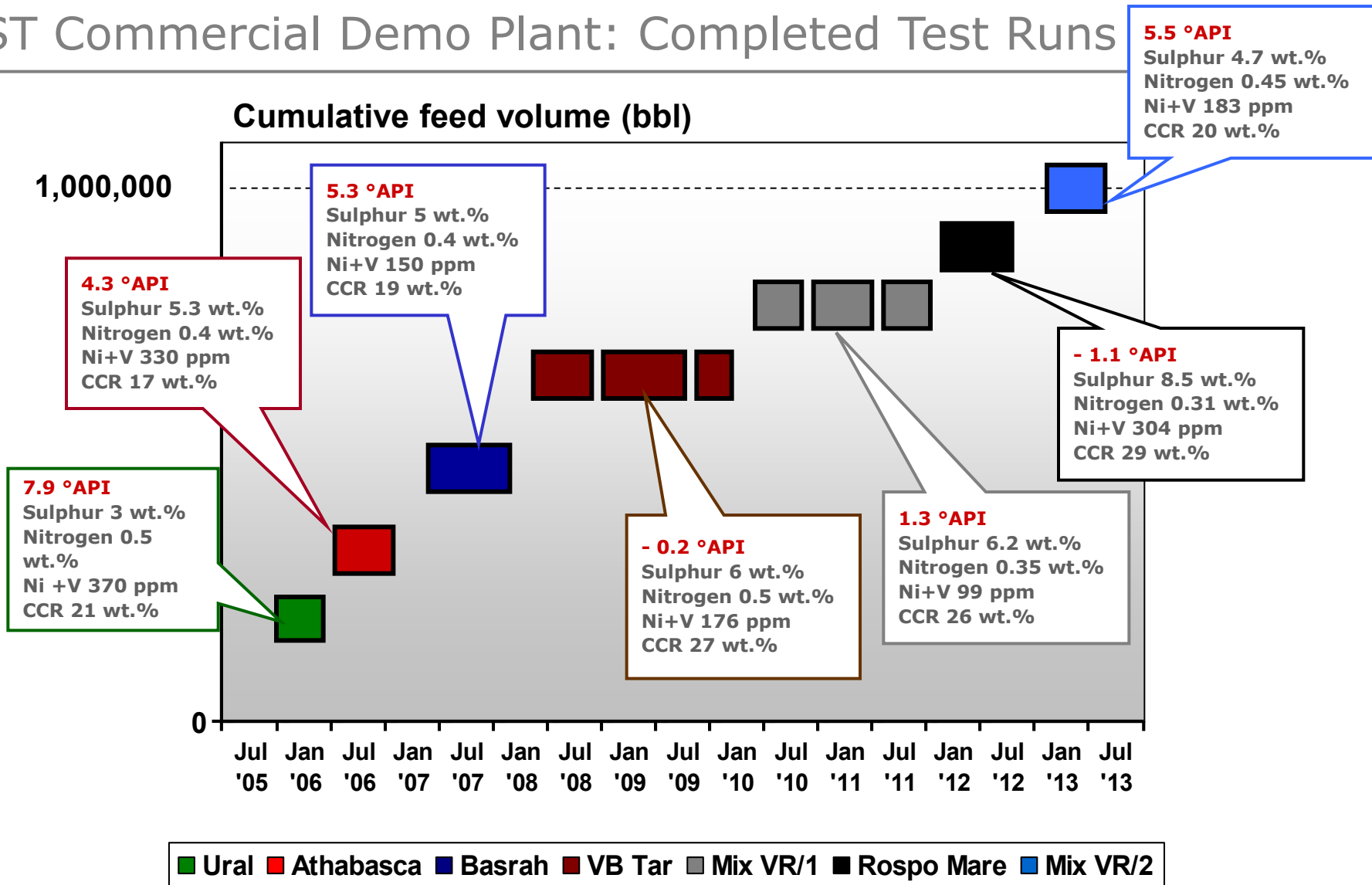
# EST: Development Road



# EST: Maximum Feedstock Flexibility



# EST Commercial Demo Plant: Completed Test Runs



# EST Sannazzaro today and EST Complex layout





# EST start-up

- The EST hydrocracker unit has successfully and safely begun operations and is producing high quality distillates  
**(oil-in: 2013, October 14<sup>th</sup>)**
- Synchronized start up / operation of all the auxiliary facilities associated with the Unit
- Results confirm the proper design of the plant:
  - slurry reactors perfectly homogeneous and isothermal
  - residue conversion  $\geq 95\%$
  - high efficiency of gas-liquid separation (no foaming occurrence)
  - product yields and quality as expected
- Some minor adjustments in order to improve the global EST plant performance



# EST: the Slurry reactor

The tailored-designed slurry bubble column reactor is:

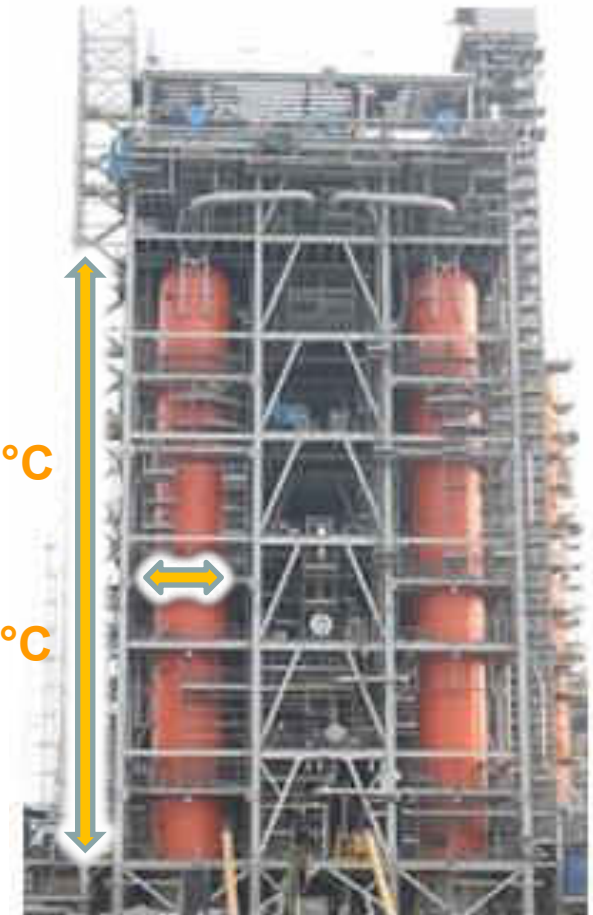
- homogeneous due to the small size of catalyst particles
- isothermal in both axial and radial profiles due to the high back mixing fluid-dynamically driven



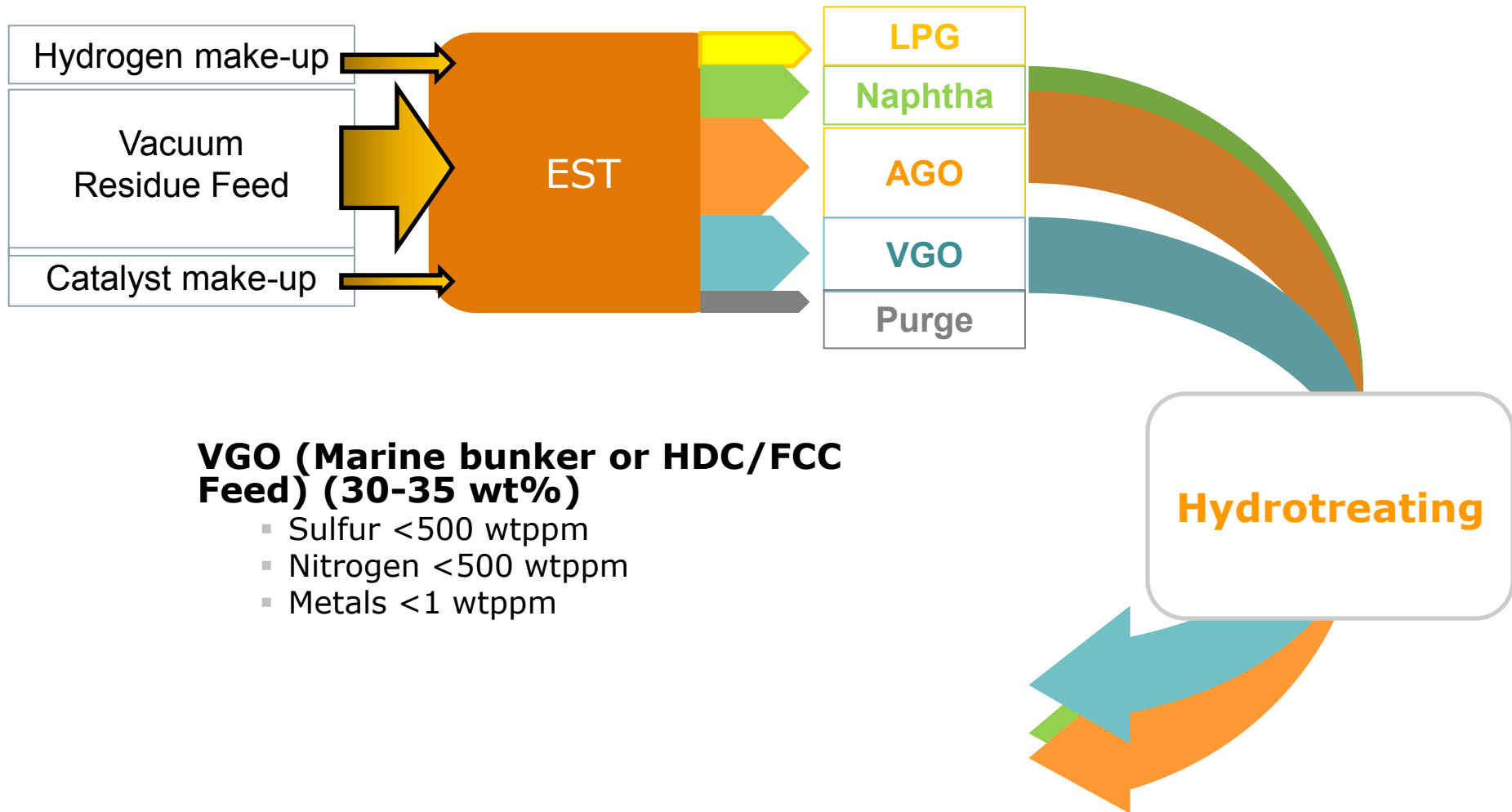
High degree of back mixing in the slurry phase confirmed by experimental data collected during EST Sannazzaro operation

**Axial**  
average  $\Delta T < 2^\circ\text{C}$

**Radial**  
average  $\Delta T < 0.3^\circ\text{C}$



# Product yields and quality



## **VGO (Marine bunker or HDC/FCC Feed) (30-35 wt%)**

- Sulfur <500 wtppm
- Nitrogen <500 wtppm
- Metals <1 wtppm





# Topsoe optimal solution in Hydroprocessing Catalyst and Technology

# Topsoe have a broad range of products and services

that combined help our customers achieve optimal performance



Process design,  
engineering and  
licensing

+



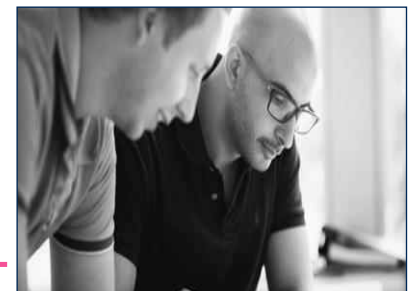
High-performance  
catalysts

+



Proprietary  
equipment

+



Business and  
technical services

We design, engineer and license a broad range of processes for chemical processing, hydroprocessing and emissions management.

We supply a range of more than 150 different catalysts and have the capability to design and manufacture custom catalysts for specific tasks.

We can provide a complete range of proprietary equipment, spare parts and consumables, designed and manufactured to last and work optimally.

From evaluating the feasibility of a new plant or product, to designing it, getting it built and running optimally, we provide a full range of services.

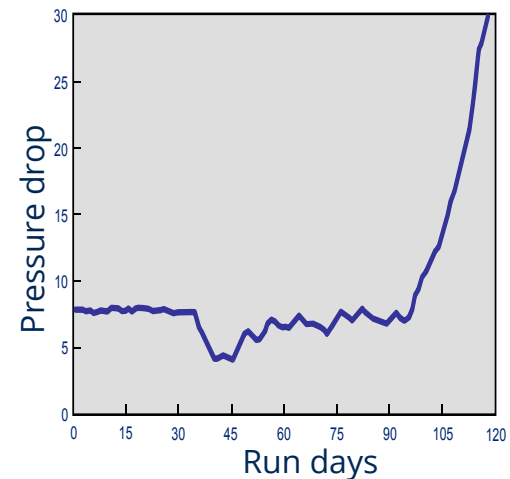
# Catalyst bed fouling

**Reduced void fraction**

"Outside":  
**Solid contaminants**



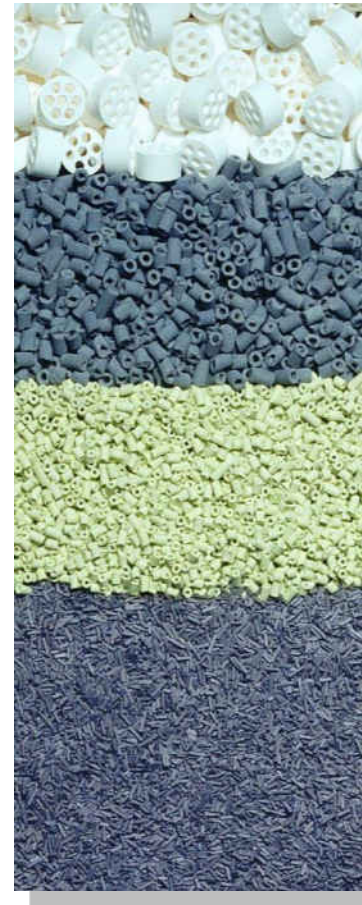
"Inside":  
**Reaction products**



**Consequence: Reduced cycle length**

# Grading - the principles

- The principles:
  - Shape-optimized
  - Void
  - Particle size
  - Catalyst activity
- **All customized based on customers needs**



# Catalyst deactivation

Contaminants Ni, V, As, Si, Coke, P, Na, K, Pb causes deactivation of the catalyst

