Axens
IFP Group Technologies

AXENS' IRAN SEMINAR

PAVING THE WAY TO A HIGHLY COMPETITIVE IRANIAN REFINING INDUSTRY

TEHRAN - 29/30 TIR 1395 (19/20 JULY 2016)

Symphony™
A New Beat in Reforming

Xavier Decoodt

What the Market is Looking for?

- BETTER Yields
- BETTER Economics with better yields stability
- HIGHER On-stream factor

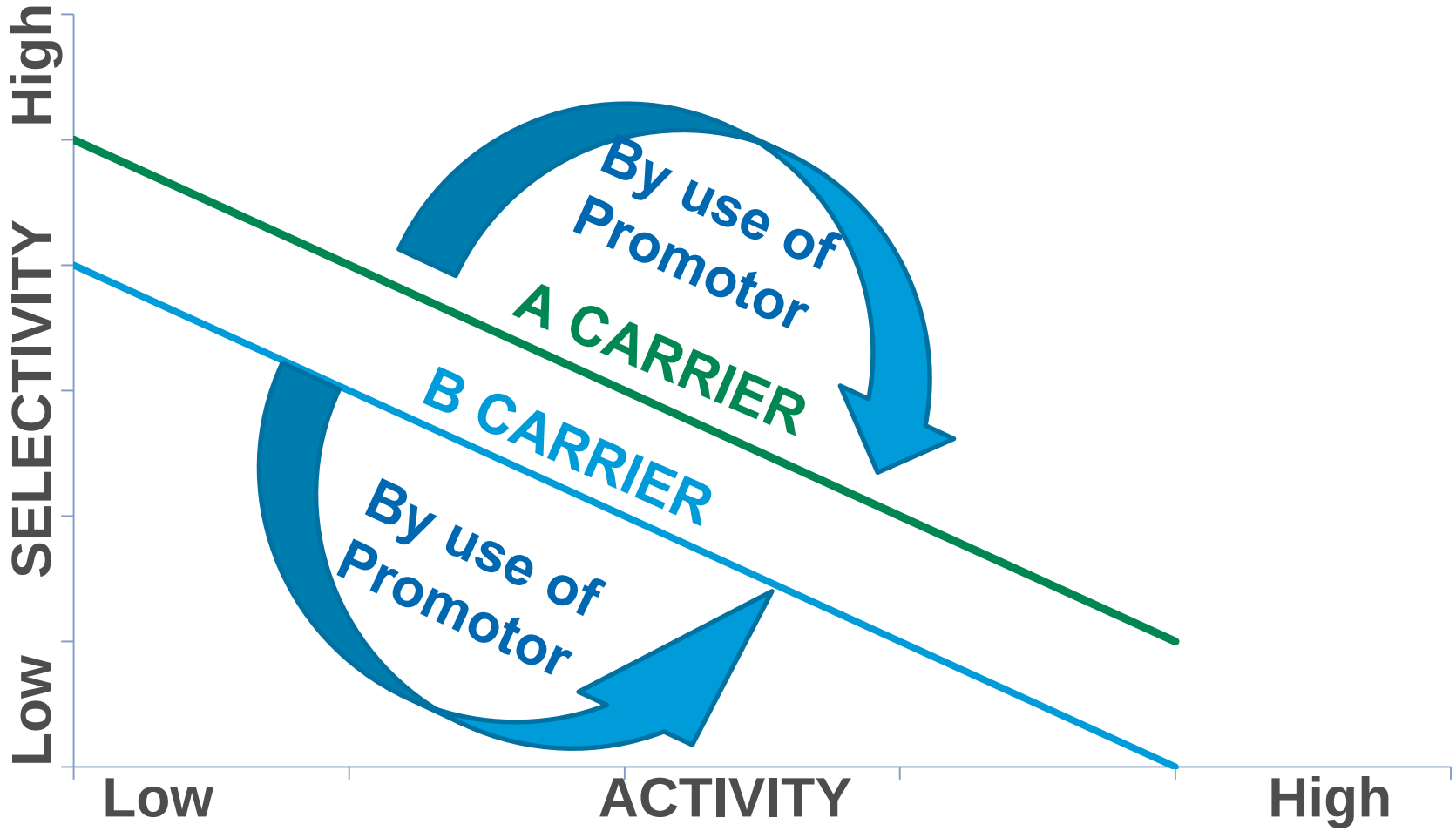
What the Market is Looking for?

- Increased C_5+
- Increased total aromatics
  - More A_7+, primarily toluene and xylenes
  - Essentially same benzene
- Increased hydrogen
- Reduced C_4-
  - Primarily LPG (C_3-C_4)
  - Also FG (C_1-C_2)
- Reduced pentanes
  - Lower RVP
  - Affords incremental C_4 blending in gasoline
- Activity maintenance

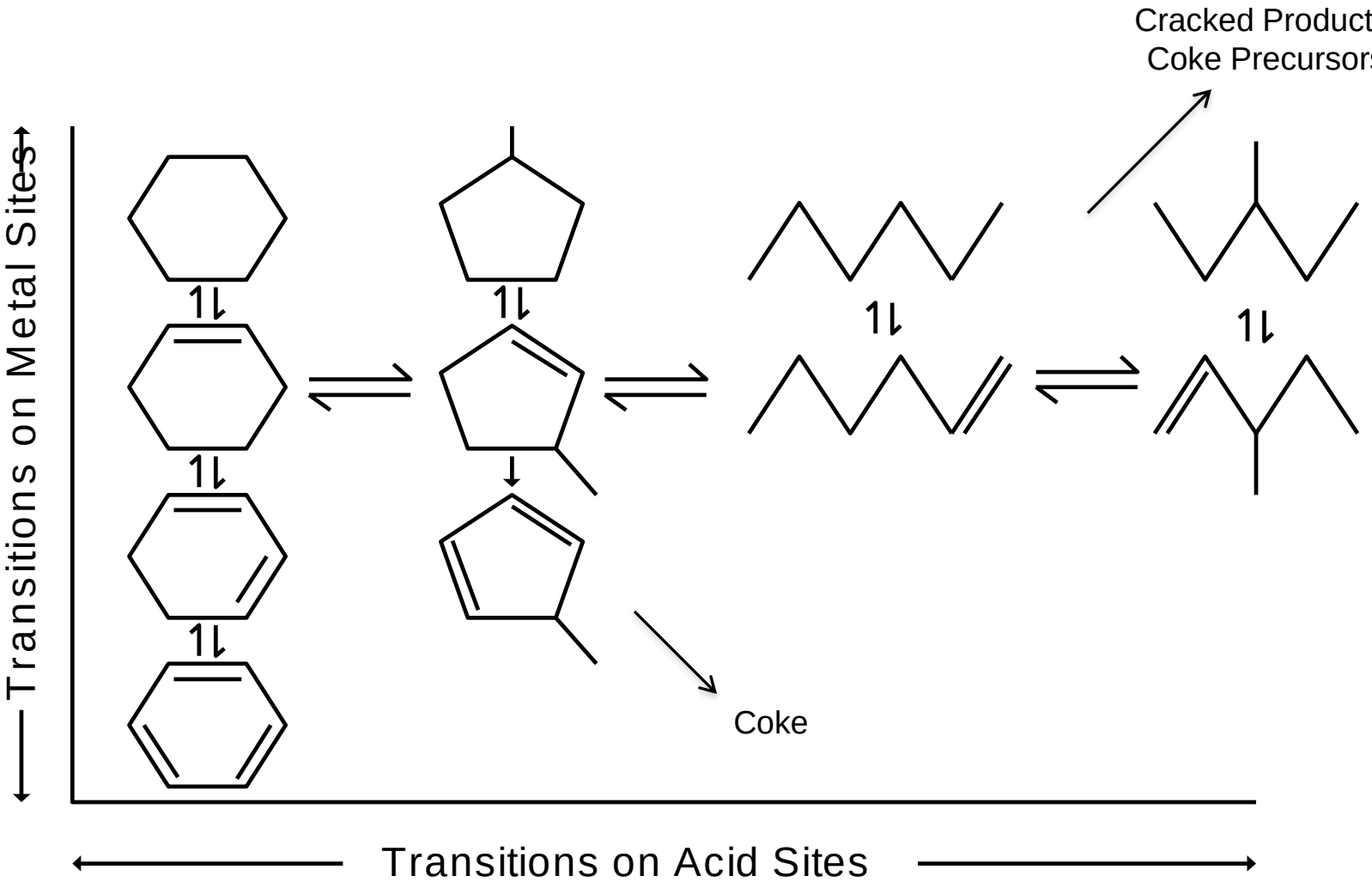
What the Market is Looking for?

- **Long term performances maintenance**
  - **Higher long term better yields**
  - **Low chlorine elution**
  - **Lower chlorine downstream side-effects**
  - **Higher catalyst surface area maintenance**
  - **Lower coke make**
- **Facilitate reactant and product diffusion efficiency**
  - **Highest catalyst activity**
  - **Lowest deactivation rate**
- **Provide requisite crush strength**
- **Minimize attrition**

Existing Formulation:
SELECTIVITY versus ACTIVITY selection

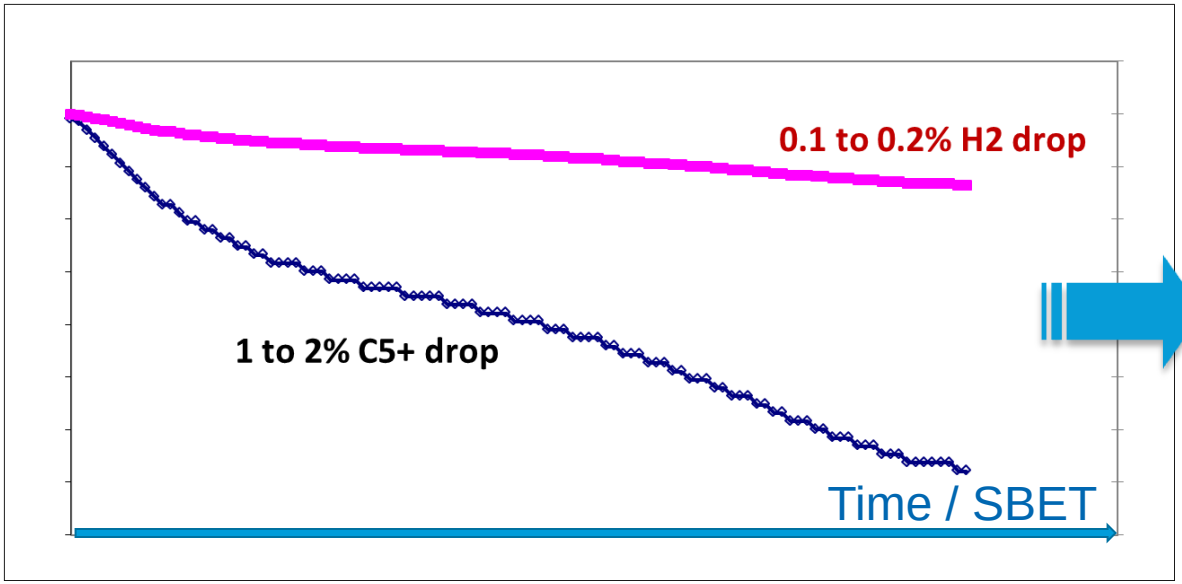


Optimized Acid-Metal Balance Key
The optimized pass way



Current General Status: Catalyst Ageing

- Regular performances drop is mainly due to surface area decrease by catalyst carrier hydrothermal degradation phenomena



- Catalyst chlorine elution is increasing through the time linked to catalyst surface area decline

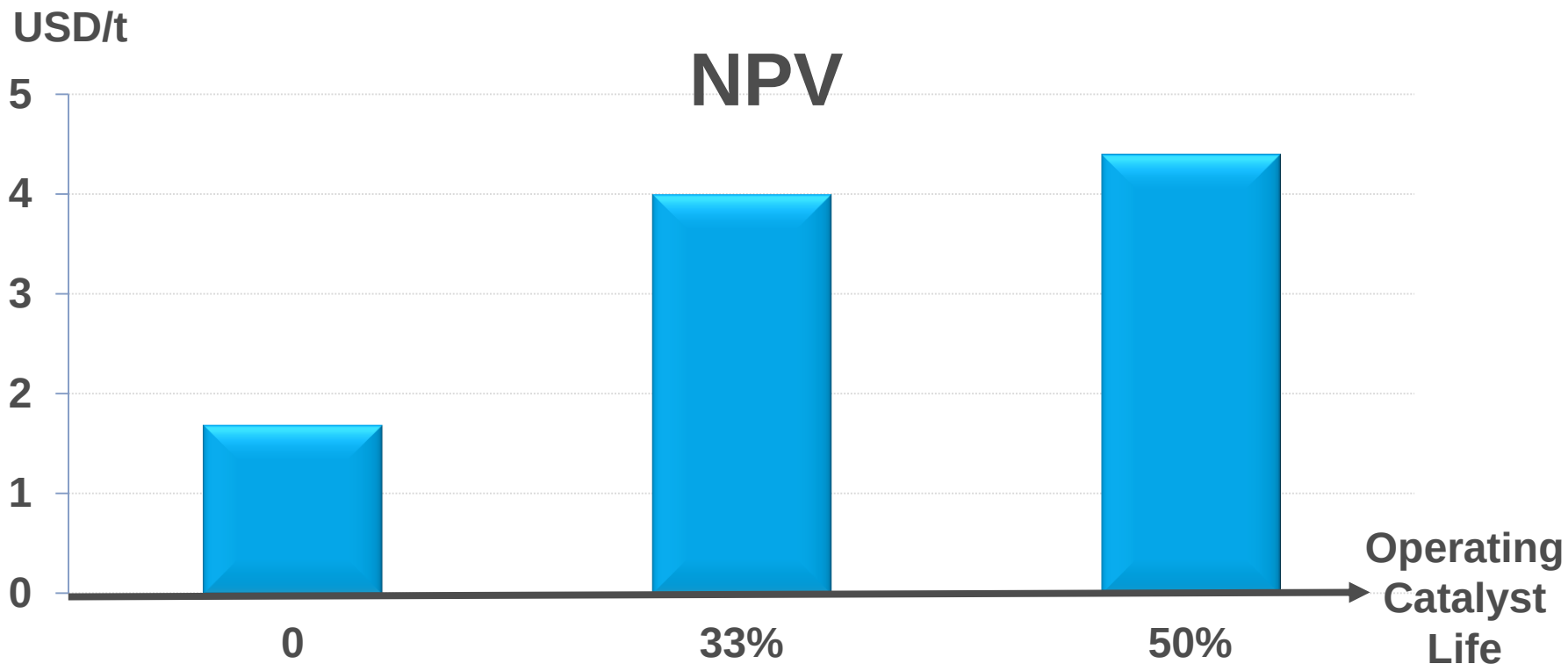
How Much Does Ageing Really Cost?
Hypothesis

- **Hypothesis**
  - **Plant located in Asia**
  - **Capacity: 50 000 bpsd**
  - **Heating with Fuel Gas**
  - **Catalyst life: 7 years**
  - **Discount rate: 10%**

- **Replacement of operating catalyst by a high hydrothermal resistance catalyst**

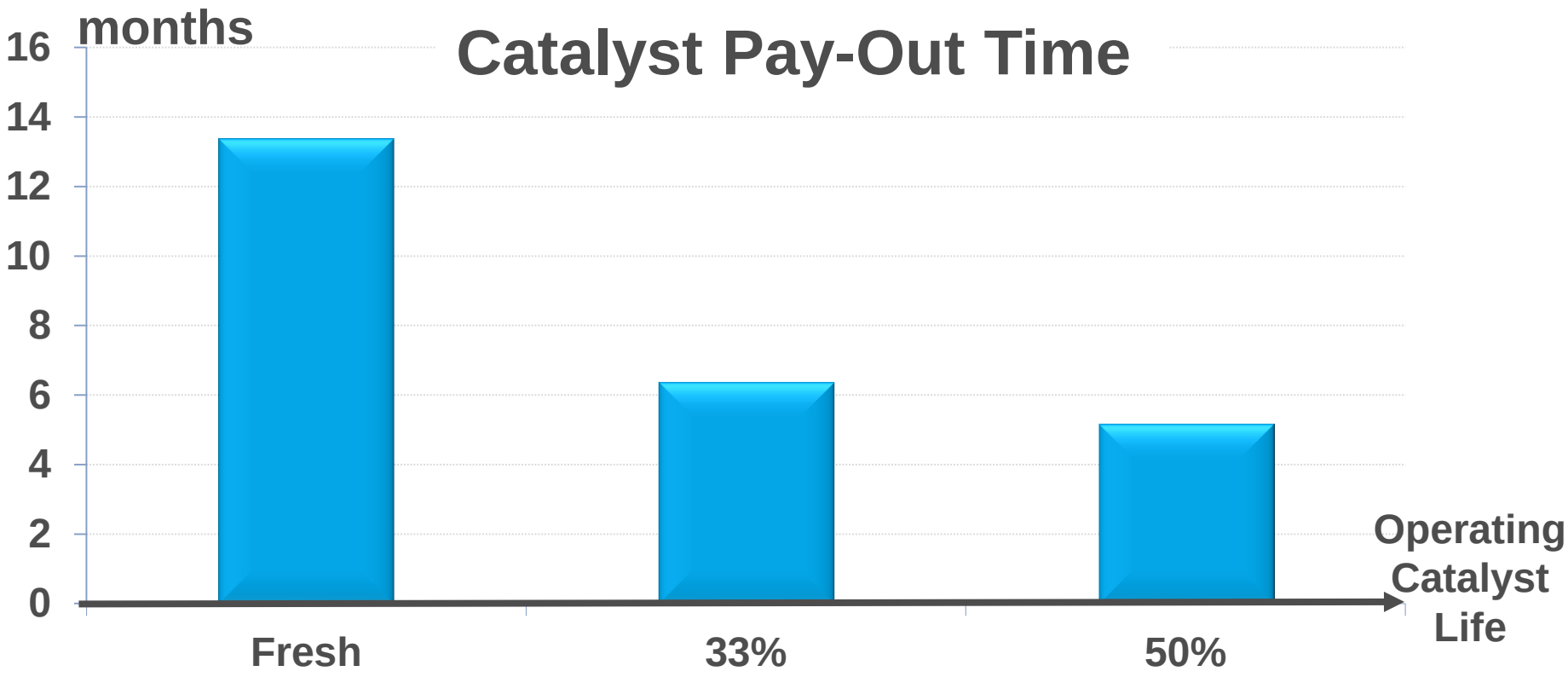
How Much Does Ageing Really Cost?
Net Present Value Impact

- **Replacement of operating catalyst by a high hydrothermal resistance catalyst**



How Much Does Ageing Really Cost?
Catalyst Pay-Out Time

- **Replacement of operating catalyst by a high hydrothermal resistance catalyst**



How Much Does Ageing Really Cost?
To sum-up

- **Selection of the highest hydrothermal resistance catalyst is a major economical driver:**

  - **Fresh to fresh increment gain between former generation type catalyst and the new generation is around 2 USD/t**

  - **Mid life catalyst (SBET ~160 m²/g) is worth to be replaced by the new generation type catalyst with:**
    - **› an additionnal margin of about 4.4 USD/t**
    - **› and a Pay-Out-Time of about 5 months**

HOW to Answer: Symphony™

Officially launched in 2013

Reforming Business Acquisition Accelerates Development of New Technology

Willow Island, USA

Salindres, France

- **Superior alumina support technology**
- **Game changer catalysts: PS 40, PR 30 & PR 15**
- **Superior multi-metal formulation technology**
- **Global leader in metallic active phase catalysts**

Over 100 years of cumulative excellence in the production of reforming catalysts

A Wide Portfolio of Reforming Catalysts

Fixed Bed Series:

- Family of products for Semi Regen and Cyclic units
- Mono & Bi-metallic
- Balanced & Skewed
- Multi-promoted
- High activity, selectivity, and longer cycle length

Moving Bed (CCR):

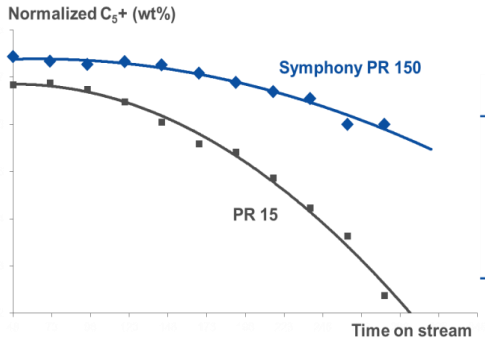
- AR series for high severity Aromatics
- CR high density & PS low density series for Gasoline
- Multi-promoted
- Superior strength and Cl retention, maximum yield selectivity & catalyst life

Axens Fixed Bed Reforming Catalysts Porfolio

Family of Multi-Promoted Fixed Bed Catalysts

Re/Pt	Pt Only	Balanced	Unbalanced
Target Unit	Cyclic	Cyclic/SR	SR
Stability	+	++	+++
S tolerance	+++	++	+
Low density	RG 532	RG 582	RG 682
Standard density	P 15	PR 15	PR 36	PR 30
	P 152	PR 150	PR 156

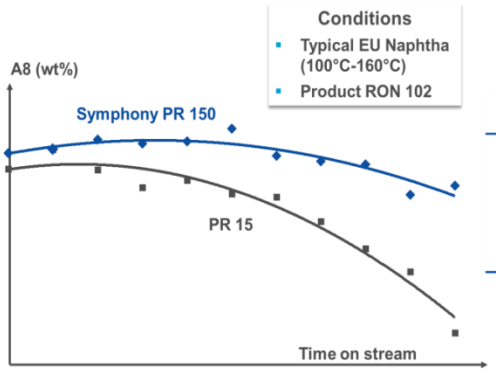
Symphony™ Fixed Bed PR Series



Cycle Average Yield Improvement

	PR 15	Symphony PR 150
H_2 (wt %)	Base	+0.15
H_2 (scfb)	Base	+60
C_5^+ (wt %)	Base	+1.5

- Higher H_2 yield
- Higher C_5+ yield
- Higher Aromatics yield



Conditions
- Typical EU Naphtha (100°C-160°C)
- Product RON 102

Cycle Average Yield Improvement

	PR 15	Symphony PR 150
A6 (wt %)	Base	Base
A7 (wt %)	Base	+0.51
A8 (wt %)	Base	+0.67

All this with 10-15% increased cycle length at same activity

Symphony™ Fixed Bed PR Series

- **Symphony™ fixed bed catalyst series products provide vs previous products, industrially demonstrated:**

  - **Yields stability**
  - **Better Stability = Extended cycle length**
    - **Due to lower coke make**
  - **Proven industrial regenerability**

Repeated orders from Majors

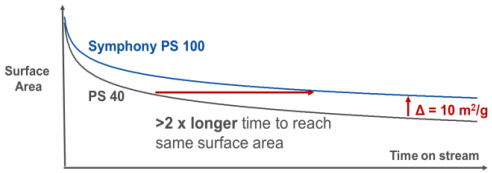
Axens CCR Reforming Catalyst Portfolio

New

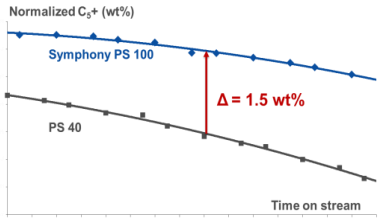
Application	Gasoline	Aromatics	Gasoline / Aromatics	
Pt, wt%	0.25	0.30	0.30	0.29
Promoters	Sn + Others (Multi-Promoted)			
Moving bed density, t/m3	0.65	0.65	0.54	0.54
Main Attributes	Activity Yields Strength	Activity Strength	Activity Strength	Yields Strength
Target Unit	All	All	Competitor	
Density	High density		Low density	

Best Performances with PS 100

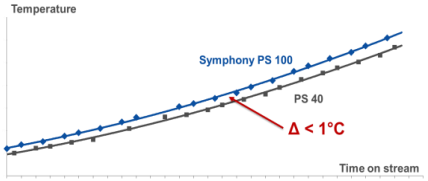
- Improved C_5+, aromatics and H_2 yields

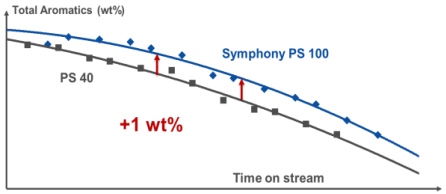


- Improved Hydrothermal Stability



- Same activity



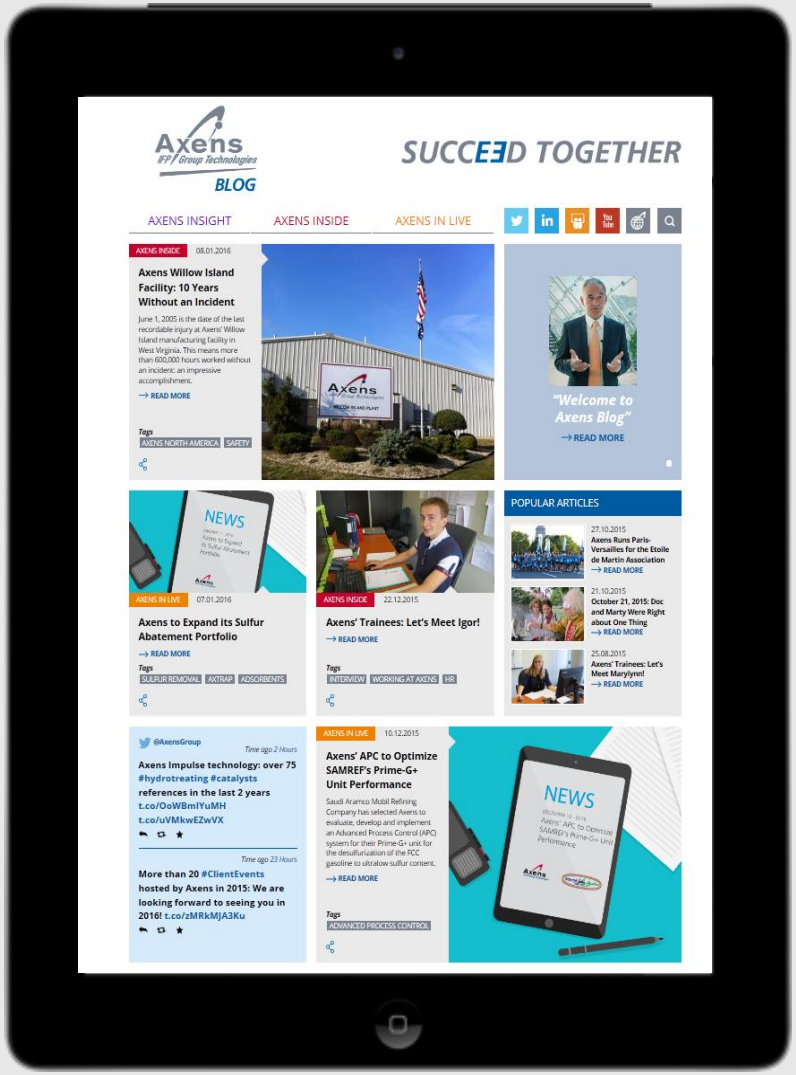


All Commercial units using Symphony™ PS 100 have confirmed these gains

Symphony™ Catalyst Family

The today's optimized solution.

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



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