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CATALYTIC SOLUTIONS FOR VGO HYDROTREATING

Principles of Catalyst Design:
Conventional VGO Hydrotreating

Application:	**FCC Feed Hydrotreating**
Objectives:	**Maximum HDN Activity**
	High HDS Activity
	Moderate HDM Activity
Catalyst Design:	**Small Average Pore Diameter**
	Narrow Pore Size Distribution
	Typically NiMo Catalyst

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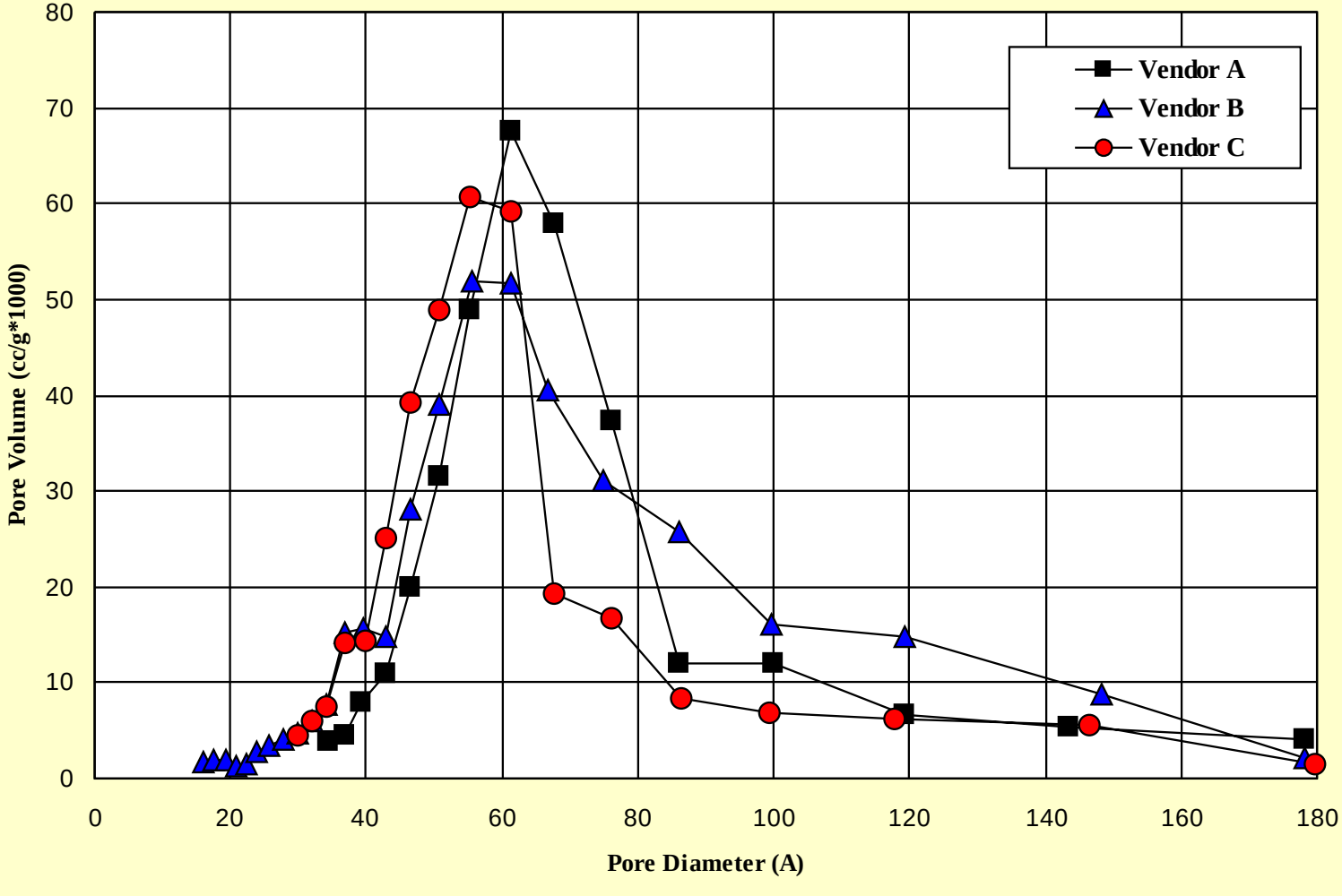
Hydrotreating Catalyst Pore Size Distribution

NiMo VGO Catalysts



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Resid Demetallation:
Catalyst Design Issues

- Typical metal-containing *porphyrinic* compound has average diameter of 40-70Å.
- Effective demetallation catalyst design must allow the large molecules to diffuse into catalyst internals.
- Reactions are rapid at active sites, such that pore mouth plugging followed by rapid deactivation (and ΔP problems) can occur quickly.
- Broad pore size distribution allows porphyrin to access internal pores allowing metals laydown throughout the particle.

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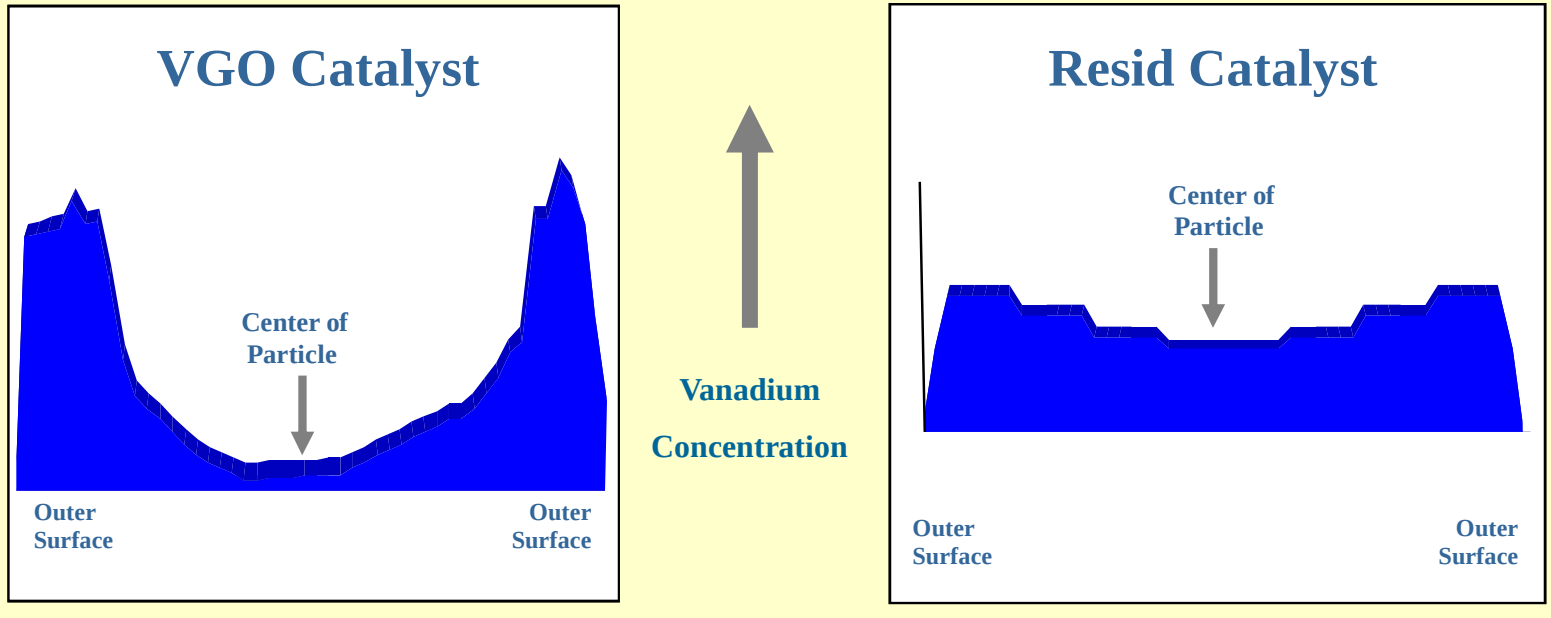
Vanadium Contamination:

VGO Versus Resid Catalyst

Vanadium Penetration



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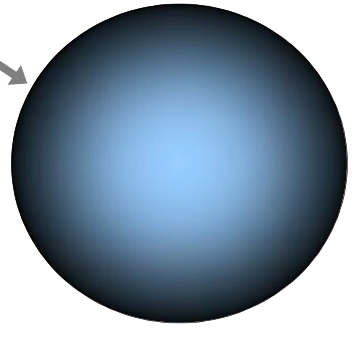
Vanadium Contamination:
VGO Versus Resid Catalyst

VGO Catalyst

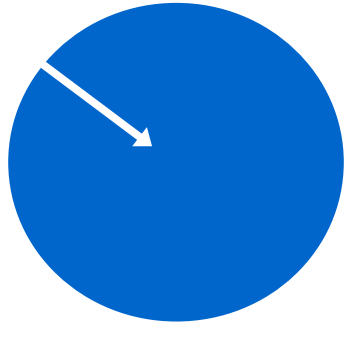
Vanadium Concentrates On Catalyst Surface



***Result*:**
- Internal Surface Blocked
- V Uptake Ineffective
- Reduced Cycle Length

Resid Catalyst

Wider Pore Size Enables Deeper V Penetration



***Result*:**
- Higher V Uptake
- Longer Cycle Length

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Principles Of Catalyst Design
Resid Hydrotreating

- **Applications:** ARDS, VRDS, H-Oil, LC Fining
- **Objectives:** Maximum HDM Activity
  High HDS / HDN Activity
- **Catalyst Design:** Larger Average Pore Diameter
  Broad Pore Size Distribution
  NiMo or CoMo

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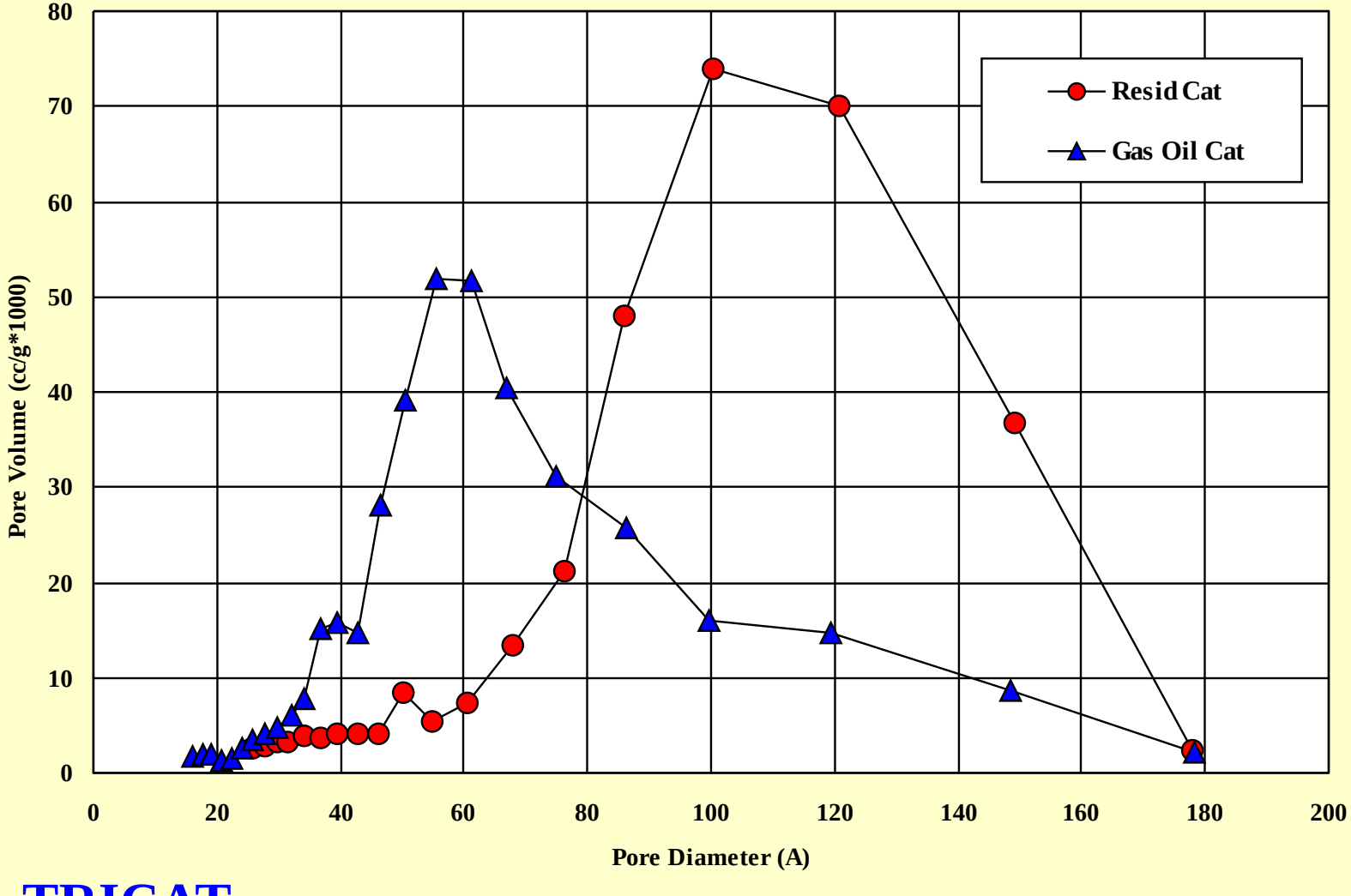
Hydrotreating Catalyst Pore Size Distribution

VGO vs. Resid Catalysts



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Principles Of Catalyst Design
Transition Catalyst

- **Applications:** Lower Beds, Reactors of Resid Units
  Guard Bed, Reactors of VGO
- **Objectives:**
  In Resid Units: Enhanced HDS/HDN at expense of HDM
  In VGO Units: Enhanced HDM at expense of HDN/HDS
- **Catalyst Design:** Intermediate Between
  Resid and VGO Catalyst

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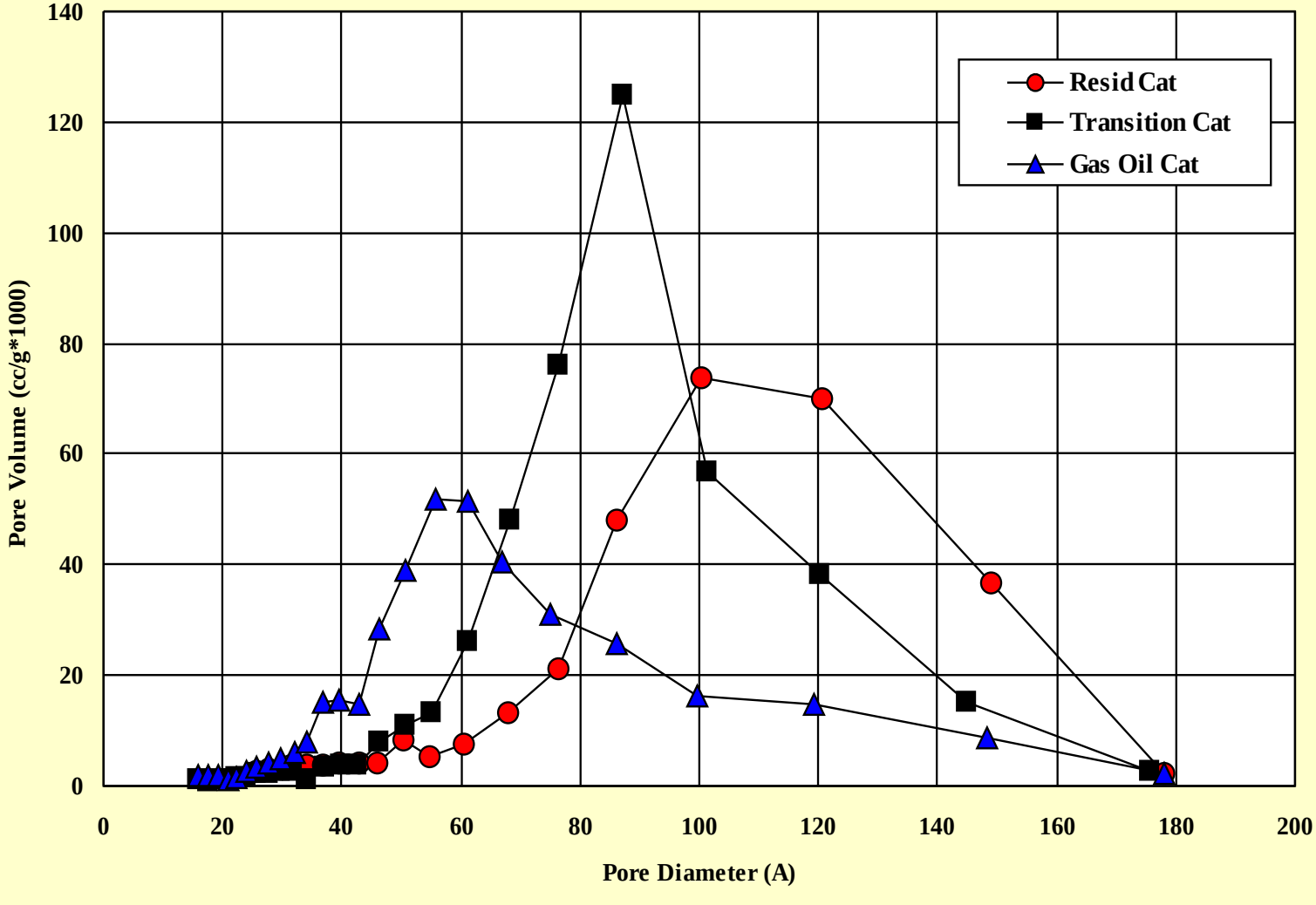
Hydrotreating Catalyst Pore Size Distribution

VGO vs. Resid Catalysts



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Vanadium Partitioning
VGO Hydrotreating Catalyst

VANADIUM ON SPENT CATALYST, Wt.%

	Conventional Gas Oil Catalyst	Transition Catalyst, Above Conventional Catalyst
Top Bed	2.5	2.8
Bed 2	2.5	0.4
Bed 3	1.1	0.3
Bed 4	0.7	0.1
Weighted Average	1.4	1.1

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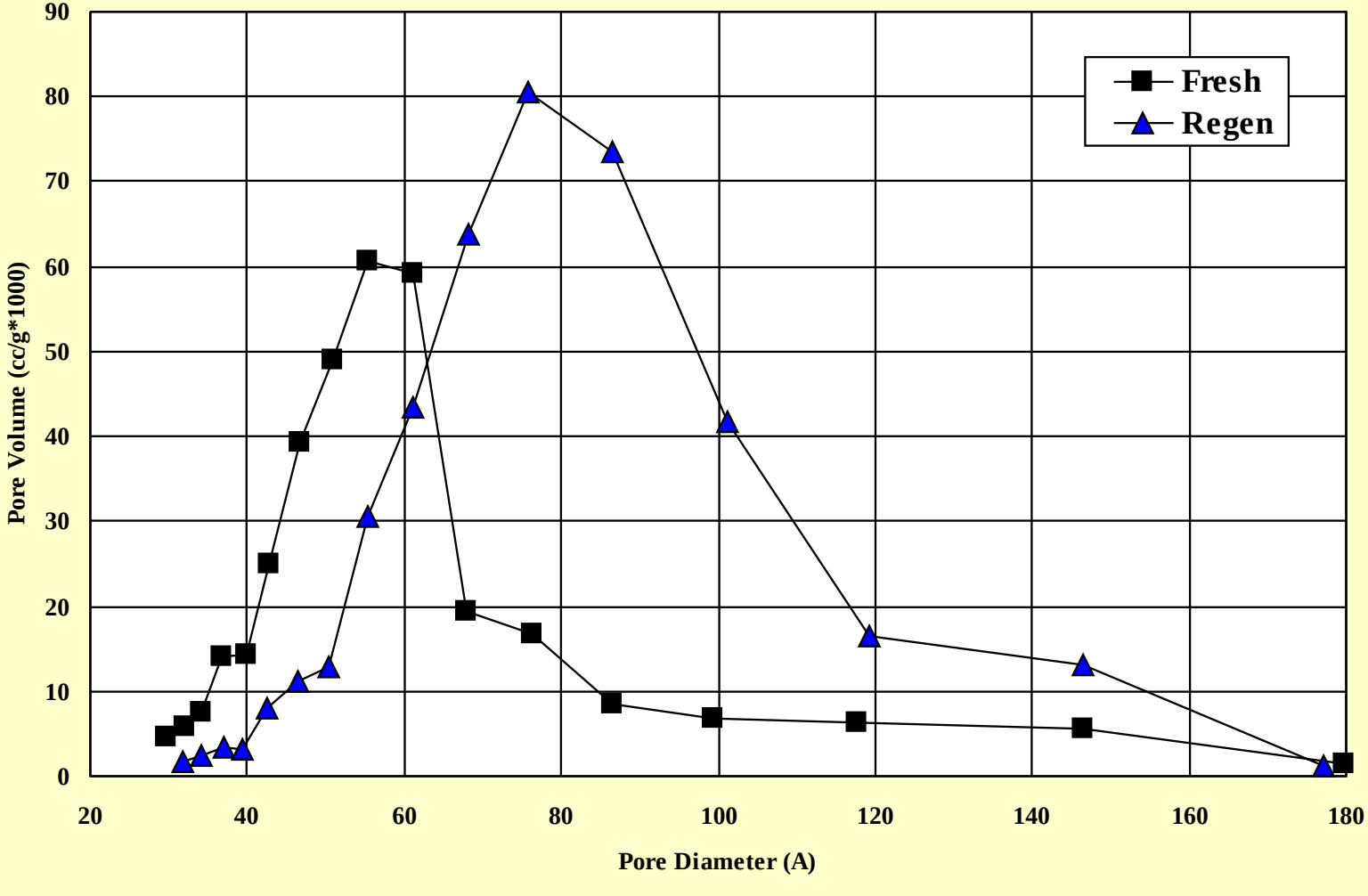
Impact of Catalyst Regeneration on Pore Size Distribution

- Thermal treatment of spent hydrotreating catalyst can open pore structure.
- Regeneration of spent VGO hydrotreating catalyst via the TRICAT Regeneration Process shifts pore distribution to larger sizes.
- Regenerated VGO catalyst pore structure resembles that of Transition catalysts.

Hydrotreating Catalyst Pore Size Distribution

Fresh vs Regenerated VGO (NiMo) Catalyst



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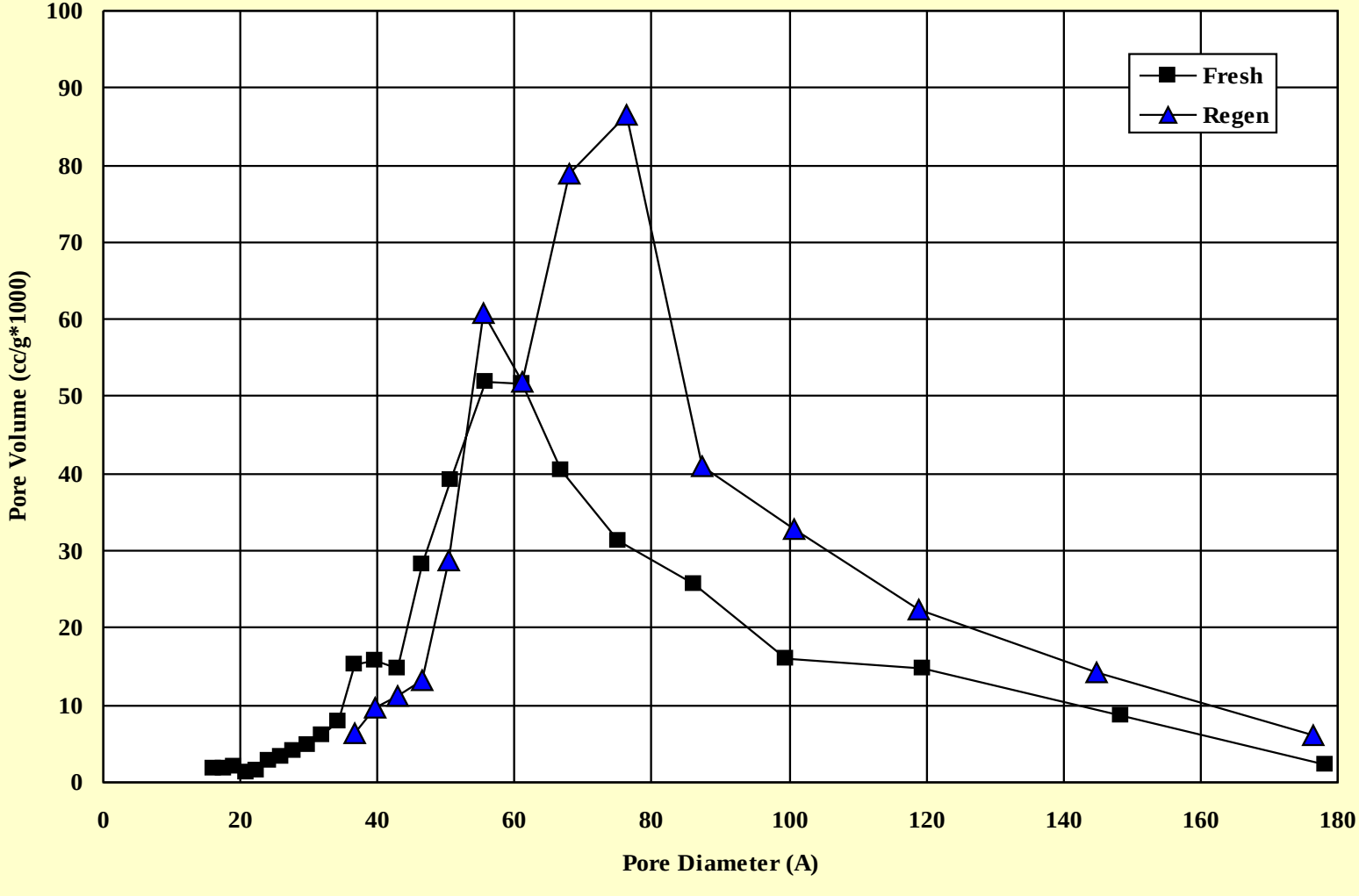
Hydrotreating Catalyst Pore Size Distribution

Fresh vs Regenerated VGO (NiMo) Catalysts



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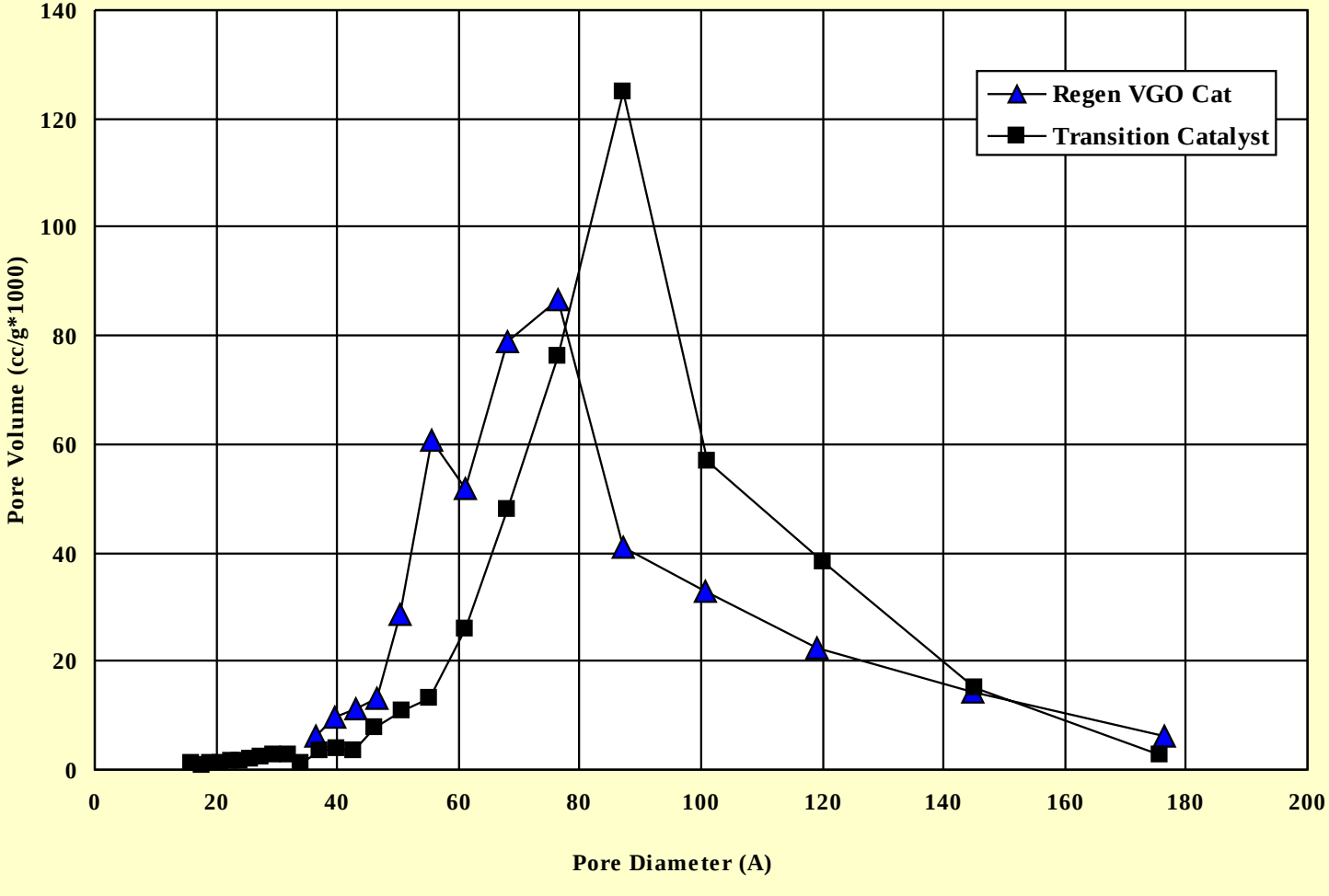
Hydrotreating Catalyst Pore Size Distribution

Regenerated VGO vs. Resid "Transition" Catalyst



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Conclusions

- Resid and Transition HDT catalysts offer wider catalyst pore size distribution than conventional VGO catalysts.
- Catalyst regeneration via the TRICAT Regeneration Process (TRP) can widen pore diameter.
- Regenerated catalyst offers an effective and economic alternative to Transition catalysts to improve vanadium uptake and improve cycle length in VGO service.