



Criterion Catalysts Fit Into Your Refinery Flow Diagram

The refining and petrochemical industries continue to undergo major changes influenced by changing global market demand for different products, tighter environmental regulations on gasoline, middle distillates and fuel oil, and declining crude/feedstock quality (heavier, more cracked streams, higher sulphur, nitrogen, aromatics and metals). In recognition of the challenges facing our customers, Criterion has intensified its research and development efforts to devise cost effective technical solutions and introduce new, improved, innovative products, on time to meet customer requirements.

Refinery Flow Diagram (RFD)

The attached figure illustrates where Criterion's catalysts fit into your RFD. Our newest/most recently commercialized products are shown in **boldface** and are discussed in more detail below.

Top Bed Catalysts and Grading Material

Criterion offers a line of hollow cylinder top bed catalysts (814HC and 824HC) and shaped grading material (854RG) designed with the following features:

1. High mechanical integrity
2. High bed voidage to control pressure drop build-up during the cycle
3. Catalytic activity necessary to hydrogenate coke precursors, as required to minimize polymerization/coking reactions at the top of the catalyst bed
4. Large pores for iron sulfide removal
5. Improved liquid distribution through size grading.

Naphtha Hydrotreating

With more cokers installed to convert heavy oils, higher silicon and nitrogen levels in cracked naphthas are becoming important issues to deal with. DN-140 silicon removal catalyst is Criterion's response to deal with this problem. DN-140 is demonstrating value-added performance by achieving longer catalyst cycle life when processing silicon contaminated coker naphthas with measured SiO₂ capacity as high as 22% wt.

DN-200 has been successfully applied in treating naphthas where improved sulfur and nitrogen removal activity is desired.

Cat Reforming

PR-11 is a front end catalyst designed to retain ring structures. In combination with PR-9 or PR-29, this staged catalyst system achieves up to 1% wt higher C₅₊ and 0.1% wt or 50 SCF/bbl higher H₂ yield versus PR-9 or PR-29 by themselves. PR-9 and PR-29, in turn, achieve up to 1% wt higher C₅₊ and 0.1% wt higher H₂ yield versus conventional bimetallic reforming catalysts.

PS-40 CCR catalyst is designed to significantly improve catalyst stability by lowering coke make and increasing C₅₊ and H₂ yields. This unique catalyst can allow the refiner to overcome operating difficulty of catalyst circulation rate limited CCR units. PS-40 can offer the refiner a more cost effective solution to debottleneck units with undersized regenerators and the capability to produce more octane barrels.

Distillate Hydrotreating

Criterion offers an innovative catalytic option using a stacked bed system comprising DN-200 or our highest activity CENTURY™ DN-190 NiMo and DC-130 CoMo catalysts to achieve lower aromatics, higher cetane, higher volume gain, and lower sulfur distillates.

VGO/Cat Feed Hydrotreating

DN-200 was developed to meet customer needs for deep HDS coupled with improved hydrogen uptake (higher polynuclear aromatic saturation and HDN) for VGO hydrotreating service. DN-200's advantages include higher activity, improved catalyst stability and lower catalyst density than the industry standard catalyst, Criterion 424. For more details, see Criterion's October 1997 publication entitled, "CFH: DN-200 Can Work for You" by Liz Allen.

Hydrocracking

CENTURY technology DN-190 catalyst continues to demonstrate superior performance as a step-out catalyst with nitrogen removal activity up to 40% higher than previous generation catalysts. This CENTURY technology is also used to manufacture HC-R which is a catalyst proprietary to UOP and is available for purchase by UOP licensees.

Within the first 9 months of introduction, CENTURY catalysts have been installed in seven units worldwide, a clear indication of customer recognition of the superior performance of CENTURY technology. This breakthrough technology offers the refiner the following value added benefits:

1. Capability to process tougher, higher margin feedstocks (e.g. cat cracked/coker gas oils, higher end point feeds).
2. Improved catalyst cycle life.
3. Increased unit feed rate.
4. Improved valuable liquid yields.

CENTURY technology catalysts can also be used to enhance aromatic saturation activity in higher pressure VGO hydrotreating/CFH units, resulting in improved FCC yields and in distillate hydrotreating units resulting in improved distillate cetane quality.

Criterion also markets a complete slate of Zeolyst International hydrocracking catalysts. The latest Zeolyst high performance hydrocracking catalysts include:

- Z-863 Maximum activity naphtha selective with high nitrogen tolerance
- Z-773 Naphtha selective noble metal/high C₅+ yield, low gas-make, high heavy naphtha yield
- Z-743 Naphtha/jet selective noble metal/high quality jet, low gas make
- Z-803 Naphtha/jet selective with higher activity, higher jet and C₅+ yields and lower gas make than Z703
- Z-673N Middle distillate selective with high nitrogen tolerance, heavy end conversion and high temperature stability
- Z-623 Maximum middle distillate selectivity with higher activity than Z-603

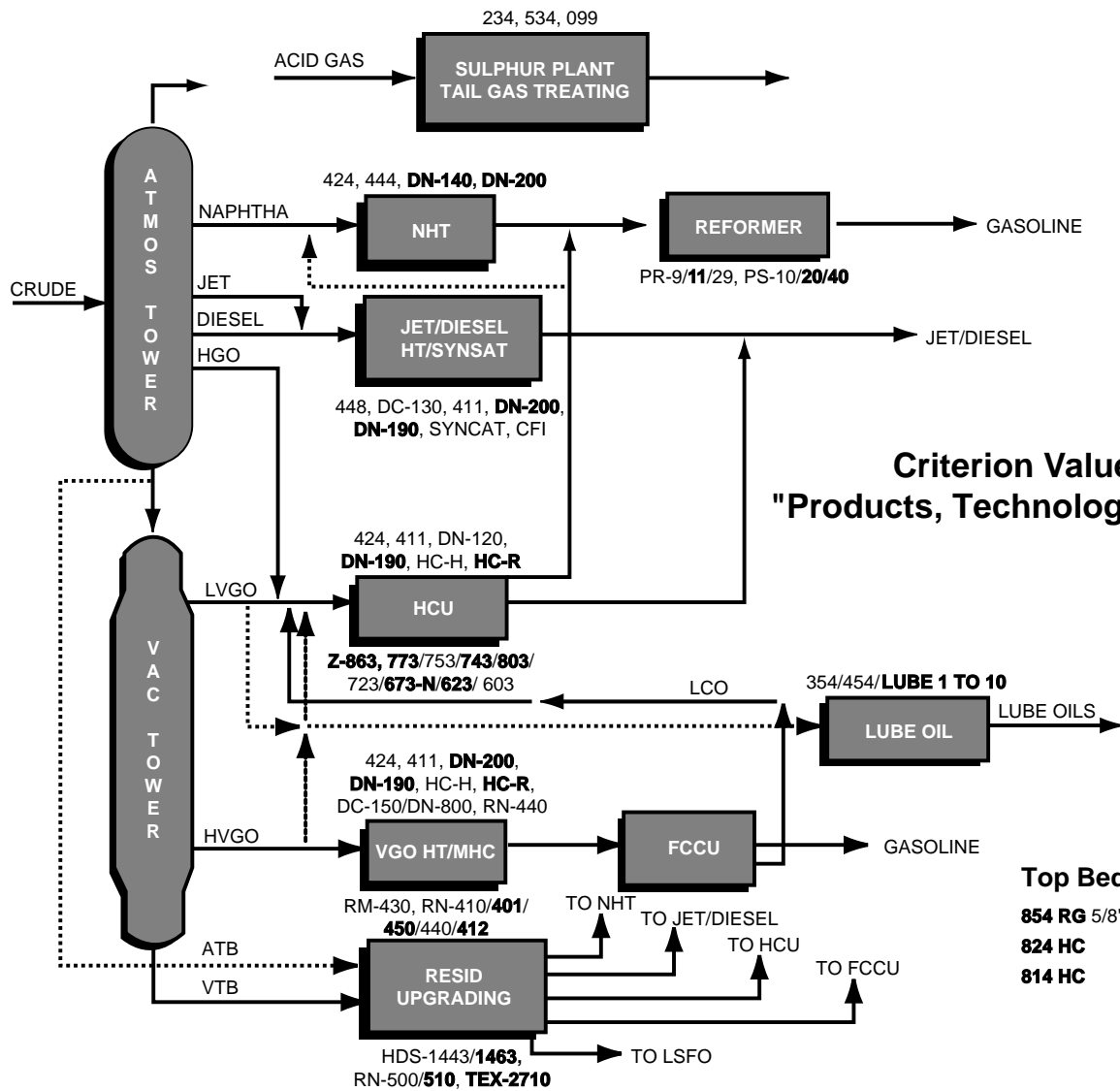
Resid Hydroprocessing

Criterion introduces RN-412, an innovative catalytic solution for deep metals removal in resid hydroprocessing for cat feed/heavy oil cracking units feed preparation. In combination with RM-430, RN-410 and RN-450, RN-412 produces low metals resid, resulting in improved value when it is processed in a resid cat cracker or combined with vacuum gas oil in a VGO cat cracker.

RN-401 is a new product offering more cost effective tail end HDS than RN-400. It is designed to allow refiners to achieve higher resid conversion without loss in a liquid product stability.

RN-450 was developed for and successfully applied in resid units processing more difficult feeds demanding deep HDS and improved carbon residue conversion without loss in catalyst cycle life. RN-450 (2500 metric tons/5500 k lbs sold) has been successfully applied in processing vacuum tower bottoms. RN-450 has also been utilized in combination with DN-200 for processing of higher metal/CCR feeds in cat feed hydrotreating.

In ebullating bed resid applications, Criterion continues to develop and commercialize improved and cost effective products (e.g. TEX-2710, HDS-1463) targeted at improved conversion of 538° C+ (1000° F+) and carbon residue without deterioration in product stability, by controlling sediment formation.



**Criterion Value Added
"Products, Technologies & Services"**

Top Bed Active Support
854 RG 5/8"x1/4" x (5/8" or 3/8" or 1/4")
824 HC (1/3")
814 HC (1/4", 1/6")



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