

Catalyst & Technology

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News

Criterion and Clean Fuels Projects

Many North American refiners will shortly be entering the implementation phase for their clean fuels projects as most need to meet the June, 2006 production date for ULSD. The expected surges in hydroprocessing catalyst demand late this year and into early 2006 have occurred and continue to challenge both refiners and suppliers alike. Successful projects have focused on several key elements when selecting their technology providers: experience, product & technology leadership, and technical support.

The demand for middle distillate product has been predicted to grow substantially for some time due to increased use of diesel and jet fuels. Tax incentives for more fuel-efficient diesel vehicles, recovering air travel and general economic growth were cited as the main drivers. At the same time, various governmental authorities in many parts of the world mandated more restrictive environmental emissions from use of such fuels leading to the requirement for better product quality - primarily ultra low sulfur diesel (ULSD) specifications. The result has been a great increase in both the use of hydrotreating processes and catalysts in order to produce cleaner burning fuels. Refiners were challenged to make cost effective capital investments based on both current and future, yet to be fully defined,

fuel quality requirements. For example, would off-road middle distillate products need to meet the same specifications as on-road fuels? if so, when?

During this period, Criterion Catalysts & Technologies L.P. and our hydroprocessing marketing alliance team members, Shell Global Solutions and ABB Lummus Global, were able to provide the catalysts, reactor internals, process technologies, and relevant operating expertise required for cost effective, non-regret solutions for a very large number of refiners.

We've helped refiners implement creative solutions in more than 150 projects to solve such key processing questions as:



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- What is the best manner for the refiner to process lower-quality middle distillates, especially cracked materials such as those from Cokers and FCC units, which may no longer be economically blended into products facing stricter product qualities?
- How can the upgrading of such streams be accomplished with the minimum consumption of additional hydrogen for a given task and yet ensure on-specification ULSD?
- Can an existing unit's reactor(s) be modified with high performance Shell Global Solutions reactor internals and Criterion state-of-the-art catalyst[s] as the most cost effective method of meeting new fuel quality regulations?
- Shell Global Solutions' proprietary reactor internals maximize the utilization of the complete catalyst volume in a given unit by achieving nearly 100% uniform gas and liquid dispersion and they perform best in eliminating radial temperature mal-distribution, both of which can lead to increased cycle lengths. These internals have been applied more than 200 times in recent years at both Shell and third party refineries;
- Syn Technology units have been producing ultra low sulfur diesel product since the first unit started up in 1994, on feeds as poor as heavily cracked blends consisting of up to 80% Light Cycle Oil and Coker Gas oil. There are currently eighteen operating units with six more scheduled to startup over the next two years totaling more than 1.3M bpsd of installed processing capacity, including six units that make use of Lummus' unique counter-current flow reactor systems. The four basic types of Syn Technology are as follows:

Criterion's CENTINEL technology, used in many of our catalyst grades, has led the way to the type of performance required by refiners to cost effectively produce environmentally friendly, improved quality middle distillate fuels. This technology, which substantially increased a catalyst's activity, produces catalysts with the ultimate in supported metal sulfides (formed during its preparation). Through special activation procedures, maximum dispersion of these active species is maintained through to the on-line operation of the hydro-processing unit.

Criterion and its clean fuels project team members have a wealth of ULSD processing experience that dates back more than fifteen years in this market segment. Illustrations of this experience include:

- Shell Global Solutions' process technology was the first to be applied to produce MK 1 fuel in the European Union and since then roughly 50 new or revamped units have been designed;

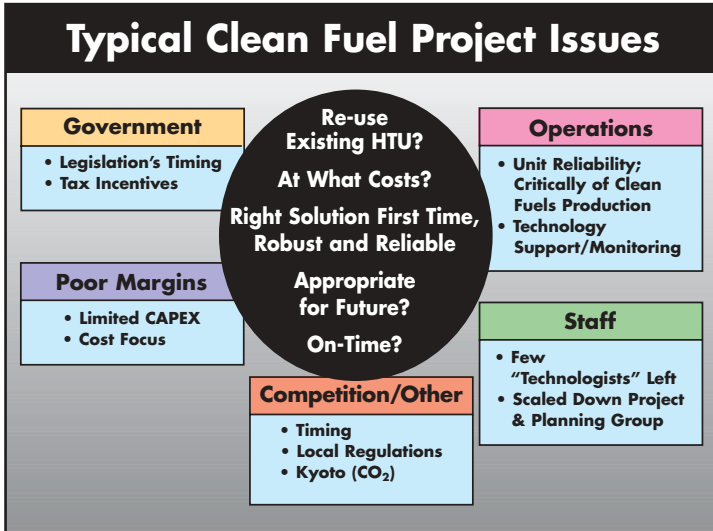
SynHDS:	Ultra Deep HDS
SynShift:	Ultra Deep HDS, Density Reduction, Cetane Increase, Distillation Shift, Poly Aromatics Saturation
SynSat:	Ultra Deep HDS, Poly and Mono-Aromatics Saturation, Cetane Increase and Density Reduction
SynFlow:	Ultra Deep HDS & Cold Flow Improvement



The Importance of Experience

Due to the complexity and uniqueness of each refinery, multiple factors need to be considered and understood for a successful clean fuels project. Often a refiner is not regularly practiced or knowledgeable in all relevant

flow technology for cost effective ULSD solutions using SynCat catalysts. The first CC Deep SynHDS application has been licensed for a U.S. Gulf coast refiner's unit. This project revamped an existing low-pressure hydrotreater to cost effectively produce ULSD. This unit will treat 17,700 BPSD of a diesel blend to produce less than 6 wppm sulfur diesel starting in the second quarter of 2006.



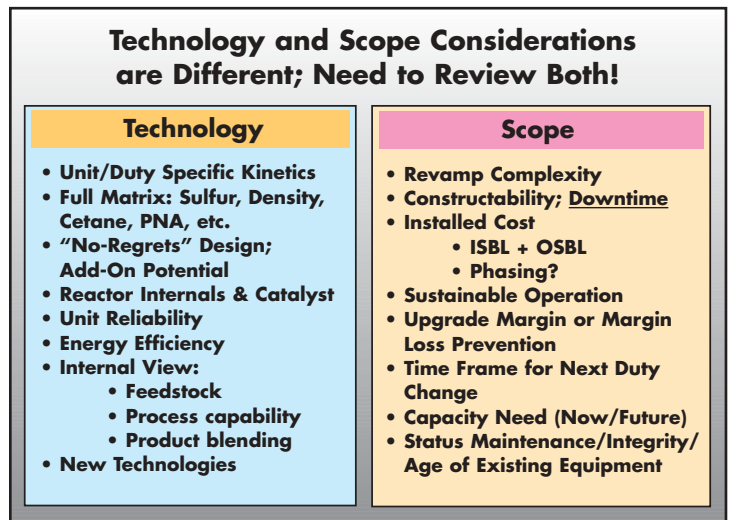
matters, so it's best to rely on an experienced technology provider to avoid costly pitfalls. The following two figures illustrate some of the key issues to consider in any (ULSD) project. Syn Technologies have been selected more than 33 times for licensed projects around the world during the past 15 years.

During just the past couple of years in North America, Criterion has been involved in more than 50 projects for clean fuels production (many for ULSD) including new as well as revamped units. Overseas during the same time period, Criterion has worked on more than 25 similar projects. Our client list is both wide and varied and includes independent and major refiners.

In addition, Lummus has continued to develop their patented counter-current

The CC Deep SynHDS process makes use of Lummus' patented, commercially proven counter-current flow reactor technology. Fresh make-up hydrogen is injected at the bottom of the reactor, which maximizes the hydrogen partial pressure at the reactor outlet. These conditions favor removal of sterically hindered sulfur species. This combined with lower outlet temperature improves product quality. The process does not require an amine absorber, inherent in older

units, and can use reformer grade make-up hydrogen. As such, it is ideally suited for revamping existing hydrotreaters. The revamp does not require any modifications to the existing reactor or recycle gas compressor. The counter-current reactor system can be built



independent of the existing unit and tie-ins can be made during a routine turn around. This minimizes downtime, which can significantly reduce revamp and operating costs for the production of ultra low sulfur diesel.

In another example of our experience, Shell Global Solutions and Criterion worked together on optimizing the catalyst loading and reactor internals of one of the world's largest hydrotreater reactors. Shell Global Solutions was first commissioned to do a quantitative estimate of what it would take for the existing unit to reach optimum production of clean fuels product. A mal-distribution quantification study identified the need for new distributors and mixing elements as well as estimated the benefits associated with fixing the problem. Concurrently, Criterion identified an optimized mix of new CENTINEL technology catalyst via pilot plant testing on the design feedstock blend. The designing and rebuilding of the internals of the hydrotreater with Shell Global's proprietary Ultra Flat Quench (UFQ) and HD (High Dispersion) tray technologies has assured thermal uniformity of the process

mixture, process vapor, and the quench medium as well as their uniform distribution across the beds of the new fill of catalyst in order to optimize the unit's performance. The client will see substantial advantage in increased catalyst cycle life and unit performance.

These examples highlight how we work with refiners to design customized solutions to meet a range of process objectives either in revamped or new hydrotreating units via phased investments to ensure maximum flexibility to meet current or future expected changes in fuels qualities. We work with each client to fit the most economic solution to the specific circumstances.

We can help you solve your clean fuels requirements.

Contact a Criterion representative to discuss your specific needs.

Important:

All information contained in this document is considered accurate at the time of the testing, based on the equipment, and specific conditions and other limitations during the testing process. It is being furnished upon the express condition that the user will make its own assessment to determine the accuracy and applicability for the user's particular purpose.

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