



# HCAT<sup>®</sup> Strategic Alliances provide “Win-Win” Benefits

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HTI's strategic alliances with world-class providers of technologies and refining catalysts are proving their benefits, not just for the alliance partners, but more importantly for the refining community using these products and services in their ebullated bed (EB) heavy oil hydrocracking units.

## HTI's Alliance with Criterion

HTI's technology alliance with Criterion Catalysts & Technologies L.P. (a wholly-owned affiliate of CRI/Criterion Inc.) was announced in April 2009 and has resulted in several HCAT applications currently in commercial development. Criterion and HTI have run tests in both companies' pilot plants, using customer oriented feedstocks and operating conditions, combining Criterion's ebullated bed solid catalyst with HTI's liquid-additive, highly dispersed HCAT hydrocracking catalyst. One world class refinery is currently using HCAT with Criterion catalyst while two more are in the process of installing new HCAT equipment with the intent to use HCAT in 2014. Together, Criterion and HTI will support the EB catalyst needs of these refiners' residual oil upgraders.

## HTI's Alliance with Axens

The strategic alliance with Axens, announced in May 2013, brings together the world's leading licensor of ebullated bed and associated downstream technologies with HTI, for the integration of the HCAT additive technology with Axens' high conversion H-Oil upgraders. While HCAT is already in use of one H-Oil unit, this new alliance will allow HTI's HCAT engineers to work side-by-side with Axens to incorporate the HCAT technology into the design of new H-Oil units as well as to retrofit HCAT where applicable into existing units. This will be particularly applicable where unit operations are limited by difficult feedstocks or by the refiner's demand for high conversion while maintaining low product sediment.

## The Combined Team

Going forward, the unique combination of Axens' H-Oil heavy oil upgrading process, Criterion's solid EB catalyst, and HTI's HCAT liquid catalyst additive will allow refining companies a unique and highly beneficial route to maximize profits from even the most difficult

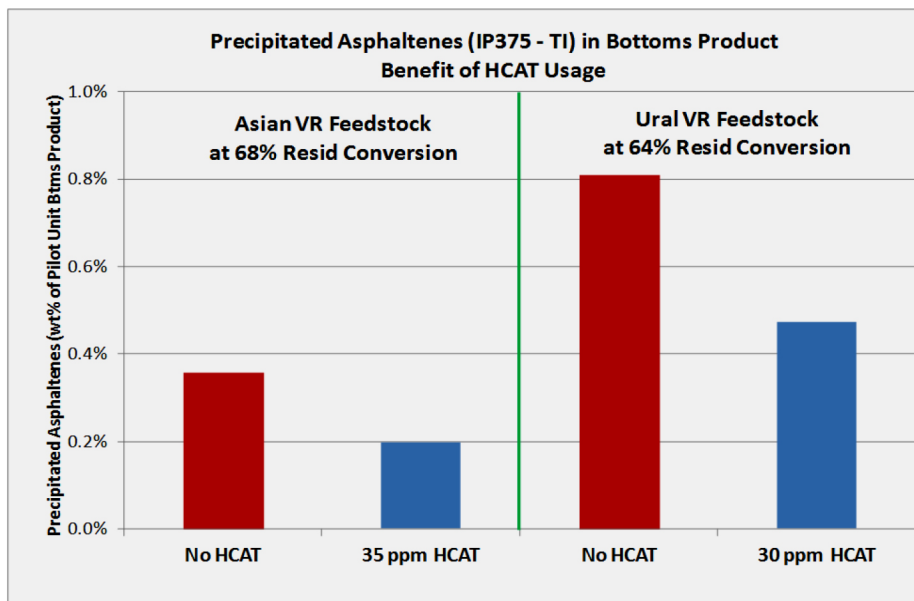
## The Value of Alliances

To prove the benefit of the Criterion/Axens/HTI alliance, HTI used its ebullated bed pilot plant to demonstrate HCAT's sediment-control ability in an H-Oil unit operating with a Criterion catalyst for hydrocracking difficult-to-upgrade residual feedstocks.

The run was carried out as follows:

1. The pilot plant was operated as an H-Oil unit with Criterion catalyst in the EB reactors but WITHOUT HCAT. A variety of conversion levels were tested and high conversion was achieved. At the most severe conditions, however, product sediment was above the customer's target maximum.
2. Towards the end of each test and while at the most severe operating conditions, HCAT was added. As the figure below confirms, the addition of HCAT produced significant reduction in product sediment.

Such results are consistent with HTI's commercial experience on HCAT's ability to reduce sediment formation even with difficult feedstocks. Adding HCAT to an H-Oil unit operating with a Criterion catalyst should provide the greatest-possible economic benefit to residual oil upgraders.



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