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HDS screening capabilities using Avantium's parallel fixed bed technology

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Abstract:
World wide specifications for transportation fuels have become more stringent over the years. This has fueled catalyst development in the field of hydroprocessing and related refining areas.
Avantium's parallel fixed bed technology, which is used in Avantium's catalyst research services and in the Flowrence™, allows our customers to increase catalysts screening capabilities and accelerate catalysts development. This technology is successfully applied in the field of hydroprocessing like hydrodesulphurization and hydrocracking..
Strict control of liquid and gas flows, as well as pressure, temperature and gas-liquid separation, enables highly accurate screening and development of HDS catalysts.
The testing accuracy using Avantium's parallel fixed bed systems is similar to those observed using state of the art large(r) single reactor systems. In the case of ULSD applications, desulfurization from high sulfur feeds until sulfur levels below 10ppm can be achieved very accurately. At levels of 10 ppm sulfur the standard deviation between individual reactors is close to 1 ppm.

Introduction

Avantium is a leader in the area of advanced high-throughput research and development services and tools, focusing on the energy, chemicals and pharmaceutical industries worldwide. The benefits of this high-throughput approach are greater speed but also the possibility to explore a wider parameter space in a shorter time frame when set against conventional R&D methods. This results in accelerated time-to-market, an increased research output and improved probability of success.
High-throughput technology platforms make it possible to screen, develop and optimize catalysts in a very short period of time. Avantium has demonstrated the potential of this technology by providing R&D services and tools to many of the world's largest energy, chemicals and pharmaceutical companies.

Fixed bed test capabilities

High throughput test equipment is the heart of the high throughout workflow. Avantium has developed both high throughout parallel fixed bed and batch test systems.
The parallel fixed bed technology as developed by Avantium is suitable to be operated in both gas and trickle flow. Avantium has experience running a wide range of refinery and related applications like hydrodesulphurization, hydrodenitrogenation, hydrocracking, reforming, isomerization and Fischer Tropsch chemistry. The back bone of the equipment is very versatile but every unit is tailored to the various applications. The units typically consist of 16, 32 or 64 reactors.

The parallel fixed bed technology is not only used in Avantium's catalyst research services but is also available for companies who want to have access to this technology in-house. This parallel fixed bed test unit is named "Flowrence™". In this tool all the successful features are incorporated that were developed for our parallel fixed bed platforms, such as feed distribution, pressure

regulation, reactor sealing, trickle-phase operation, gas-liquid separation, automatic liquid sampling, on-line analytics, and very user friendly automation. The unit is successfully applied in even the most challenging applications in the refinery industry such as ULSD and hydrocracking.

HDS capabilities

Strict control of liquid and gas flows, as well as pressure, temperature, gas-liquid separation and plug flow, enables highly accurate screening and development of HDS and hydrocracking catalysts.

In the case of ULSD applications, desulfurization from high sulfur feeds (>1wt%) until sulfur levels below 10ppm can be achieved very accurately with Avantium's parallel fixed bed reactor systems. In figure 1, the test results are shown for a 16 reactor unit in which all reactors have been loaded with the same catalysts. The test has been run at 40 bars and low space velocity for 2 weeks. As can be seen from this figure, the bandwidth of sulfur contents in the diesel, after the catalyst activity has been stabilized, is very narrow. The standard deviation between individual reactors is close to 1 ppm. Realizing that this implicates a bandwidth in sulfur conversions within 0.02% indicates that all key unit process parameters are very well controlled.

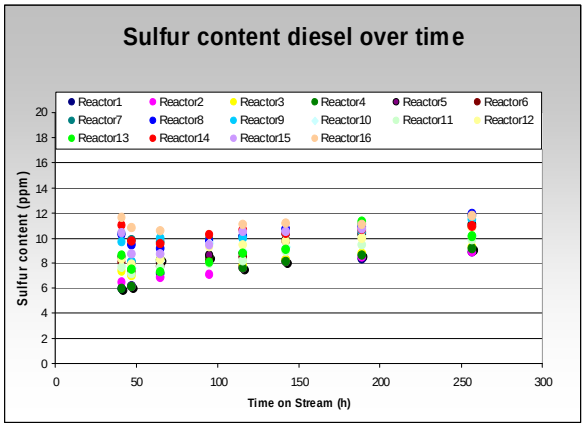

Figure 1. Sulfur content in diesel over time

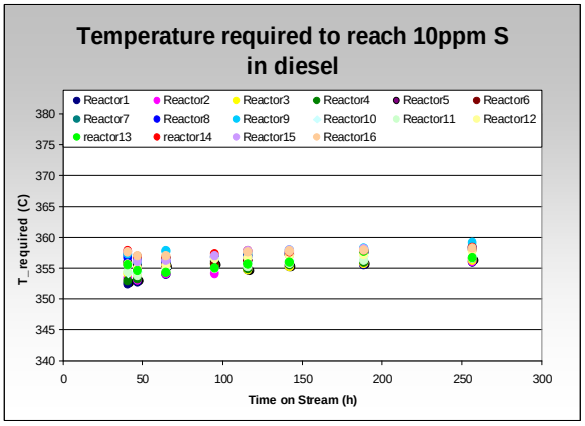

Figure 2. Temperature required to meet 10 ppm S in diesel

In the refinery industry it is very common to compare the performance of various catalysts by ranking the catalysts at the reaction temperature required to meet certain sulfur specification. In figure 2, the temperature variation of the 16 reactors to meet 10 ppm sulfur in diesel is shown. The standard deviation over all 16 reactors is close to 1°C. Besides the accuracy of the conversion, also the mass balance for both HDS and hydrocracking applications is very important. In figure 3, the liquid yields are shown. The liquid yields are within 100±2.5%.

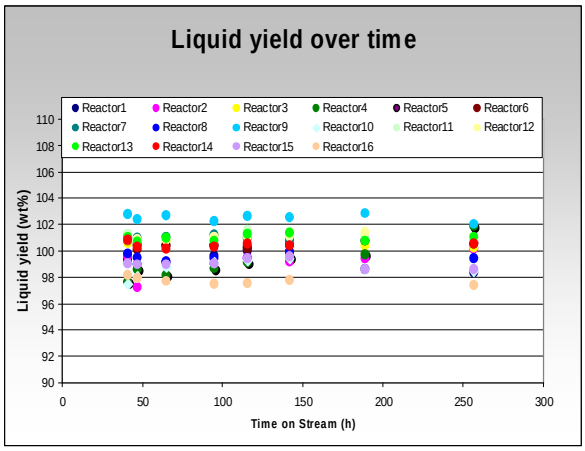

Figure 3. Liquid yield over time

The testing accuracy using Avantium's parallel fixed bed systems is similar to those observed using state of the art large(r) single reactor systems.
In the presentation on November 16th, more details will be presented on Avantium's High Through put test capabilities and especially on the use of the parallel fixed bed reactor system for hydroprocessing applications.

Keywords: Hydroprocessing, HDS, ULSD, Hydrocracking, High Throughput Experimentation.