Updated Proposal: Select Client Study

Hydroprocessing Catalysts and Processes: Recent Advances in Technology and Impacts on the Competitive Landscape

November 2020
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The proposed study will cover recent technical developments in hydroprocessing catalysts and processes and assess the implications on the competitive landscape. As always, “charter” subscribers (those who sign up prior to launch) are encouraged to provide feedback on the Table of Contents.
Implementation of MARPOL Annex VI has caused a step-change in the demand for low-sulfur bunker fuels and thus hydropprocessing.

Global diesel and gasoline sulfur limits are decreasing but remain highly variable, although this is expected to change as more countries adopt Euro IV to VI-style regulations.

Even in the face of stagnating fuel demand the demand for desulfurization is expected to increase.

This report will examine the recent shifts in hydroprocessing catalyst demand on a regional and global basis and technologies in response to changing fuel regulations.
Need for the Study

- The drive toward zero sulfur in transportation fuels is dictated by regulations, which are increasingly becoming more stringent, best evinced by the recent implementation of Marpol Annex VI through the IMO.

- In response, catalyst technologies and catalytic processes are becoming more sophisticated to meet this challenge. The market is complex, with various segments and regional differences. Understanding these differences can separate winners from losers.

- As refining margins are now compressed due to a depressed market, metal recycling, catalyst regeneration and catalyst rejuvenation are expected to play a larger role. Understanding these segments is important as they could significantly impact the demand for replacement catalysts.

Hydroprocessing is now the largest refining catalyst segment, with fierce competition. A clearer picture of the market is being asked for by catalyst producers and users.
Proposed Study: Scope & Methodology

- The highlight of this report will be TCGR's detailed assessment of the hydroprocessing catalyst market, with breakdown by major category and a market share assessment of the major players.

- In addition, TCGR will document the current benchmark or incumbent technologies for hydroprocessing and highlight the major areas where technology development has resulted in process improvements and market share shifts.

- This report will examine technology developments (both recently commercialized as well as future developments anticipated by commercial announcements and patent literature) across the full breadth of hydroprocessing and desulfurization (i.e., non-catalytic technologies) technologies.

- The outlook over the next five years for hydroprocessing catalysts will include a regional assessment, highlighting capacity expansions and market demand drivers by region.

This TCGR study will provide the fullest assessment of the hydroprocessing catalyst market and technologies available today.
Regulatory and Technology Changes have Impacted the Market

- Recent catalyst introductions as well as increased competition from newer entrants have shifted share.
- Regional capacity expansions due to regulatory changes have affected the market.
- This report will provide details on market size and growth by application, as well as market share from the main catalyst providers. Regional suppliers will be noted where applicable.

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This study will use TCGR's exclusive models and extensive network to determine market information.
Catalyst Advances - Highlights

Albemarle
- **Pulsar Catalyst**: Albemarle has developed a new CoMo catalyst in the Pulsar platform known as KF787. Advantages of KF787 include high tolerance toward nitrogen and high activity for desulfurization under low partial pressure of H$_2$. (Source: Catalyst Courier, 2019).

ART
- **SmART Catalyst System**: 548 DX is a new NiMo catalyst for use in the SmART catalyst system. 548 DX uses advanced chelate technology and alumina surface modification to provide high activity for HDS and HDN. (Source: Catalgram No. 122)

Haldor Topsoe
- **TK-6001 HySwell**: TK-6001 HySwell is a recently launched alumina-supported NiMo catalyst for ULSD applications. The catalyst maximizes activity for N removal with increased swell. Designed for severe feeds, it can be used with other feeds to obtain longer cycle life. (Source: ERTC, 2018).

Shell
- **CENTRA Type II**: Shell has introduced Centra GT DN-3655 as a high-performance catalyst for high-severity, FCC-pretreat applications. Nitrogen removal is enhanced, along with aromatics saturation, allowing for increased conversion in the FCC unit. (Source: Shell, 2019).

UOP
- **HC Catalysts**: UOP has developed several hydrocracking catalysts in its HC line for producing heavy naphtha for chemicals from diesel and VGO feeds. These catalysts can be combined with UOP’s reforming catalysts to produce aromatics.

Catalyst advancements are occurring for different applications. This report will also examine the patent literature to discern directions for research and development.
Technology Advances - Highlights

- **Haldor Topsoe has introduced their TK-26 TopTrap.** TK-26 is a macroporous trap designed to eliminate inorganic contaminants between the traps and smaller contaminants within the pores of the trap. Use of a particulate trap can avoid the necessity to skim the catalyst bed, a significant savings to the refiner.

- **Axens has recently introduced Equiflow internals for hydroprocessing reactors.** The use of advanced reactor internals can help refiners maintain a more homogeneous temperature before entering the lower catalyst bed. In some cases it is also possible to add more catalyst to the bed, extending unit cycle length.

- **KBR’s VCC process continues to make advances.** The VCC process offers alternative outlets for fuel oil, with high residue conversion, liquid yield, and feedstock flexibility. KBR claims reduced energy consumption, with up to 95% conversion under multiple configurations.

- **INVISTA expands the use of ExoS.** Originally developed by China Petroleum University-Beijing and Hebei Refining Technologies, ExoS uses a proprietary solvent to extract sulfur and aromatics from a naphtha stream, so that the low-sulfur raffinate can be sent directly to the blending pool, reducing the hydraulic load on the hydrotreater while retaining high-octane olefins for blending.

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While catalysts are the focus of this study, non-catalytic technology advances will be examined to determine potential threats as well as areas of potential synergy.
Commercial Advances - Highlights

- **ExxonMobil, Together with Albemarle, Creates the Galexia™ Platform, a Transformative Suite of Hydroprocessing Catalysts and Services – Oct. 2019**
  - The Galexia platform goes beyond traditional product offerings to help refiners optimize performance and efficiency by analyzing operations and identifying opportunities to extract additional value across the plant. As a result, customers will benefit from access to combined pretreat and dewaxing solutions through a single partner that provides both refinery owner/operator and catalyst experience.

- **Breakthrough Oil-to-Chemicals Process to be Commercialized Soon - Nov. 2019**
  - Aramco is working on several new technologies to convert crude oil to chemicals. In the McDermott tie-up, it is working with Chevron Lummus Global (CLG). McDermott’s (now Lummus Technologies) ethylene and CLG’s hydroprocessing processes are being combined with Aramco’s proprietary thermal COTC technology.

- **CNOOC Huizhou Petrochemicals Achieves China V Diesel Target with High Energy-Efficient DuPont IsoTherming® Hydrogenation Unit – Jan. 2019**
  - DuPont Clean Technologies announced the successful performance test of a 3.4 million tons/year IsoTherming® diesel hydrogenation (DHT) unit by CNOOC Huizhou Petrochemicals Co., Ltd. at its Huizhou refinery in Guangdong, China.

*Catalyst producers, refiners, and technology providers are all making progress, impacting market shares.*
Commercial Advances - Highlights

• Oregon’s Red Rock Biofuels Site Signs Contracts with Wood Group and Valmet – March 2019
  – The design will incorporate three technologies – gasification, Fischer-Tropsch and hydroprocessing – which will yield ASTM-approved fuels.

• INVISTA and Koch-Glitsch Expand Partnership – June 2019
  – INVISTA Performance Technologies (IPT) and Koch-Glitsch, affiliates of Koch Industries Inc., announced an expansion of their partnership to offer the proprietary ExoS™ technology to customers. The technology allows refineries to generate an olefin rich C6/C7 raffinate with less than 10 ppm sulfur that bypasses the FCC naphtha hydrotreater for direct blending.

• Honeywell Technology Selected for Largest Petrochemicals Project in China– Jan 2019
  – Honeywell announced that Zhejiang Petrochemical Co. Ltd. (ZPC) will use a range of process technology from Honeywell UOP for the second phase of an integrated refining and petrochemical complex in Zhoushan, Zhejiang Province. In the first phase of the project announced in 2017, ZPC selected Honeywell UOP technologies for hydroprocessing and heavy oil upgrading, and to make aromatics for plastic resins, films and fibers that are the basis for millions of products.

Commercialization of advanced processes will impact the competitive landscape with implications defining winners and losers.
Strategic Implications

• Although global refining capacity and fuel demand is expected to plateau, hydroprocessing catalyst demand is expected to remain one of the stronger growth areas for refining catalysts. It is a global, fragmented industry offering ample opportunity to process licensors, catalyst suppliers, engineering contractors, and operating companies.

• Fuels and lubricants demand is currently impacted due to the coronavirus pandemic, but the long-term trends due to vehicle electrification, environmental regulation, the global growth of the middle class, and oil-to-chemicals processing cannot be ignored. Marginal improvements in efficiency and cost will provide significant savings in terms of increased production, efficiency, and operational performance.

• TCGR and its Dialog Group®, which includes industry experts with significant experience, will provide an analysis of the key technological advancements. The completed study will provide valuable intelligence in a succinct format that can be shared with multiple members of your team in different roles (from R&D to operations to strategy).

• From newly announced commercial catalysts and process enhancements to cutting-edge research currently at the pilot-scale (or earlier), look to TCGR and this select-client study to provide the business and engineering knowledge needed by your company.

TCGR reports provide intelligence and analysis on the key technologies that cannot be found elsewhere in the industry.
Proposed Study Outline

I. Executive Summary
II. Background and Introduction
III. Hydroprocessing: Current & Future Status (2020-2030)
   A. Highlights: Regulatory Overview, Capacity Expansions, Regional Trends
   B. Current Environment: Demand Drivers
   C. Highlights: Catalyst Market Size & Growth
   D. Highlights: Catalyst Provider Market Share
IV. Recent Catalyst & Process Technology Developments (2018-2020)
   A. Resid
   B. FCC Pretreat
   C. Middle Distillates
   D. Dewaxing
   E. Other Process Technology Advances
V. Regional Outlook
VI. Conclusions
   A. Competitive Landscape
   B. Strategic Takeaways

“Charter” subscribers (those who sign up prior to launch) will be able to shape the content of the report including specific companies, technologies and other factors to be included...

The report will be delivered in PowerPoint format and consist of 50-75 slides.
TCGR Experience & Qualifications

- TCGR will leverage its access to refining industry experts that have nearly 40 years’ industry experience via its Dialog Group® (a mixture of commercial & technical) in completing this study.
- TCGR will utilize publicly available and in-house information to complete the deliverables as well as patent searches, technical literature reviews, and in-field interviews with catalyst manufacturers and process licensors.
- TCGR Dialog Group® experts have deep experience in the required technology from a process technology, catalyst technology & application perspective.

The Catalyst Group Resources has covered related technical process advancements in similar reports; those can be seen here on our website. Other advancements are also tracked as part of our Catalytic Advances Program and CO₂ Capture and Conversion Program.

The Dialog Group® is a renowned group of industry-leading experts that provide key intelligence and analysis of the chemical industries.
Please enter our order for Hydroprocessing Catalysts and Processes: Recent Advances in Technology and Impacts on the Competitive Landscape to be completed within 10-12 weeks of launch as follows:

____ Hydroprocessing Catalysts and Processes: Recent Advances in Technology and Impacts on the Competitive Landscape, as a “charter” subscriber (i.e., prior to study launch) for US$16,500 (US$19,500 after study launch) to be delivered as a PDF file containing PowerPoint slides, which includes use across locations (i.e. site license).

____ We are subscribers to The Intelligence Report: Business Shifts in the Global Catalytic Process Industries 2019-2025 (May 2020) and are entitled to the $1,000 discount off the subscription rate.

In signing this order form, our company agrees to hold this report confidential and not make it available to subsidiaries unless a controlling interest (>50%) exists.

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Dedicated to monitoring and analyzing technical and commercial developments in catalysis as they apply to the global refining, petrochemical, fine/specialty chemical, pharmaceutical, polymer/elastomer and environmental industries.

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