

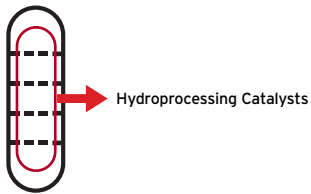


Our World of Cats: Acinonyx jubatus. A fully grown cheetah with a body length of between 1.1 to 1.6 meters and a weight between 45 to 65 kg can reach speeds in excess of 100 km/h and can easily outrun any animal over short distances.

Topsøe Refinery Catalysts



Hydroprocessing Catalysts



The demand for cleaner transportation fuels continues to drive the refining business. Although there are different routes available to meet environmental legislation limits, hydroprocessing is the dominant solution for the industry.

Hydroprocessing Catalysts

Hydroprocessing, the catalytic upgrading of oil products, is a highly and increasingly important process in any refinery. Currently, we are experiencing further tightening of refinery product specifications: e.g. product sulphur level requirements down to 30-50 wt ppm or less for diesel and gasoline. This is a far cry from a few years ago where much higher sulphur levels were acceptable. Today, the markets for high sulphur products are disappearing and burning of high sulphur fuel is becoming environmentally unacceptable.

With a background in catalysis and catalytic processes spanning more than half a century, Topsøe is committed to produce catalysts with a high and uniform quality. In addition, we strive to grow while continually improving our products in order to meet current, as well as future, needs of our customers.

Background

Topsøe are not strangers to the world of low sulphur products. In fact, in order to protect steam reforming catalyst in the production of hydrogen or synthesis

gas, we have for decades been removing sulphur down to 0.01 wt ppm.

This development and marketing work of hydroprocessing catalysts expanded in the 1980s to include all refinery applications. During the past 5 years Topsøe's hydroprocessing research has expanded dramatically as we have doubled the number of pilot plants and increased research staffing by 50%.

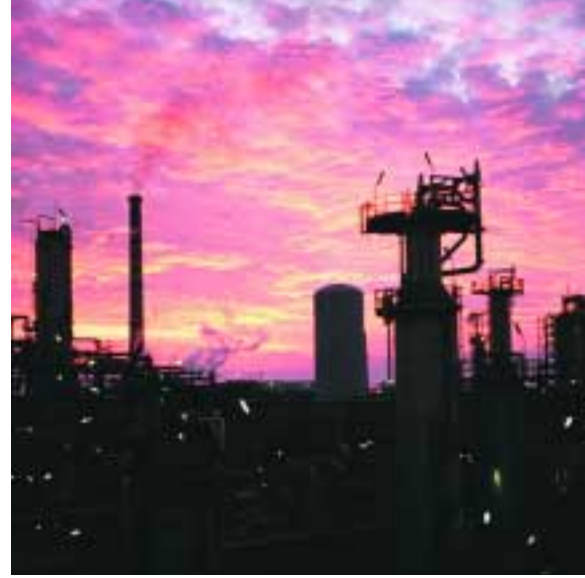
Topsøe hydroprocessing research efforts include the following groups:

- * fundamental surface science
- * catalyst development
- * product scale-up
- * process development
- * reaction kinetics

Due to the important role played by the alumina carrier in hydroprocessing catalysts, Topsøe have integrated backward and we now produce our own alumina. This gives us the capability and the advantage to tailor and optimize the catalyst carrier for each member of our catalyst family.



Strong R&D

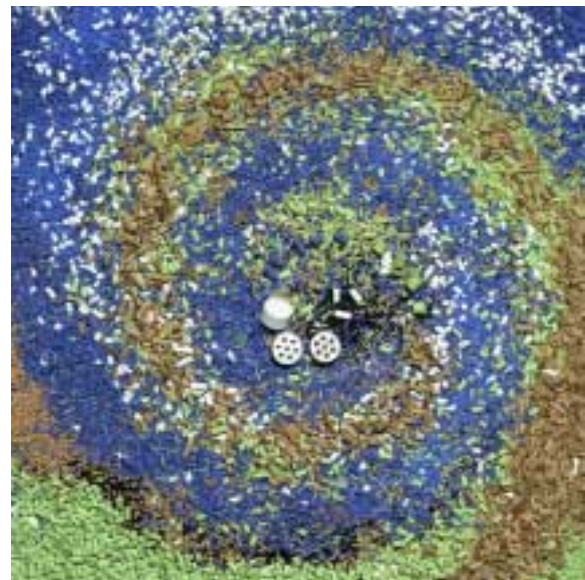


We have the technology and know-how to make high quality products. With a strong background and ongoing commitment to research and development in all aspects of hydroprocessing and catalysis, we are well equipped to support the refining industry, meeting the future challenges and achieving process objectives.

Applications

Many years of development have brought Topsøe to a leading position in a number of fields. The most important hydroprocessing catalysts and services that are offered to the refining industry cover the following applications:

- * Deep HDS of Diesel
- * Hydrocracker Pretreatment
- * Hydrocracking
- * FCC Pretreatment
- * Aromatic Reduction
- * Kerosene and Naphtha Hydroprocessing
- * Resid Upgrading
- * Pressure Drop Control



Commitment

Our Hydroprocessing Catalysts - the TK Series

From Naphtha to Resid

For the refining industry, Topsøe have developed a wide range of hydroprocessing catalysts; in general referred to as the TK series. These catalysts are designed for sulphur reduction, nitrogen reduction and metals removal. But also for aromatics saturation, olefin reduction and cracking/conversion in fractions ranging from naphtha to resid. The TK catalyst family is divided into four main series dependent upon the application area:

400/500 Series - Distillates

The 400/500 series cover catalysts ranging from traditional naphtha processing catalysts to catalysts developed for ultra-deep desulphurization of diesel and pretreatment catalysts in VGO service.

Naphtha Processing

Besides traditional naphtha processing catalysts, Topsøe offer speciality catalysts for naphtha hydrotreaters limited in cycle length by silica poisoning.

Diesel Production

Topsøe has available a range of catalysts for diesel production:

- * CoMo or NiMo catalysts for meeting the stringent European diesel specifications
- * CoMo catalysts with an activity targeted for producing diesel in the 350-500 wt ppm sulphur range

Hydroprocessing of Heavier Feedstocks

Hydroprocessing of heavier feedstocks can be optimized with:

- * our NiMo catalysts for hydrocracker pretreatment or other applications where hydrodenitrogenation is critical
- * our catalysts for FCC pretreatment and VGO desulphurization

Low to Medium Severity Operations

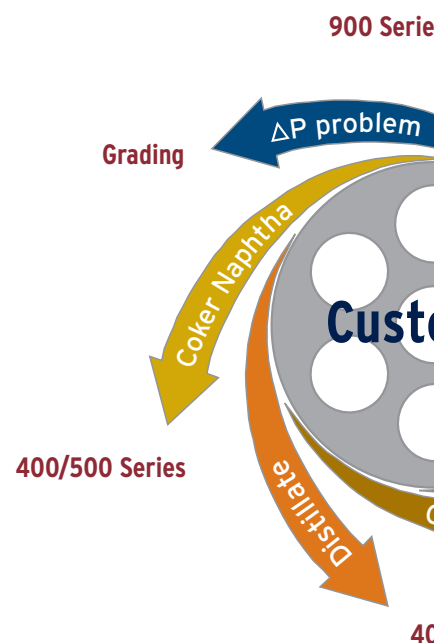
Furthermore, traditional catalysts are available for low to medium severity operations as:

- * catalytic reformer pretreatment
- * jet fuel production
- * hydrodesulphurization and hydrodenitrogenation of straight-run or cracked gas oils

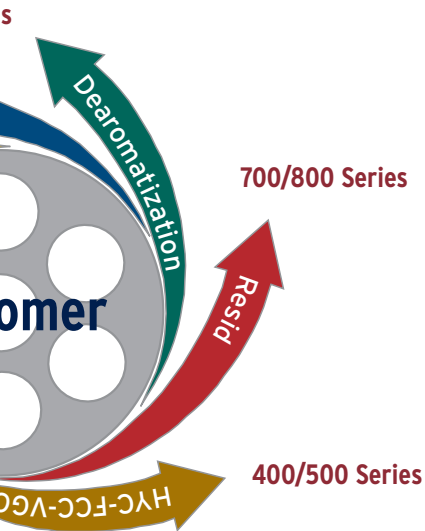
700 Series - Fixed Bed Resid

Fixed bed resid hydroprocessing catalysts are found in the 700 series and can be divided into three categories:

- * Hydrodemetallization catalysts (HDM)
- * Transition catalysts (HDM/HDS)
- * Hydrodesulphurization catalysts (HDS)



Catalysts for All Applic



400/500 Series

The hydrodemetallization catalysts are characterized by having high metal removal activity, high tolerance for metals deposition and moderate activity for sulphur removal.

The transition-type catalysts have properties in between those of the hydrodemetallization and hydrodesulphurization catalysts with respect to activity and tolerance for metals.

The hydrodesulphurization catalysts have high activity for sulphur removal and moderate tolerance for deposition of metals.

Depending on operating conditions, product requirements and unit constraints, the optimal quantities of each type of catalyst are determined to achieve maximum run length.

800 Series - Ebullating Bed Resid

Topsøe supply a number of catalysts for ebullating bed resid hydroprocessing. The catalysts are specially designed for meeting the following requirements:

- * conversion
- * low sludge formation
- * demetallization
- * operational stability

900 Series - Saturation and Hydrocracking

This series comprises catalysts designed for restructuring of the hydrogen-carbon configuration by saturation or cracking.

Our noble metal catalysts for production of low aromatic diesel can with advantage be used together with the 500 series catalysts in existing or new units.

Catalysts for hydrocracking of VGO feedstocks are other products in this series. Hydrocracking is a new growth area for Topsøe and the first catalyst introduced will target hydrocrackers for maximum distillate production.



7-hole tablet



ring



three-lobed



quad-lobed



cylinder

Catalyst Shapes

ations

Topsøe Solutions

Topsøe Grading Approach

Fouling of fixed-bed catalytic reactors is a well-known phenomenon in the industry. Irrespective of whether the fouling is caused by solids in the feed or by reaction products, the resulting gradual reduction of bed void fraction is inevitably accompanied by an increase in bed or reactor pressure drop. Historically, the use of "scale traps" or trash baskets at the top of the reactor bed addressed this type of problem.

Although trash baskets provided relief in some units, the pressure drop problem still persisted. The Topsøe approach was to engineer new high-void topping materials to replace spheres and, more importantly, alter hydroprocessing catalyst shape to the form of a ring. This technology approach provides high-void fraction exactly where it is needed at the inlet of the catalyst bed.

Our solution not only provides the opportunity to grade the catalyst bed by particle size, shape and void, but also by catalytic activity. We have more than twenty years experience in this field and, in many cases, we have been able to utilize a graded catalyst bed without

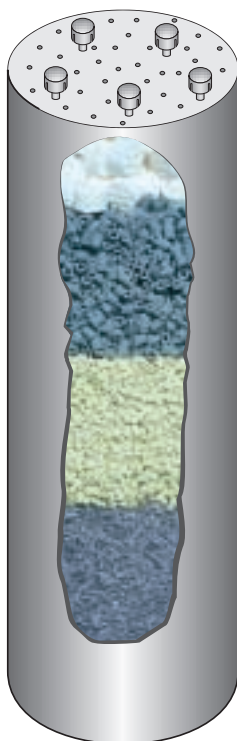
the use of trash baskets. This is in itself important, because trash baskets actually contribute negatively to distribution of reactants within the catalyst bed.

We at Topsøe have a whole family of close to 20 high-void configuration catalyst products, which can be applied singly or in combination, to address any pressure drop-limited operation with or without trash baskets.

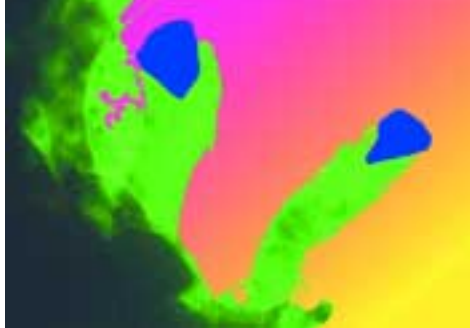
Technology

Topsøe is a known catalyst supplier and we have through the years seen the importance of efficient and uniform flow through the catalyst loaded reactor. Based on this understanding, we have developed high efficiency liquid distributor trays for use in hydroprocessing reactors. The hydroprocessing reactor, with its distributors and other internals, catalyst and catalyst bed configurations, is the heart of the upgrading process. Topsøe have developed proprietary designs for liquid distributors, redistributors and internals for quench. The distributor design features outstanding liquid distribution, resulting in efficient catalyst usage.

Topsøe's proven, graded loading illustrated with the use of (from top to bottom) inert topping material, two sizes of ring-shaped catalyst and three lobes as bulk catalyst.



Customized



In connection with the design of reactor internals, Topsøe have expanded into licensing and engineering of hydroprocessing technology resulting in capability to supply:

- * process know-how
- * process engineering
- * detailed engineering

Technical Service

Besides extensive efforts in R&D, a competent customer service is an important element in the guarantee of quality. Topsøe's technical service programme depends upon on-going exchange of information between the client and us to provide clients with the latest relevant information. Based on half a century's experience Topsøe have an extensive service program available to our catalyst users:

- * Topsøe representatives visit you regularly for general discussions of catalysts and operation.
- * In connection with loading and start-up or other cases where special technical assistance is

required, our experienced service engineers are available. Custom-made procedures are included when needed.

- * During the catalyst lifetime, Topsøe offer their service by evaluating the catalyst performance based on actual operating data collected by the refinery. In reports forwarded regularly, catalyst activity and remaining lifetime is described, thus helping in planning catalyst change-out.

We hope that this brochure has aroused interest in our catalysts and we would be pleased to pay you a visit to further elaborate on the advantages of using our catalysts and services.



All Topsøe catalysts have been developed in-house and are manufactured in Topsøe plants in Frederikssund, Denmark (left) or Houston, USA (right). The manufacturing quality system is certified to comply with the ISO 9002 Standard.

After Sales Service

Refinery Services

Topsøe's worldwide services to the refining industry are based on a fundamental understanding of heterogeneous catalysis, including catalysts, process technologies and engineering services.

Topsøe's unique integrated approach has resulted in profitable solutions in the areas of:

- * FCC Pretreatment
- * Hydrocracker Pretreatment
- * Hydrocracking
- * Deep HDS of Diesel
- * Diesel Dearomatization
- * Resid Upgrading
- * Kero/Naphtha Hydroprocessing
- * Pressure Drop Control
- * Reactor Design
- * Reactor Flow Distribution
- * Hydrogen Production
- * Sulphur Management
- * Spent Acid Regeneration
- * Alkylation
- * Flue/Waste Gas Treatment

Visit www.haldortopsøe.com for more information.

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The information and recommendations have been prepared by Topsøe specialists having a thorough knowledge of the catalysts. However, any operation instructions should be considered to be of a general nature and we cannot assume any liability for upsets or damage of the customer's plants or personnel. Nothing herein is to be construed as recommending any practice or any product in violation of any patent, law or regulation.

