HALDOR TOPSØE

Customized grading solutions for your feedstock

Grading - your weapon against **pressure drop** build-up and **catalyst poisons**

Inert and active grading solutions for more run days and fewer catalyst replacements

topsoe.com

Tailor-made grading solutions

Match your catalyst grading to your feedstock for minimum pressure drop build-up and maximum demetallization

As today's opportunity crudes and heavier feedstocks become more economically viable, the oil fractions you refine are posing new challenges. Creating the optimal grading solution for your individual feedstock is essential to minimize pressure drop build-up, increase metals pick-up, and reduce downtime and catalyst replacement.

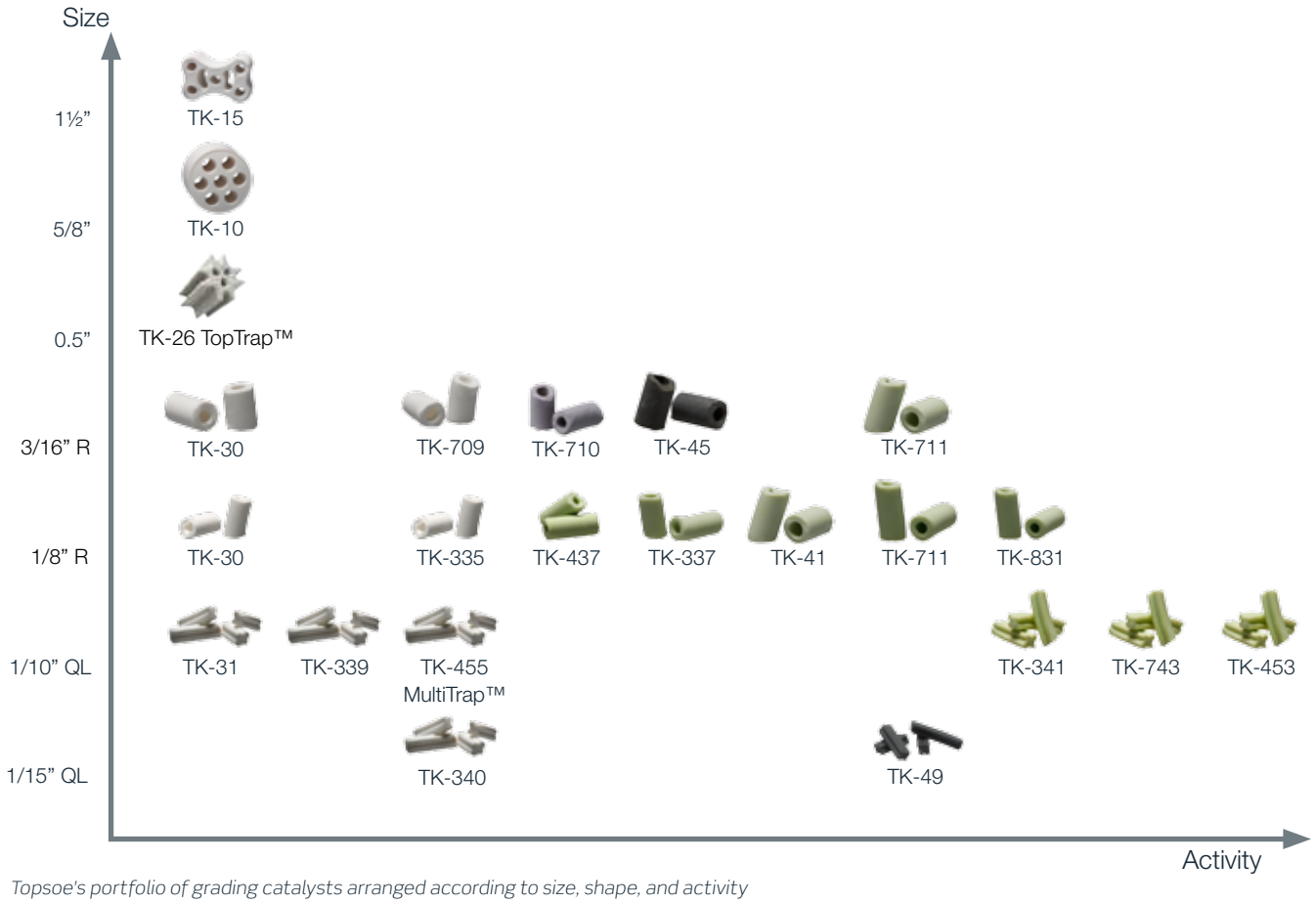
An overlooked advantage
The importance of catalyst grading is often underestimated when evaluating the overall efficiency of a unit. With focus only on the main catalysts, you may be unaware of the dramatic difference a well-designed grading solution offers.

Different feedstocks need different solutions
All oil fractions are unique, with their own profile of inorganic particulates and dissolved contaminants. A specifically matched Topsoe grading solution delivers the most efficient hydrogenation activity, traps poisons and metals, and converts coke precursors. As a result, your high-active main catalyst lasts longer, requiring fewer turnarounds, giving you more productive run days.

One size does **not** fit all

Controlling activity for optimal performance
In hydroprocessing, refiners are often faced with pressure drop build-up in the catalyst bed that shortens the cycle length. Our graded bed solutions are individually designed to maximize the cycle length by ensuring that the pressure drop across the reactor is not limiting the throughput until the activity of the main bed catalysts has reached End-Of-Run (EOR). By integrating the effect of inert and active grading layers, you obtain a smooth transition in activity.

More choices, better match
Creating the optimal match for your specific feed requires a wide range of grading products. At Topsoe, we have the industry's widest range of sizes, shapes, and variety of inert and active grading solutions with different pore sizes, pore volumes, surface areas, activities, and affinity for specific poisons. This means we can design the perfect match for your specific feedstock – or even blends of feeds.



Topsoe's portfolio of grading catalysts arranged according to size, shape, and activity

TK-15

Inert grading designed with hold-down capabilities to prevent catalyst milling.

TK-26 TopTrap™

Inert grading uniquely designed to pick up iron scale and other contaminants.

3/16" ring catalyst

Large void fraction grading to remove contaminants with a low activity to control the conversion of reactive compounds to minimize coke formation.

1/8" ring catalyst

Large void fraction grading to remove contaminants with a medium activity to control the conversion of reactive compounds to minimize coke formation.

1/10" QL catalyst

Medium void fraction grading to remove small contaminants with a medium-high activity to facilitate the transition to the main catalyst.

1/20" TL bulk catalyst

High-activity main catalyst to meet product specifications and maximize the cycle length.

Control pressure drop

Maximize trapping capacity by managing catalyst void fractions
By using grading materials of various shapes and sizes to create a loading with a differentiated filtering effect, you will trap the largest inorganic feedstock contaminants in the upper layers and the smaller particles in the lower layers.

Because our grading products are designed with different void fractions and different void sizes, the volume of each catalyst layer is created to retain the various sizes of inorganic particulates and reaction products in the graded bed system throughout the life cycle of the hydrotreating unit.

Avoid catalyst milling with a high-density hold-down layer
Catalyst milling sometimes occurs, particularly in naphtha units, when the gas rate is high, and no gas liquid distributor is installed. It is also seen in units, where the inlet diffuser is poorly designed.

To avoid catalyst milling, we have specifically designed TK-15: Its optimized shape and high density deliver an effective hold-down function and a high void fraction.

Prevent crust formation by grading catalytic activity
Crust formation usually occurs at the top of the catalyst bed, causing increased pressure drop, flow maldistribution, and difficulties during catalyst unloading. It is often caused by “over-activity” of the catalyst.

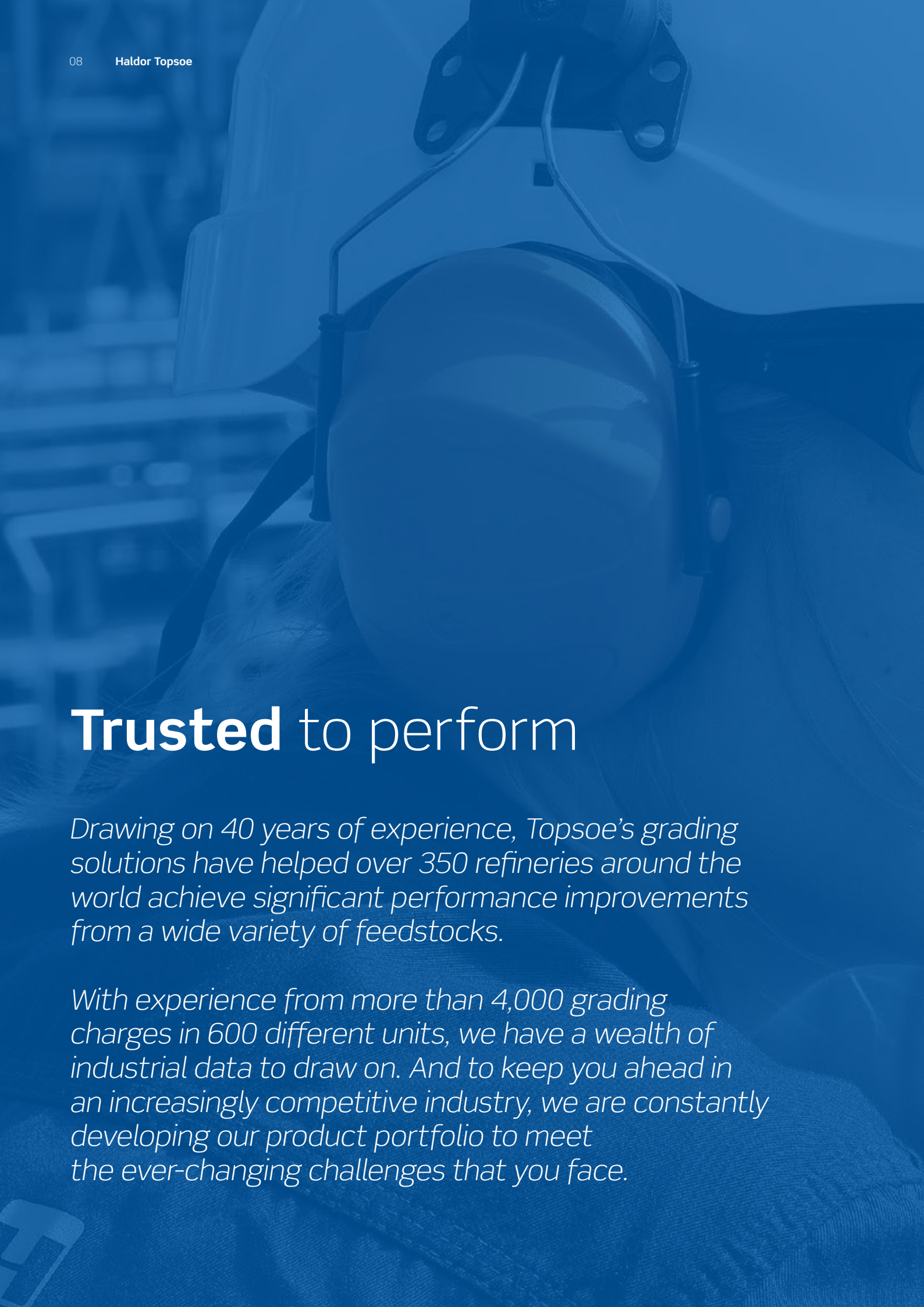
By grading catalytic activity, you can incrementally increase activity from the inert topping down to the main bed to control the level of catalytic reaction and avoid crust formation.

Pressure drop **build-up**

Cause:
- Deposition of solid feed particulates
- Crust formation
- Catalyst milling
- Corrosion products

Effect:
- Channeling or bypassing
- High radial temperature spread
- Operating difficulties
- Maldistribution

CUSTOMIZED
GRADING SOLUTION



Trusted to perform

Drawing on 40 years of experience, Topsoe's grading solutions have helped over 350 refineries around the world achieve significant performance improvements from a wide variety of feedstocks.

With experience from more than 4,000 grading charges in 600 different units, we have a wealth of industrial data to draw on. And to keep you ahead in an increasingly competitive industry, we are constantly developing our product portfolio to meet the ever-changing challenges that you face.

Trap particulates

Using a macroporous grading layer

Some feedstocks contain corrosion products not trapped by your feed filters. These can cause severe pressure drop build-up in your catalyst bed.

TK-26 TopTrap™ is an inert grading material designed to pick up iron scale and other inorganic contaminants. As opposed to other particulate traps in the market,

TK-26 TopTrap™ contains a large internal pore volume which picks up contaminants without adding to the bed pressure drop.

Thanks to its optimized shape, large void fraction, and macroporous material, TK-26 TopTrap™ traps even very small solid particles.

Solid particulates in feedstock:

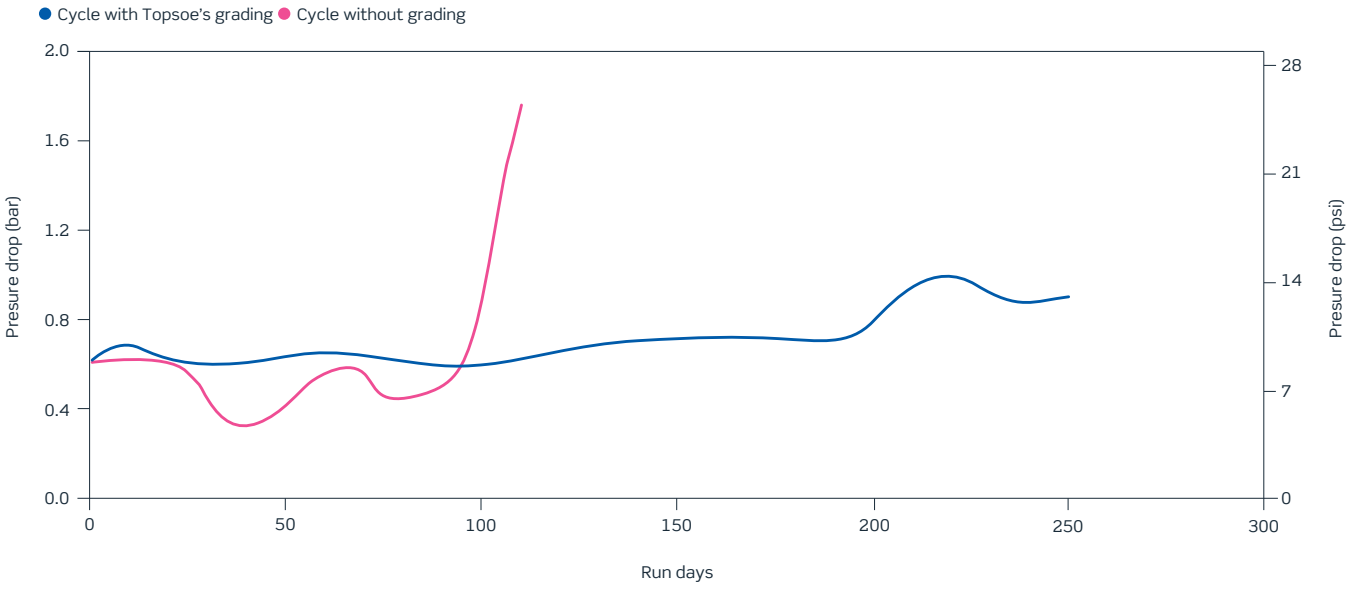
- Iron scale (iron oxides/sulfides)
- Coke fines
- Catalyst fines or dust
- Large carbonaceous scales
- Sediment
- Salts (sodium, potassium, calcium, etc.)

TK-26 TopTrap™

Commercial experience and know-how are keys to optimal performance

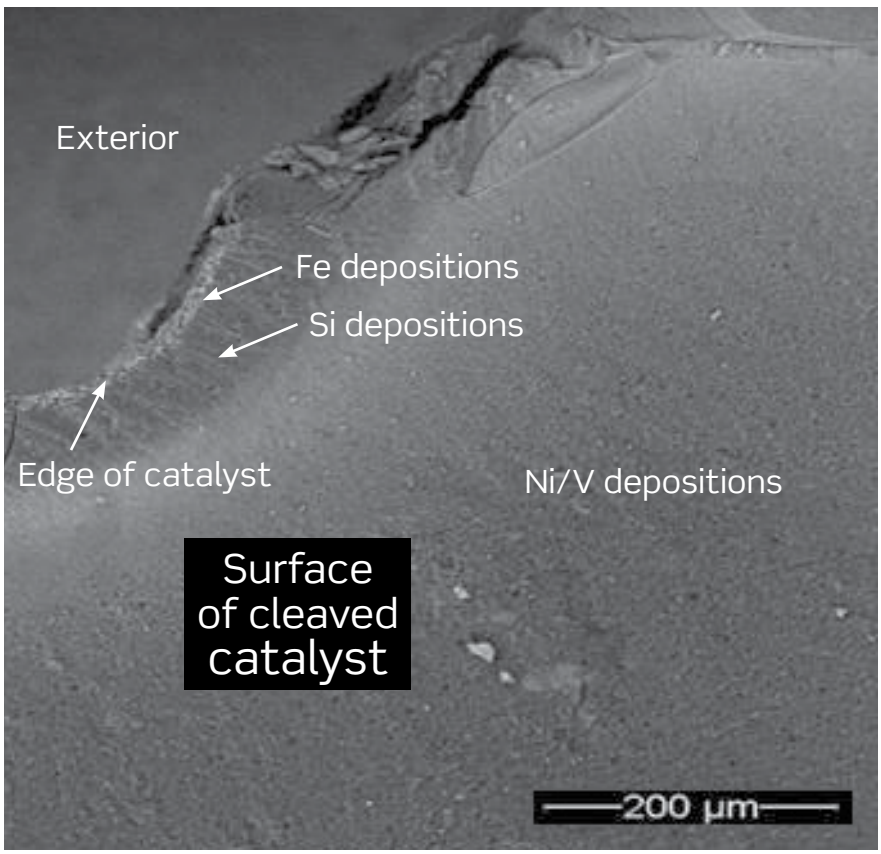
This naphtha hydrotreater was experiencing severe fouling of the catalyst bed. This was caused by carbonaceous material spalling from the heater and heat exchangers. The installation of a graded bed solution removed this bottleneck and extended the cycle length. By avoiding three unit turnarounds, including replacement catalyst cost savings, the substantial financial impact at this refinery was significant.

Pressure drop development over time in a naphtha hydrotreater



Reduce metal deposition on main catalysts by **customizing pore sizes** in grading

Certain metal compounds, such as organic nickel and vanadium, penetrate into the pores of hydrotreating catalysts, where they rapidly react to form metal sulfides, plugging the pore mouth and decreasing catalyst life



Thanks to their high hydrodemetallization (HDM) activity and high tolerance for metals deposition, our ring products trap metals inside the pore system while simultaneously retaining interstitial material in the void fraction. By using the different pore sizes of the grading products – with large pores for metal deposition in the top of the first catalyst bed – the lifetime of your main catalyst can be significantly extended.

SEM image of cross section of a cleaved spent demetallization catalyst shows the location of deposited contaminants

Stop contaminants and poisons with specialty **traps and guards**

Today's crude oils have become more diverse and can contain compounds of arsenic, silicon, and phosphorous, which are severe catalyst poisons that significantly deactivate the catalyst. Trapping these feed contaminants is essential to the protection and efficiency of your main catalyst throughout the cycle.

Our specialty guards, such as TK-49, which features a high arsenic uptake, TK-453 for high silicon feeds or TK-455 MultiTrap™ for a general high level of contaminants, can be tailored to your specific unit for maximum catalyst protection.

Catalyst contaminants and poisons:

- Coke (hard or soft)
- Vanadium and nickel
- Iron
- Silicon
- Arsenic
- Sodium
- Phosphorus
- Mercury, calcium, lead, and other heavy metals

Example of graded bed solution		Pellet size	Pore size	Void fraction	Activity
	TK-10 (inert)	5/8"	Very large	55%	None
	TK-26 TopTrap™	1/2"	Very large	61%	None
	TK-711	3/16" rings	Large	53%	Low
	TK-831	1/8" rings	Large to medium	53%	Low to medium
	TK-743	1/10" qudralobes	Medium	48%	Medium
	TK-578 BRIM®	1/20" trilobes	Smaller	47%	High

Additional solutions

Maximize the potential of your grading solution with a wide range of related technologies

SCALE CATCHERS

Prevent pressure drop and maldistribution with Topsoe's scale catchers

When your feedstock contains large amounts of fines, scales, inorganic matter or corrosion products, we provide scale catchers for installation above the top distributor tray. The scale catcher collects particles before they reach the top bed. This reduces the plugging of the catalyst bed, which otherwise leads to maldistribution and increased pressure drop. Installing a scale catcher can also reduce the amount of top grading material needed and thus increase the active catalyst volume.

DISTRIBUTION TRAYS

Fully utilize your main catalyst with Topsoe's distribution trays

You're aware that protecting against pressure drop build-up is essential for the efficient utilization of your bulk catalyst. However, it is equally important to have a uniform distribution of feed and hydrogen over the entire cross section of the catalyst bed.

See **www.topsoe.com/reactor-internals-overview** for more information about our industry leading internals.

Why **partner** with Topsoe?

Because solutions that are designed to work together, simply work better

When you choose a Topsoe grading solution, we will use our expertise to guide you to get the optimal performance out of your unit.

By considering all the factors involved, we can help you design a solution ideally suited to your individual feedstock. And following an analysis of your spent catalyst, agglomerates and deposits, operating history, feed type, feed rate, treat gas rate, unit upsets, and unscheduled shutdowns, we can arrive at a solution tailor-made for your unit.

When you partner with Topsoe, you team up with the world's leading technology licensor and supplier of hydroprocessing catalysts. You also partner up with a company that takes a uniquely holistic approach to your refinery and your business.

Topsoe is a world leader in catalysis and surface science. We are committed to helping our customers achieve optimal performance. We enable our customers to get the most out of their processes and products, using the least possible energy and resources, in the most responsible way. This focus on our customers' performance, backed by our reputation for reliability, makes sure we add the most value to our customers and the world.

Get in touch today
topsoe.com/processes/pressure-drop-control

Get in touch today
topsoe.com/processes/catalyst-poison-removal

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