Guard bed

Protect your catalyst from foulants

Catalyst bed fouling is present to some degree in all hydrotreating units. But when fouling begins to affect hydrotreater cycle length, it is time to take action. Albemarle has a complete portfolio of guard bed catalysts to protect valuable downstream catalyst and maximize unit cycle length. More importantly, we have the expertise to analyze the situation in your reactor and apply effective bed grading to solve your fouling problems.

The foulants that cause problems in your hydrotreater come from several different sources; the primary foulants are in the feed, or are generated in the equipment upstream of the hydrotreater or even in the hydrotreater itself. These foulants fall into three different categories:

- particulates of widely varying sizes and compositions
- reactive molecules such as olefins and oxygenates
- inorganic poisons such as arsenic, nickel, iron, vanadium, and silicon.

Particulates

Particulates usually enter a hydrotreater with the feedstock. For years, scale baskets were used to trap such particulates but they have several problems:

- They are only effective at removing relatively large scale particles.
- They are likely to cause maldistribution.
- They extend shutdown time during catalyst change outs, as it is time-consuming to remove and install them.

The smaller particulates that cause most of the pressure drop problems, such as coke fines, FCC catalyst and iron sulfide, pass right through the openings in the baskets. These small particulates then flow through the inert balls in a traditional grading scheme and collect on top of the catalyst bed. It does not take long for these particulates to reduce the pathways available for liquid and gas to flow, which results in increased pressure drop. What happens when particulates deposit in the catalyst bed? First, the void fraction of the catalyst bed is reduced by the volume of the particulate and, second, pathways through the catalyst bed are fully or partially plugged. Over time, one of these mechanisms causes the pressure drop to increase, which possibly shortens the cycle length. The solution is a graded system of guard bed catalysts (Table 1) to balance the deposition and storage of particulates at different layers in the catalyst bed (and the removal of the scale baskets).

Reactive feedstock

Fouling due to reactive feedstocks is another problem commonly seen in hydrotreating reactors. Hydrogen-deficient feedstocks containing olefins or oxygenates are most susceptible to this type of pressure drop buildup. When these molecules come in contact with a high-activity catalyst, they react rapidly and exothermically to create reactive free radicals. These very reactive sites may combine with hydrogen or with a neighboring molecule. When these reactive molecules react

	KG 55	KG 1	KF 542-9R/5R	KF 542-5Q
Function	Hold down	Iron trap	High void active support	Active support
Composition	Alumina	NiMo/alumina	NiCoMo/alumina	NiMo/alumina
Shape	Pentaring	Sphere	Ring	Quadralobe
Diameter (mm)	19	5	5R: 6 x 3 9R: 9 x 3.5	5.4
Void fraction, %	62	35	50	45
Av. length (mm)	9.5	–	6 / 8	10
Sock density (kg/m^3)	900	950	600 / 550	480

Table 1: Guard bed catalysts for control of particulates.

with each other, large polymeric molecules with high viscosity, such as gums and varnishes, can form. These molecules can plug the catalyst bed or, over time, condense to form coke. The solution is to hydrogenate the feed slowly by staging catalyst activity (Table 2). The effect of this activity grading is to spread out the zone of hydrogenation. This enables the exotherm to be spread out and decreases the potential for a localized hydrogen-deficient atmosphere that might lead to increased coking and polymerization.

Inorganic poisons

A third type of fouling occurs when inorganic elements such as nickel, vanadium, arsenic and silica enter the hydrotreater. These metals are poisons to hydroprocessing catalysts and cause deactivation and, in some cases, control cycle length. They are not always measurable in the feedstock and often require the analysis of spent catalyst to confirm their presence. Albemarle has developed special hydrotreating catalysts that offer high activity and capacity for trapping these elements (Table 2). Installing these catalysts on top of traditional hydrotreating catalysts provides protection from the harmful effects of inorganic poisons.

Each of these three types of foulant presents a unique processing challenge. Albemarle offers a wide range of catalysts and expertise to provide the best possible solution.

For more information on this or other Albemarle products and technologies, please contact your Albemarle representative.

	KF 647	KF 648	KF 841	KG 6
Function	Hydrogenation, Demet	Hydrogenation, Demet	Hydrogenation, Demet	Arsenic trap
Removes	Ni, V, As, Si	Ni, V	Ni, V	Ni, V, As
Composition	NiMo	NiMo	NiMo	NiMo
Shape	Quadralobe	Quadralobe	Quadralobe/cylinder	Quadralobe
Diameter (mm)	1.3 / 2.6	1.3 / 2.6	1.3 / 2.1 / 2.6	2.6
Av. length (mm)	3.5 / 5.0	3.5 / 5.0	3.5 / 5.0	5.0
Sock density (kg/m^3)	510	510	625 – 695	530

Table 2: Guard bed catalysts for control of fouling caused by reactive feeds and poisons.

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