Question 14: Have you successfully dumped, screened and reloaded spent hydrotreating or hydrocracking catalyst without regeneration during a turnaround? Can you share any best practices during this operation to avoid problems on restart?

Kaspar Vogt (Albemarle)

We have experience with dumping, screening and reloading hydrotreating and hydrocracking catalyst. Here are two typical times this occurs:

1. After a full cycle – In these cases spent catalyst has been reused, without regeneration or reactivation, in a lower severity application for which the remaining activity is sufficient.

2. Early in the cycle – If at the start of the cycle the pressure drop is very high (due to, for example, broken inert balls or when significant maldistribution in the catalyst bed is measured), it can make sense to unload, screen and reload the catalyst.

Although it has been performed successfully, more often it has led to more pressure drop problems.

Best practices:

First, the safety aspects of handling a pyrophoric or self-heating material MUST be addressed. We believe it is critical to use proper detectors (SOX, H2S, etc.) and have proper emergency procedures and properly trained personnel in place before executing the catalyst dumping, screening and reloading process.

It is also important to dry the catalyst before unloading. Dust and small particles stick to the oily catalyst during dumping and screening and are not removed until liquid washing of the catalyst surface. This can lead to fouling of the catalyst bed and reactor internal trays and create excessive pressure drop at restart. H2 stripping to remove liquid between particles before unloading the catalyst is highly recommended.

It is important to split the different catalysts layers by either vacuum unloading guard and grading layers from the top or size screening after dumping in order to be able to reload a properly designed catalyst system.

If the screening is done on-site, we recommend the use of a relatively large screen to ensure broken fragments and small particles are rejected. This will prevent differential pressure issues with the reloaded material.

Providers of onsite screening services are typically limited in available equipment compared to offsite specialized companies. It is important to have adequate equipment to determine the particle size

distribution of the screened catalyst. Evaluating the entire length distribution and not just the average length is a critical step for preventing excess pressure drop. It is also advisable to conduct a pressure drop test on the pilot scale to fully evaluate the effectiveness of the screening and predict the corresponding pressure drop for the screened catalyst load. Often some additional fresh guard, grading and main bed catalyst is needed to ensure a complete reactor fill.

Martin Gonzalez (BP)

Dump, screen, and re-load of spent hydrotreating catalyst are usually unattractive for various reasons. To minimize oxygen exposure, catalyst loading companies can usually keep screening equipment under inert atmosphere. Vacuuming catalyst rather than dumping can help to simplify screening by avoiding a mix of many sizes of material. Modern vacuuming equipment can also result in less breakage of catalyst, compared to gravity unloading.

Tim Lewer (Shell)

The practice of unloading, screening, and reloading still-viable hydrotreating or hydrocracking catalysts during turnarounds and without off-site regeneration has been done successfully – with catalyst vendor on-site support or project management. However, there are numerous factors involved in the decision to do so, especially with the advent of stacked bed catalyst schemes with multiple layers of materials either equal in size or too close in size to screen successfully using typical mobile equipment. For single bed hydrotreating reactors, which often contain a majority of same type/size catalysts, the task is more manageable but still a complex undertaking.

Extensive pre-planning is paramount to the success of this type of operation. There are a number of “best practices” that will help to ensure a successful outcome after the decision is made to re-load unregenerated catalysts versus loading fresh catalysts:

1) Research and hire a catalyst handling contractor that possesses the latest catalyst vacuuming/N2 recirculation, dust control, and screening equipment. All equipment used in such an endeavor must have the capability of being effectively purged with nitrogen.

2) Vacuuming support/grading layers from the tops and bottoms of beds and keeping these materials separate from main bed catalysts will allow for quicker screening rates and cause fewer losses due to breakage.

3) Ensure that there are excellent QA/QC measures in place, such as container labeling (where in the bed material is from, pre- and post-screened tare and net weights of all containers, etc.) and strict, written tracking and segregation of unscreened and screened containers.

4) It is imperative to establish clear guidelines prior to the start of the project to ascertain what properties need to be met in order for screened catalysts to be acceptable for reloading. These guidelines should include acceptable levels of fines, average catalyst length, and acceptable levels of cross contamination

between different catalyst types and/or sizes. Screen sizes and opening shapes (slotted or square), controlled rates and constant oversight by personnel aware of the established guidelines and desired outcomes of the screening operation are critical to a successful end product.

5) Consult with your catalyst supplier to arrange for lab testing of unloaded materials to ascertain viability of the catalyst and be prepared to perform average length testing on-site (pre and post screening) to ensure catalyst to be reloaded will meet preset guidelines and properties and perform as desired. Catalyst and support losses due to breakage and attrition must be anticipated with assurance that ample make-up quantities of all materials are in ready supply and available as needed. It is also wise to have a “Plan B” prepared in the event that results are less than desired.

6) Pre-plan for sufficient acreage to accommodate a high traffic operation with requirements for staging of empty, unloaded (full) containers, weighing (pre- and post-screening), and staging of materials for reloading. Screening areas should also have weather protection constructed prior to the start of screening operations.

Greg Rosinski (ART)

Spent hydroprocessing catalyst is pyrophoric due to small particulates of iron sulfide scale that are present, so care must be taken to minimize the exposure of the spent catalyst to air. In addition, spent sulfided catalyst has some coke on it and it will slowly oxidize in air. If the spent catalyst is exposed to air, it will slowly heat up, and if iron sulfide is present, it will combust which may ignite the coke or other residual hydrocarbon on the catalyst.

The key to this procedure is to have competent and experienced personnel performing the required tasks. The reactor must be thoroughly swept of hydrocarbons, and a nitrogen purge should be kept on the reactor at all times. During the unloading, the screener and the dump nozzle should be continuously purged. The containers that will hold the catalyst during unloading should be blanketed with nitrogen or have dry ice placed inside until ready for loading. The containers should not be open to the atmosphere. The loading should be done under inert conditions with experienced personnel.

When preparing your procedure, make sure to involve your refinery EH&S group and give careful consideration to all aspects or the process to ensure you take all the precautions necessary.

Fouling

Operations

Process

Reactor Vessel

Safety

Start-up

Year

2011