Question 14: Do you have experience with CCR heel catalyst contaminating the circulating inventory during operation? How can this contamination be prevented?

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The most common situation that results in the contamination of a catalyst load with heel catalyst occurs during a turnaround as a result of accidentally reloading drums of used catalyst that contain heel catalyst back into the reactors. This type of contamination occurs in one or two units every year. However, it is rare for a CCR Platforming™ catalyst inventory to be contaminated with heel catalyst during normal operation. Honeywell UOP is only aware of a small number of instances (about five) where contamination of the circulating catalyst inventory by heel catalyst occurred during normal operation. In these cases, no definitive cause of the contamination was identified.

UOP has identified several scenarios that could lead to heel catalyst contamination during normal operation. These include for the formation of metal catalyzed coke (MCC), reactor internals damage, and abnormal catalyst collector operation.

If MCC masses begin to grow at the bottom of a reactor, they may displace heel catalyst in the bottom head of that reactor and push it into the circulating catalyst. This could cause a slow trickle of heel catalyst to mix into the flowing catalyst contaminating the entire inventory. An event such as this is likely to end with the catalyst flow path in the reactor being completely blocked by the coke mass and the unit having to be shutdown. The risk of MCC formation can be significantly reduced with injection of small amounts of sulfur into the reformer feed and proper fired-heater operation.

Reactor internals damage–in particular, scallop or expander ring damage–could lead to heel catalyst contamination. If one of these components is knocked loose, it could sink to the bottom of the reactor and disturb the heel catalyst in the bottom head of the reactor. There may also be some non-flowing catalyst between the scallops near the reactor wall which could be disturbed if the scallop is dislodged, bent, or crushed flat against the reactor wall. This type of internals damage is best prevented by following prescribed heat-up and cool-down rates, proper use of the UOP Cooldown Mode System (if available), and good turnaround inspection and repair practices.

Abnormal catalyst collector operation typically occurs in response to a catalyst flow issue. The first abnormal operation that can pose a risk of disturbing heel catalyst is “jet loading” of the spent catalyst lock hopper in an atmospheric CCR Platforming™ regenerator. Jet loading is a procedure that is sometimes used to reestablish catalyst flow through plugged external catalyst transfer lines in older CCR units. During the jet loading operation, the heel catalyst at the bottom of the last reactor could be disturbed as the catalyst and gas rush into the external catalyst transfer pipes.

The other abnormal catalyst collector operation that could pose a risk for heel catalyst disturbance is reverse nitrogen purging to unplug a bridged catalyst collector outlet nozzle. Occasionally, if a refiner believes there may be bridging or an obstruction at the catalyst collector outlet nozzle, a reverse flow of nitrogen is directed up the catalyst withdrawal line to try to break up the obstruction. This reverse nitrogen flow might disturb the heel catalyst at the bottom of the catalyst bed in the reactor above.

The keys to preventing the need for the abnormal catalyst collector operation examples above are proper catalyst collector operation (temperature and flow) and monitoring, good insulation with proper weather shielding, and maintaining a low catalyst-fines make.

There are also means of contaminating the circulating catalyst bed with highly coked catalyst without actually disturbing the heel catalyst. Examples of this are pinning, reactor internals damage, and temporary catalyst flow path obstructions. These examples do not actually disturb the heel catalyst. Instead, sections of the circulating catalyst bed are slowed down or stopped. This longer residence time leads to higher coke levels on this portion of the catalyst, thereby creating a heterogeneous coke profile in the spent catalyst. This circumstance may initially be perceived as heel catalyst, but the peak carbon levels are expected to be much lower unless the obstruction in flow persisted for a long time.

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