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## **Question 15: How do you remove the CCR heel catalyst from the unit during an outage and under what atmospheric conditions?**

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Catalyst unloading from a CCR Platforming™ reactor stack is done under nitrogen atmosphere using the normal catalyst transfer line under the catalyst collector. Typically, the last 10 to 15% of the catalyst unloaded will be contaminated with heel catalyst. This percentage may be higher if there has been damage to internals or blockage of catalyst transfer lines.

The catalyst disposal nozzles (off-center on the bottom head) must not be used if the catalyst will be reloaded into the unit, because any portion of the catalyst unloaded from these nozzles is likely to be contaminated with heel catalyst. As the name suggests, the catalyst disposal nozzles should only be used if the catalyst will not be reused and will only be sent for metals recovery.

Heel catalysts are pills that do not move with the normal circulation of catalyst; they remain in the reactors (at the bottom of each reactor and between the scallops) and develop a very high level of coke (up to 50 wt%). Average heel catalyst volume for downflow reactors is about 9% but about 7% for up flow reactors due to improved flow paths. Because the coke level is so high, heel catalyst cannot be loaded back into the unit as the regeneration tower is not able to safely burn that level of coke. Drums or bins of normal, unloaded catalyst that is contaminated with heel catalyst are detectable by visual inspection and can be confirmed by lab testing of average coke content must be segregated and not loaded back into the unit.

Not all heel catalyst will be removed from the reactor stack during the first phase of the unloading. When the circulating catalyst is unloaded by gravity through the normal flow path, some heel catalyst will be found at the bottom of each reactor. In addition to being very high in coke, it may also contain hydrocarbons or trace pyrophoric iron sulphide scale. Therefore, this catalyst must be handled carefully and removed from the reactors before they can be made safe for inspection and maintenance.

The remaining heel catalyst is generally removed by vacuum. Care should be taken during this operation due to the risk of self-ignition. Honeywell UOP recommends that the reactors be kept under inert conditions until the heel catalyst is removed, even though this requires inert personnel entry. Only once all reactors are free of catalyst and the reactor section has been completely isolated from the other sections of the unit should air be admitted to the reactors following the refiner's standard safety procedures.

Some refiners chose to introduce air prior to entry for removal of residual heel catalyst because of the inherent risks entailed with inert vessel entry. They consider that the risk of self-ignition is lower than the risk associated with inert entry, since instances of self-ignition are rare. UOP advises against this as consequences of ignition can be significant; but if this choice is made, then we suggest that an ample draft of air be established through the reactor stack in order to facilitate the removal of residual hydrogen and hydrocarbon vapour and to oxidize any pyrophoric material before any personnel enter the reactors.

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2016