Catalyst Handling
Inert Entry Hazard Mitigation

Disclaimer

This document merely provides an overview of controls used to mitigate the life-threatening hazards associated with confined space entry into oxygen-deficient reactors during catalyst un/loading operations. It is not an exhaustive list.

Background

Some catalysts require un/loading under inert conditions to exclude air and avoid pyrophoric ignition, catalyst damage or polythionic stress corrosion cracking of stainless steel reactor internals. Nitrogen is most commonly used for this purpose but its use poses an extreme risk of asphyxiation to personnel. Sadly, there have been numerous fatalities by asphyxiation during inert-entry activities in the refining industry even when the work is being carried out by specialist inert-entry contractors. Therefore, inert-entry should only be used if other techniques such as wet dumping or spent catalyst passivation are deemed unsuitable and senior management endorse that decision. A thorough job safety analysis (JSA) should be carried out on each individual inert-entry job and all permitry must be rigorously checked.

Contractor Selection

The contractor selection process must ensure the contractor uses only highly trained personnel and carefully maintained and tested life support equipment (including lockable "clam-shell" type helmets requiring assistance for removal and incorporating integral breathing apparatus and communications systems). The contractor must also provide video surveillance equipment, emergency rescue equipment and adhere to rigorously-enforced procedures. Additional special conditions apply for inert entry into multi-bed reactors and catalyst beds susceptible to "crusting".

Preparation

After the reactor to be unloaded has been swept with process gas, cooled below 38 °C (100 °F), depressured and drained it should be positively isolated from all hydrogen and hydrocarbon sources. All access and egress points around the reactor should be barricaded with warning signs posted to alert personnel to the use of nitrogen purge and potential presence of a life-threatening hazard (oxygen-deficient atmosphere). An access control system should be set up to log all personnel entering/leaving the barricaded area. All personnel entering the barricaded area should be wearing a personal gas detector providing an audible and visible alarm if the oxygen concentration falls below 19%. The reactor should then be purged to flare with the nitrogen from the refinery nitrogen header until the atmosphere in the reactor is below 10% of the lower explosive limit (LEL). Once the atmosphere is below 10% LEL, the nitrogen purge should be switched to a dedicated supply (to avoid risk of contamination) and the purge rate trimmed to maintain a slight positive pressure in the reactor while the flare connection is positively isolated and the manway or top elbow is removed in preparation for vessel entry. When not in use, manways should be fully covered to minimise venting of nitrogen and avoid ingress of air. If the top nozzle also serves as a manway, its temporary cover should be strong enough to prevent anyone accidentally falling through.

When testing to verify that the atmosphere in the reactor is below 10% LEL, be sure to use a flammable gas detector ("explosimeter") that is capable of measuring gas in an inert atmosphere (many portable gas detectors used on refineries work by catalytic oxidation and therefore give false readings in oxygen-deficient atmospheres). An air-line respirator (preferred) or self-contained breathing apparatus (SCBA) should be worn during gas sampling (unless the sample point is design as a closed loop system) or when working near to open manholes or vent points during nitrogen purging (temporary enclosures placed over open nozzles or manways for weather protection can inadvertently create an oxygen-deficient atmosphere). Refinery standard respiratory devices are only suitable for working in unconfined spaces. Lockable clam-shell type helmets connected to a full life support system via armoured umbilical cords must be used for confined space entry in oxygen-deficient atmospheres. Once entry into the reactor has been accomplished, the atmosphere inside the reactor should be continuously monitored for LEL, oxygen (O_2), hydrogen sulphide (H_2S) and carbon monoxide (CO) using an appropriately placed fixed gas detector unit.