

Ni Passivator by Ken Peccatiello

Ni, as a dehydrogenation element, generates Hydrogen and coke. There are several types of Ni passivators. The first are ultra-fine particle metals added to the feed injection system, employing a fluid such as diesel or LCCO as the carrier medium. These ultra-fine particle metals are Antimony (Sb) and Bismuth (Bi). These metals work by permanently attaching to the Ni. The Sb or Bi that have formed this attachment reduces the surface area of the Ni exposed to the process, reducing the H₂/coke forming tendencies. In other words, the Sb or Bi then retard the dehydrogenation effect of the Ni, by reducing the exposed surface area of the Ni to the process flow.

Generally, Sb has a lay-down efficiency of ~65% to 75% and the same efficiency as to passivation. Generally, Bi has a lay-down efficiency of ~30% to 40% and the same efficiency as to passivation. So, you can see that from an "effectiveness" point of view, Sb would be the material of choice.

The balance of the undeposited Sb or Bi is transported with the feed to the Main Fractionator Bottoms where it has been observed to increase the coking & fouling tendencies of the oil in the bottoms circuit. The use of Sb has also been observed to increase NO_x emissions from the regenerator. A good target for Sb-to-Ni is a ratio of 0.35 (example 700 ppm Sb for 2000 ppm Ni).

The second type of Ni passivator is Sulphur (S). This is a temporary passivator. It also binds to the Ni reducing H₂&coke formation; also reducing the available surface area of the Ni. However, the S is burned from the Ni within the regenerator, thus "reactivating" the Ni. The most effective way/manner to introduce the S is thru the use of a S containing gas (sour refinery fuel gas or FCC off-gas) as lift gas, instead of steam at the bottom of the Wye or J bends (Wye or J bends depend on the FCC Licensor technology).

Given some of the process issues associated with Sb use (increased NO_x emissions & increased Main Fractionator Bottoms circuit coking tendencies), I recommend that you consider/review the use of FCC catalyst Ni passivation technologies first. Catalytic passivation technologies are the Third method of passivation. They work by forming a Ni Aluminate which traps and "submerges" the Ni; again, reducing the surface area available for dehydrogenation. These catalytic trapping technologies are fairly effective. At very elevated Ni levels (greater than 3500 ppm Ni), a combination of the catalytic trapping technology & another passivation technology (either Sb or S) is used.

The duration and the magnitude of the expected Ni excursion would help dictate the type of passivation to employ. A short duration & high magnitude excursion would dictate the use of either Sb or S passivation technology depending on availability and timing. A long duration & moderate to high magnitude would dictate catalytic passivation.

A long duration & high to severe magnitude would dictate a combination of catalytic and either Sb or S passivation.

I normally target as a control methodology the Hydrogen to Methane (H₂/C₁) ratio. The H₂/C₁ is easily/quickly derived at the refinery (no-to-little turn-around time as compared to E-cat catalyst analyses). A H₂/C₁ ratio of 0.85 to 0.9 (depending on the Wet-Gas Compressor, WGC, constraints) is a good target.

I hope this information is helpful. Please let me know if you require additional information or if you have additional questions.

Ken

Kenneth A Peccatiello
Ken@CatCracking.com
Principal Consultant

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