Question 49: What experience have you had in identifying the incompatibility of feeds to a Hydroprocessing Unit? Can these feeds create pressure drop issues? What kind of feeds/compounds are typically incompatible? What test(s) do you suggest? Are there any solutions such as catalyst loading modifications to eliminate typical issues?

Dorian Rauschning (Criterion Catalysts & Technologies)

Feed stock incompatibility has typically been observed in VGO hydroprocessing and is related to the precipitation of asphaltenes.

Asphaltenes are large hydrocarbon molecules consisting of condensed heterocyclic and aromatic rings with hetero atoms (e.g. S, N, Ni, V, etc.). These structures become less soluble as the oil undergoes hydrogenation and side chain cracking resulting in asphaltene precipitation. The precise point of precipitation within a catalyst bed depends on the solubility characteristics of the asphaltenic oil and severity of hydroprocessing. The precipitated asphaltenes can generate coke, deactivate catalyst and may cause pressure drop due to the coke bridging catalyst pellets. Pressure drop growth has been observed in the top portion of the reactor but also further down a reactor where higher temperatures are experienced.

The asphaltene molecules can exist in the higher boiling point ranges (975+F) of VGO, coker derived products and DAO. Crude source can also influence the magnitude of ashphaltenes.

Controlling the feed asphaltene content is the best solution to mitigate risk of accelerated catalyst coking/deactivation and the risk of pressure drop growth. A safe region is typically less than 0.05 wt%. Regular monitoring of asphaltenes is also recommended. One measurement is the n-Heptane Insoluble test - ASTM D3279.

Also, potential incompatibilities can be experienced when blending different crudes – especially more paraffinic crudes like typically encountered in light tight oils being blended with synthetic derived crudes. Refiners processing LTO’s have been careful to control the blend ratios of the various crude types.

Further risk mitigation is obtained by loading catalyst systems within the top bed to selectively treat asphaltenes. In addition, graded bed technologies can be used in the top bed to mitigate pressure dropgrowth. Their activity gradient and void fraction, in conjunction with the selective asphaltene hydrogenation catalyst, can be used to control the asphaltene hydrogenation reaction rate and distribute any precipitated asphaltenes over high void volume grading to mitigate coke forming pressure drop growth. Should dP growth be observed in lower beds presumably due to asphaltene precipitation, thenmodifying the reactor profile may be a short term solution to mitigate dP growth but reduction of asphaltenes and / or changing crude blend ratios are the best solutions.

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