Question 37: What is the impact of CO (carbon monoxide) and/or CO2 (carbon dioxide) on noble metal catalyst performance?

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CO and CO2are poisons for noble metal catalysts, with CO being a very strong poison. Contamination level as low as 50 to 100 ppm can result in significant and permanent loss of activity. CO should be limited to less than 10 ppm. In our experience, units which achieve long cycles (10 years plus) typically have CO levels less than 5 ppm.

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It is known that CO can inhibit noble-metal active sites by competitive coordination, there by effectively preventing hydro carbons from adsorbing and reacting in aromatic saturation or isomerization reactions, for example. CO and/ or CO2 can be introduced as impurities in the treat gas or, in some cases, when using natural gas as stripper gas. The effect is temporary and disappears when the impurities are removed from the feed. CO2 is relatively inert and only has a minor effect on reactions; but in the presence of hydrogen, the CO2 will be partially converted to CO in a water /gas shift reaction (Eq.1).

Eq.1: CO2 + H2 ? CO + H2O

It is also well known that transition metals, like Pd (palladium) or Pt (platinum), can facilitate the reduction of carbon monoxide into methane and water Eq.2: Methanation).

Eq. 2: CO + 3H2 ? CH4 + H2O

The methanation reaction can provide an “outlet” for the CO that would otherwise inhibit the intended reactions. Methane and water do not inhibit reactions. The extent of these reactions and the surface coverage of CO depend critically on the catalyst activity and the process conditions, which means that the degree of CO inhibition is a function of these parameters. In particular, the reaction temperature has a high impact on both the adsorption strength and on the methanation rate constant. Haldor Topsoe has performed pilot plant tests that illustrate this calculation. In one test, the addition of 100 ppmv (parts per million by volume) CO to the treat gas resulted in a hydro dearomatization activity only one-third of that when using pure hydrogen as treat gas. In another test done at higher temperature, the effect of up to140 ppmv CO was negligible and a diesel product with less than 0.5wt% total aromatic content could be produced. In this case, complete conversion of CO to methane was observed. The process conditions that enable high noble metal catalyst activity to depend on catalyst composition and feedstock. HaldorTopsoe has a wide portfolio of noble metal catalysts and extensive process design experience that enable optimal performance, even in cases where impurities such as CO make life hard for the catalysts.

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