



Titania Catalyst Placement in a Claus SRU Converter – Part II

Part I of the discussion of this topic in The Contactor explored the ramifications of different decisions about where to place Titania Catalyst in a Claus type SRU. The configuration in Part I used steam type reheaters, and it was found that the best overall placement for Titania catalyst was indeed in the first bed. This is in complete agreement with industry practice. However, steam reheaters are not the only type of reheat that is available for use in an SRU. Several other types include direct- and indirect- fired reheaters. In this edition of The Contactor, we will revisit Titania catalyst placement in a Claus SRU when acid-gas-fired reheaters are used. Because this acid gas combustion product is being introduced after the first catalytic stage, perhaps it is more beneficial to place Titania in bed 2 or 3 to catch the COS and CS₂ that is being bypassed?

Unlike steam-heated and indirect-fired reheaters, direct-firing, like the acid-gas-fired ones we are looking at here, burns a fuel source and mixes the hot combustion product directly into the process stream to increase the process stream's temperature. The fuel source is likely to be a small slipstream from the main acid gas flow to the Thermal Reactor, and therefore it will contain some level of hydrocarbons. Although this is an excellent way to heat the process stream to relatively high temperatures, it also creates a number of potential problems. One of them is the additional COS and CS₂ introduced by each fired heater associated with direct firing using CO₂- or hydrocarbon-contaminated acid gas as the fuel source. A direct fired second or third stage heater introduces more COS and CS₂ after the initial conversion stage(s) where titania catalyst has already been used to virtually eliminate COS and CS₂.

If the SRU is equipped with downstream tail gas treating (including a hydrogenation reactor), the production of COS and CS₂ may not be such a big issue because these sulphur compounds have another opportunity to be converted in the hydrogenation reactor before the tail gas is vented to atmosphere. But all SRUs are not equipped with a tail gas treating unit and then extra sulphur compounds in the stack gas can be fatal to meeting emissions regulations. What is the possible outcome

when this acid gas is used as fuel in direct-fired heaters before the second and third converters?

Case Study: Introduction

This case uses an SRU configuration identical to the one used in Part I with the indirect steam reheaters replaced by direct-fired acid-gas reheaters. This scheme takes a small portion of the original acid gas and redirects it to the burners at the reheaters where it is combusted and mixed with the process gas coming from Condensers 1, 2, and 3 as shown in Figure 1. The Solver (S) blocks shown are designed to adjust the flow of acid gas to the burners to meet a specific temperature in the mixed outlet to the converters. These temperatures are shown in Figure 1 below.

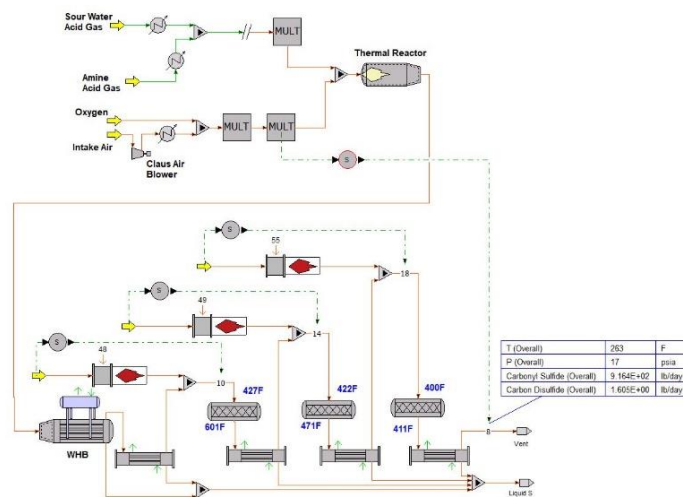


Figure 1: PFD of 3 Bed SRU with 3 AG Reheaters

Just as we did in Part I of this topical discussion, we will be looking at Titania placement in the top of the first bed, the bottom of bed one, the bottom of bed two, and the bottom of bed three. We will be assessing the overall COS and CS₂ destruction as well as the equilibrium conversion of COS, CS₂, and Claus conversion for the converter vessel containing Titania.

Acid gas fired reheaters combust acid gas and if that acid gas contains any hydrocarbons or CO₂, then CS₂ and COS will form as per the reaction set detailed in Part I.

Case Study

The set of simulations was chosen to elucidate how the formation of COS and CS₂ from fuel gas containing hydrocarbon (specifically 0.4%, 0.8% and 1.6% methane) leads to a methane-dependent sulphur leak from the converters to the stack and how placement of titania catalyst can mitigate sulphur emissions. The study assumes that the SRU that does not have a tail gas treating unit. The most common TGTU configuration includes a hydrogenation reactor whose purpose is to convert CS₂, COS and SO₂ into H₂S which is then recovered in an amine unit and recycled back to the front end of the SRU. Hydrogenation greatly eliminates the effect of hydrocarbons on sulphur emissions from the stack. So, our interest is in answering the questions 1) what is the main contaminant resulting from hydrocarbon (methane) in the fuel gas, and 2) where should the titania catalyst bed be placed to minimize sulphur leak caused by the presence of hydrocarbons?

The simulation results are shown in Figures 2 and 3 for COS and CS₂, respectively. First of all, it is quite evident that very little sulphur appears in the stack gas as CS₂. The base case (no titania catalyst bed at all) shows that almost 5% of the total sulphur entering the stack is COS almost regardless of the amount of methane in the fuel gas.

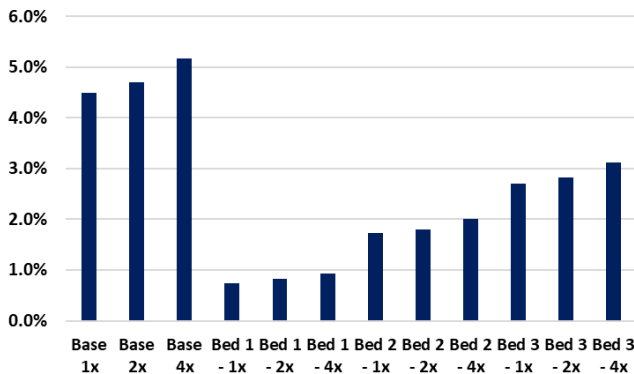


Figure 2 Effect of Titania Placement and Methane Content of the Fuel Gas on Percentage COS in Stack Gas

The amine acid gas feed to the SRU (and reheaters) is 6.4% CO₂ and nearly 0.5% methane at the base level. Methane at 2 and 4 times this level was examined. It is apparent that most of the COS is not sourced from methane, but rather from CO₂. CO₂ is, however, a combustion product of hydrocarbons, so COS formation from hydrocarbons is an indirect pathway which is why only

marginal increases to COS were seen at increasing levels of contamination. The more fuel gas is used for preheating, the greater the COS (and CS₂) in the stack gas, but it is only marginally more. Again, methane in the fuel gas is only an indirect source of COS in the stack gas.

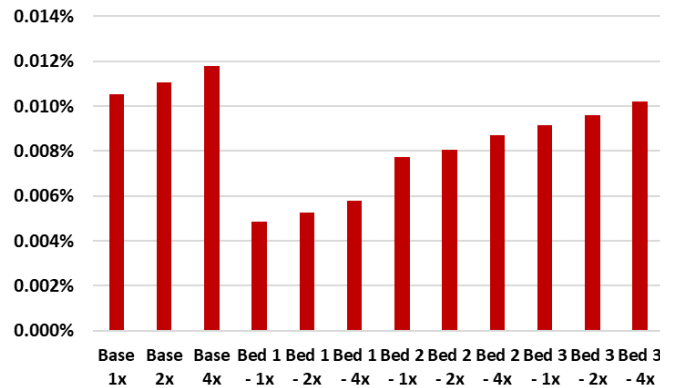


Figure 3 Effect of Titania Placement and Methane Content of the Fuel Gas on Percentage CS₂ in Stack Gas

COS and CS₂ are reduced the most when the titania bed is placed in the first reactor, even to the extent that putting titania in the last reactor is almost equivalent to not using titania at all when it comes to CS₂ mitigation.

To answer our original questions, the main carbon containing contaminant is COS and it originates with CO₂, not hydrocarbons directly. Carbon Disulphide is comparatively a very minor contaminant that hardly figures into the discussion at all. The difference between titania bed placement probably has more to do with reactor temperatures than anything else. Higher reactor temperatures lead to greater COS and CS₂ reduction just by virtue of reaction kinetics and the first reactor in the series is the hottest of the three by far.

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