

ST-101

It is well known that in ammonia, methanol and hydrogen plants the sulphur content in the hydrocarbon feed should be reduced to the ppb range to achieve long lifetime of the downstream catalysts. However, in some plants due to unfavourable process conditions, the desired minimum sulphur level cannot be achieved. In these cases a final purification step is needed.

Sulphur Guard for Final Purification

Topsøe's ST-101 is developed for final purification of sulphur in hydrocarbon feedstocks, but it could be used also for purification of other process streams. ST-101 is based on the combined action of copper and zinc oxide with a very high surface area and will remove hydrogen sulphide as well as organic sulphur compounds which may pass through the conventional desulphurisation section. ST-101 will pick-up sulphur even in the absence of hydrogen recycle.

ST-101 should be placed as a bottom layer in the final sulphur absorption reactor. The optimum temperature range is 150-360°C (300-680°F) but it can operate down to 80°C (175°F).

The sulphur pick-up capacity of ST-101 depends on operating conditions and sulphur level in the feedstock. When cleaning up the ppb levels of sulphur leaking through the zinc oxide, the absorption capacity is 1 wt %, but if exposed to several ppm of sulphur, ST-101 will be saturated to a level of as much as 18 wt %.

At certain conditions as much as 100 ppb of hydrogen sulphide may leak through hot zinc oxide due to the equilibrium conditions. When ST-101 is placed downstream the zinc oxide absorbent, the sulphur leakage can be reduced to a few ppb.

Typical Application Areas of ST-101

Process layout and feed gas composition will in existing units have an impact on the sulphur leakage from the desulphurisation section. ST-101 is typically the solution in the following cases:

Desulphurisation Section

Operating at Low Temperatures

At low temperatures, the hydrogenation catalyst may not convert all organic sulphur compounds into hydrogen sulphide. Whereas mercaptans and



disulphides are relatively easy to hydrogenate, mono-sulphides and thiophenes are much less reactive and will not be picked up by the zinc oxide.

Only Zinc Oxide Used to Purify Feed

The desulphurisation section in some plants only consists of sulphur absorption reactor(s) loaded with zinc oxide. The common reason for this situation is that the plant has been designed to operate on natural gas with no organic sulphur compounds.

Many of these plants have later seen the composition of the natural gas changing to include organic sulphur compounds. Even if the temperature of the zinc oxide absorbents is as high as 400°C, some organic sulphur compounds may still pass partly or totally through the bed.



The Hydrocarbon Feed Contains Carbon Dioxide

The hydrocarbon feed often contains carbon dioxide either as a native constituent of natural gas or in methanol plants as a part of the recycle hydrogen stream. For the desulphurisation system the presence of carbon dioxide in the feed gas is a distinct drawback. It will react with the hydrogen in the recycle gas over the hydrogenation catalyst according to the following equation:



The steam formed by the above reaction will influence the equilibrium concentration of hydrogen sulphide over the zinc oxide according to:



The increased steam level will result in a higher equilibrium concentration of hydrogen sulphide exiting the zinc oxide reactor.

Variation in Sulphur Content in Feed

When the normal sulphur level in the feedstock is very low (below 1 ppm), the hydrogenation catalyst is not kept in its fully sulphided state and as a result, the catalyst activity will be low. If the feedstock is changed to one with high organic sulphur content or if the

organic sulphur level in the feed is fluctuating, the hydrogenation catalyst may temporarily have insufficient activity to cope with the higher content of organic sulphur. This will result in occasional breakthrough of organic sulphur, until the hydrogenation catalyst has regained activity by picking up sulphur.

All the above cases will lead to a situation where the downstream catalysts are subject to an increased concentration of sulphur in the process gas. If the zinc oxide absorbent is fresh, the problem will not appear during the initial operating period; i.e. not before the chemisorption capacity of the zinc oxide is used up. In time, however, the effects of the increased sulphur load will become apparent and the advantages of using ST-101 for final purification of the feedstock will become evident.

Activation of ST-101

ST-101 is activated by reducing CuO to Cu. This is done by adding a small amount of hydrogen to a carrier gas passing through the catalyst. Since the reduction is exothermic, the hydrogen addition should be controlled carefully to maintain proper control of the reduction temperatures. Typically the carrier gas is the normal feed, but in case the feed gas contains more than 1-2% of hydrogen, circulating nitrogen is the preferred carrier gas.

CATALYST CONFIGURATION IN A DESULPHURISATION SYSTEM

