JM ProcessWise webinar

Ammonia synthesis

February 2021

Questions and answers

Please note that a number of similar and repeated questions have been combined.

Q1. What *is the normal life of **KATALCO** 74 series catalyst?*

A1. The catalyst is very stable in operation, with most charges installed for well over 10 years and some operating for over 20 years. Quite often the reason for the replacement is not to do with the activity of the catalyst, which is relatively stable after 10 years, but inspection requirements for the ammonia synthesis vessel or cartridge, or mechanical issues within the converter.

Q2. *What causes end of life for ammonia syn catalyst - it seems to last a long time, why would I consider changing it? How do I work out when it is best to change it?*

A2. As covered in the previous answer, quite often catalyst changeout is dictated by mechanical issues encountered within the converter or inspection requirements of the basket or vessel. The decision of when best to change it is either dictated by these factors, a revamp project, or a desire to increase efficiency or production rate by utilising the extra activity shown by the catalyst in the first 5-10 years.

Q3. *Can **KATALCO** 74-1 be used in any technology plant? My plant is a Chemico one the loop pressure is currently around 160Bar, we have a S-300 converter*

A3. Yes, the **KATALCO** 74 series catalysts can be used in place of iron based catalysts, being suitable for operation at a wide range of converter designs, temperatures and pressures. If the converter had axial beds where pressure drop becomes a factor in design, various size grades of the catalyst are available to adapt to this.

Q4. *What does tKIS stand for?*

A4. tkIS stands for thyssenkrupp Industrial Solutions, formerly known as Uhde, one of the main designers of ammonia plants.

Q5. *How sensitive is the catalyst to poisons (oxides, oil, etc.)?*

A5. It is no more susceptible to poisons and process upsets than a standard magnetite catalyst.

Q6. *What do we do with amm syn catalyst at the end of life if we change it?*

A6. As the catalyst is mainly iron oxide based the discharged catalyst is of limited value in terms of metal extraction and recycling and the discharge process and subsequent catalyst oxidation means that it is not suitable for reuse/regeneration. Johnson Matthey can help to advise on appropriate disposal plans for your region/country

Q7. *What happened if this catalyst comes into contact with an important quantity of water? And can it recover its previous activity?*

A7. Water is a poison to the catalyst; at elevated levels it causes localised oxidation and re-reduction of the catalyst, resulting in sintering and an associated loss in activity. At substantially higher levels, potentially associated with a process upset or cooler leak, a greater level of oxidation occurs and it becomes necessary to carry out a controlled reduction of the catalyst to regain activity. If the reduction is carried out in a stable and controlled way it is possible to regain much of the activity of the catalyst.

Q8. I*s there any difference physical characteristics between the 74 and 35 series?*

A8. In terms of the bulk physical characteristics of the catalysts they are very similar, the 74 series catalyst has a marginally lower bulk loaded density but in terms of strength and other physical characteristics they are extremely similar.

Q9. *Does this **KATALCO** 74 catalyst have high activity and high conversion at low pressure such as 86 bar?*

A9. Yes, the **KATALCO** 74 series catalysts show high activity even at low pressures, having originally been developed for low pressure applications. They have operated in the plant with the lowest loop pressure while it was operational for 20 years (at 80 bar) and are also installed in the current lowest pressure plant in operation at approximately 85 bar

Q10. *Will 74-1 behave better if I get oxygen in my loop - this occasionally happens and we see activity drop and take a long time to recover. Do the promoters help prevent that?*

A10. The **KATALCO** 74 series catalysts are no more susceptible to poisons and process upsets than a standard magnetite catalyst, so show a similar effect after

oxygen (or oxygen containing species) get into the loop, but since it starts from a higher overall activity the reduced activity would be higher than it would be for a standard magnetite catalyst after being exposed to the same levels of poisoning.

Q11. *Is there any known impact of high pressure due to its utilisation in the synthesis main loop instead of OT converter?*

A11. No, the **KATALCO** 74 series catalysts have successfully operated in synthesis loop converters operating at 200 bar, showing high performance and conversion at these conditions.

Q12. *Is there a cost premium for the 74 series catalyst and can you describe, in general the internal revisions required for using the 74 series catalysts?*

A12. The **KATALCO** 74 series catalysts are more expensive than the standard activity magnetite catalysts, but the plants that have these catalysts installed quickly recoup this difference in energy savings or increased production and overall see a net benefit economically. As the physical characteristics of the catalyst are virtually identical to standard magnetite catalysts no internal converter revisions are required for the switch.

Q13. *What typical lifetimes you can get out of catalyst and are there any complications as a result of using mixed catalyst types?*

A13. As per the previous answers on the subject of catalyst lifetime, the catalyst is very stable in operation, with most charges installed for well over 10 years and some operating for over 20 years. Quite often the reason for the replacement is not to do with the activity of the catalyst, which is relatively stable after 10 years, but inspection requirements for the ammonia synthesis vessel or cartridge, or mechanical issues within the converter.

There aren’t issues with operation in plants that have the first beds within a converter installed with **KATALCO** 35 series followed by the latter beds installed with 74 series. The only slight complexity compared to vessels with common catalyst in all the beds is that the two catalysts start reducing at different temperatures (with **KATALCO** 74 series catalysts starting to reduce at a lower temperature), so care is needed to keep the lower beds cooler than would otherwise be required whilst reduction of the upper beds is progressing.

Q14. *What about oil contamination?*

A14. If you are talking about compressor oil, well maintained centrifugal compressors and circulators should not leak significant amounts oil to the loop in normal operation, although process upsets may occasionally result in slugs of oil. Carbon deposition (from thermal or catalytic cracking of higher hydrocarbons) from lubricating oils can cause a permanent loss of activity as a result of physical covering of the catalyst surface which obstructs the active sites. This effect is partly reversible if the problem is recognised quickly.

Sulphur-free lubricants should generally be used to avoid the risk of Sulphur poisoning, but the effect of compressor oil also depends on the design of the loop. In many cases the oil will be captured by either the ammonia catchpot or in the ammonia chillers where it can form wax and therefore reduce chiller efficiency.

Q15. *Is there any difference in strike temperature between 74 and 35 catalyst?*

A15. What is considered as the strike temperature, in fact the lowest bed inlet temperature for stable operation of the converter, is dictated by the particular conditions of the loop (pressure, ammonia inlet concentration, levels of inerts) and the catalyst activity. Assuming there are no bottlenecks elsewhere within the loop that prevent it, if you have a more active catalyst it is possible to operate at a lower inlet temperature to the first bed, relative to a standard magnetite catalyst, whilst maintaining stable operation of the converter.

Q16. *Maybe I have missed that part, have you said that the catalyst contains Cobalt? If that so, is it acting as support or both iron and cobalt are participating in synthesis reaction? What is the usable lowest temperature for this catalyst?*

A.16 The Cobalt acts as an electronic promotor, increasing the adsorption of nitrogen and decreasing that of ammonia. Cobalt is also incorporated into the magnetite lattice rather than just staying at the surface of the crystals and the combination of cobalt addition and a unique production route lead to the formation of smaller crystals, increasing the activity of the catalyst.

As covered in the previous answer, the lowest bed inlet temperature for stable operation of the converter is dictated by the particular conditions of the loop (pressure, ammonia inlet concentration, levels of inerts) and the catalyst activity. Assuming there are no bottlenecks elsewhere within the loop that prevent it, if you have a more active catalyst it is possible to operate at a lower inlet temperature to the first bed, relative to a standard magnetite catalyst, whilst maintaining stable operation of the converter.