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Amine Unit Contamination Basics

Amine Units play a key role in today's refinery operations and gas plants in the quest for lower sulphur emissions and improved safety. It is thought that a well operated amine unit has no need for amine filtration. This might be the case in an ideal system; however, these are seldom encountered. Therefore, filtration and other separation technologies are not only the last line of defense for an amine unit or any other plant for that matter, but might also be the only line of protection. It is then to any plant's advantage to deploy the best and most advanced contamination control devices to ensure process stability, equipment reliability, and enhanced throughput. Proper separation technologies can mitigate some of the most common problems found in amine units (and TGT units) such as:

Fouling: This is deposition of solids and hydrocarbons along with other components to form a coating over equipment surfaces, typically in hot, low velocity locations such as heat exchangers and reactor columns. Fouling has many formation mechanisms, but there is some agreement that is has two components, a) a free radical polymerization or decomposition of dissolved species present in the stream or b) deposition of suspended matter in the stream. Today, fouling is generally prevented by chemical means (free radical inhibitors such as hindered phenols) or by mechanical means such as filtration. Fouling leads to energy losses and flow reductions and is a source of major maintenance costs.

Corrosion: Corrosion is part of the daily life in amine units, and correct filtration is key to minimizing suspended solids. However, typically where there is fouling, the next natural progression is to encounter under deposit corrosion. This is caused by localized and elevated concentrations of corrosion initiators under the deposit material. Usually if fouling is minimized, corrosion rates will be lowered as well. Also in a similar category, it is often found that erosion-corrosion is also prevalent in certain cases. This is caused by the impact of hard and dense suspended particles such as carbon residues with solid surfaces.

Heat Stable Salts: Heat stable salts are components in the amine solutions hindering reaction reversal under normal regeneration conditions. Hence, the name heat stable salts. However some salts are not precisely heat stable, just stable to the available process conditions. It is believed that many of these salts are formed at an accelerated rate due to the presence of solid surfaces from suspended solid contaminants and mediated by metal ions in solution such as iron. Solid surfaces possess considerable active sites for heterogeneous reactions and they are also rich in metals species. This catalyzes salt formation, increasing heat stable salts concentration rapidly and promoting amine decomposition.

Foaming: This is generally produced by the association of gases and liquids stabilized by a surfactant and the lowering of surface tension. These surfactants are surface active materials, acting at the interface of oil/water boundaries. These can be solids (i.e. micron and sub-micron iron sulphides) or molecules (i.e. compressor lubrication oils – lubrication oils in general have many are surface active molecules in their formulation). Removal of solids and hydrocarbons among others greatly reduce foaming events and the use of antifoam additives. Foaming invariably leads to amine loss and lower sweetening efficiency. Other factors can also lead to amine foaming, have a number of root-causes. Hence, proper plant

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evaluation (process, equipment, feed composition) is required to determine its source and mitigation. However, in general good inlet feed gas separation is the key to avoid Amine Unit foaming episodes.

Regenerator/Absorber Protection and Amine Solution Quality. Filtration and separation systems on the rich amine stream are designed to protect the heat exchanger and regeneration section of an Amine Unit and to protect the Sulphur Recovery Unit (SRU) by facilitating the delivery of good quality acid gas. This is done by ensuring that the amine is free of contaminants that foul the rich/lean heat exchanger causing added duty to the reboiler leading to possible corrosion episodes. More plants are adopting rich amine filtration in addition to lean amine filtration for iron control. In fact, both filtrations are not only necessary, but are complementary to each other functioning in different modes. The fundamental function of lean amine filtration is to both remove suspended solids and also to separate dissolved components via the activated carbon bed ensuring a clean amine solution delivery into the absorber.

Low Efficiency: Filtration is designed to remove suspended solids from the amine solution. It is known that an amine solvent with high solid contents is less prone to produce efficient H_2S/CO_2 phase transfer and absorption. This is caused by the multilayer arrangement of solids at the interface of the gas (or liquid) and the amine solution, essentially hindering mass transfer. Good quality amine solution with minimal contaminants performs much better, produced a more sable process and prevents equipment damage.

Concluding Remarks

Perhaps the most relevant learning made during the many years in the field is that a key step in process control is proper contamination control. Most plants that don't take this critical step, struggle with high operational costs and low systems reliability, in addition to many additional detrimental technical, economic and environmental aspects. There is no significant disadvantage with implementing enhanced separation and filtration besides a marginal increase in capital costs. One might tend to believe that total cost will be prohibitive, but experience shows that this is not the case and operational costs can actually be lower. On the other hand, there are real and serious issues involved with neglecting separation and filtration systems or using systems with deficient designs, low cost systems and not giving the proper attention to contamination control. Invariably, any capital savings in low cost separation and filtration will ultimately lead to exponentially high processing costs, low reliability and frequent unit upsets. The included figure illustrates such situation. This was taken from two real cases and historical operational and capital data from two fairly similar Amine Units. As one can observe, low capital cost (CapEx) do not necessarily translate into lower overall cost due to much higher operational cost (OpEx). The associated consequences also have significant negative economic impacts due to far more frequent plant upsets (measure in days the plant was in upset mode per year).

For more information, please contact **Amine Filtration** at Help@AmineFiltration.com