



Application Note

Corrosion Monitoring in Amine Units

Aqueous mixtures of alkanolamines and/or alkylalkanolamines (amines) have been used in regenerable processes to remove acidic contaminants, usually hydrogen sulfide (H₂S), carbon dioxide (CO₂) and mercaptans, from liquid hydrocarbons and process gas streams for over 60 years¹. This activity is driven by either product specification necessary for sale or by avoidance of environmental emission permits.

Amine units are an essential part of refinery operations and use one of the primary amines, i.e. MEA, DGA (the most reactive amines), or secondary amines, i.e. DEA, DIPA, or tertiary amines, i.e. MDEA, TEA. Their importance is increasing as refinery feeds become more sour and sulfur limits of refinery products are lowered. A poorly operated amine unit can result in high amine losses, poor unit reliability, amine solution contamination, off-specification products and increased operating costs to the refinery. Plant economics are negatively impacted by the loss of revenue due to unplanned, corrosion-caused plant outages and the cost for repair of corrosion damage² in amine units.

Amine Unit Corrosion Issues

There is already a significant amount of information in literature on corrosion in amine units³. The amine itself is not corrosive, but corrosion is promoted by entrained acid gases, higher concentration of corrosive species, higher temperatures, corrosion on heat transfer surfaces, higher velocities and HSAS-Heat stable amine salts.

Corrosion in a rich amine circuit is increased by high acid gas loading. Acid gas flashing disturbs the FeS protective films. Acid gases breaking out of the solution cause acid attacks when there is a high velocity and high temperature and when the pressure is too low to suppress vaporization. Also it is important to avoid too low a level of H₂S in the lean amine, as a small amount of H₂S is helpful in producing a protective sulfide film.

Heat-stable amine salts (HSAS) form from stronger acids which can come in from the feed system. The presence of HSAS reduces acid gas removal capacity, lowers pH, increases conductivity, dissolves protective films and

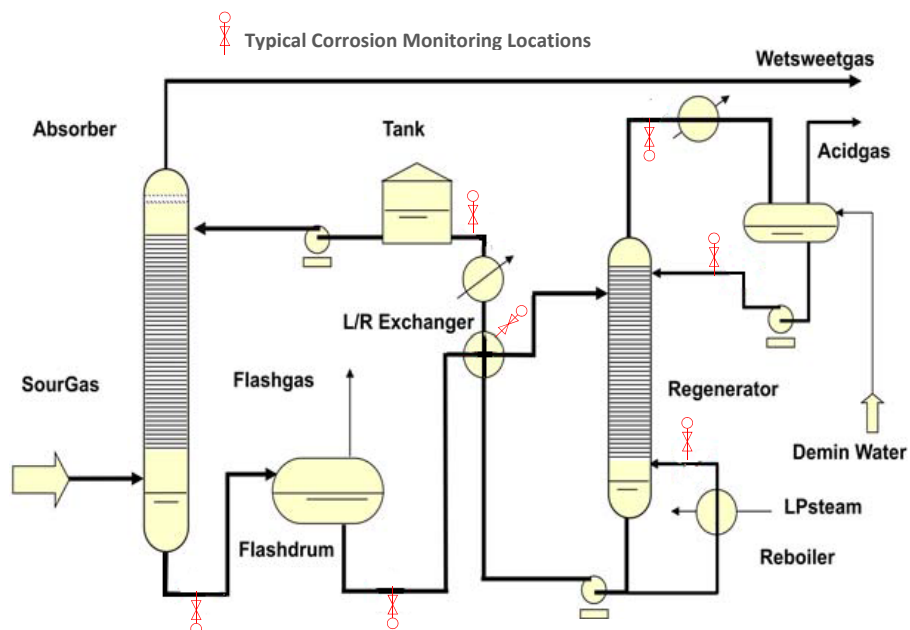


Figure1. Typical corrosion monitoring locations in Amine unit of gas processing plant

causes corrosion. Velocity accelerated corrosion causes erosion by dirty amine solutions containing solid particulates which remove the protective FeS layer.

Corrosion in the overheads of the regenerator takes a different form from that occurring elsewhere in the amine unit. H₂S, NH₃ and HCN are important factors that are involved, which can cause corrosion since they remove sulfide scales. Conditions are more aggressive when treating streams from cokers, visbreakers, FCCUs and hydroprocessors.

Hence it is essential to evaluate the effectiveness of a corrosion control program and establish operational constrain/limits by using online corrosion monitoring systems in amine units.

Online Corrosion Monitoring Scheme in Amine Unit

In today's market where losing 50 MMSCF of natural gas production can cost upwards of \$400,000 per day in downtime⁴, it is critical for these units to be online as much as possible. A rigorous corrosion monitoring and inspection program that includes online and near real-time monitoring can significantly contribute to maximizing uptime by minimizing failures and reducing inspection frequencies. Significant savings can also be realized through optimizing utility consumption within the unit.

On-line corrosion monitoring can quickly help define the optimal lean acid gas loading windows which can prevent wasting steam by regenerating an amine solution further than required. An on-line corrosion monitoring system integrated with a plant process control system will allow corrosion data to be viewed along with other operational and process parameters for early detection of corrosion events and the ability to manage the corrosion rates by fine-tuning of the process.

In an amine unit, corrosion is usually most severe where the gases are absorbed or de-absorbed from rich amine solutions where temperature, flow and turbulence are important considerations⁵. The areas of highest

corrosion potential are the reboiler and its overhead piping, hot lean amine piping, lean/rich exchanger, hot rich amine piping, stripper and stripper overhead systems.

Along with coupon systems, corrosion monitoring with MS2500E/MS3500E Electrical Resistance (ER) and MS2500L/MS3500L Linear Polarization Resistance (LPR) technology are the most commonly used for on-line monitoring on these process units. Metal Samples' **ultra high resolution CorrVelox ER technology** is the latest addition to measure even the minute changes in the corrosion rate.

Since the amine system is a water based system, electrochemical methods such as MS2500L/MS3500L LPR systems are well suited to on-line monitoring in the liquid phase areas of the plant. However, in areas of the re-boiler, continued presence of a liquid phase is not so obvious hence electrochemical probes can become very erratic and essentially nonfunctional. In these cases, it is desirable to implement ultra-high resolution CorrVelox electrical resistance technology. However, in amine systems, it is preferable to use LPR technology wherever suitable because it immediately measures change in corrosion rates.

Metal Samples also provides expert services to design custom probes that will suit specific applications and can assist engineering and installation teams to ensure a smooth implementation of the system. Once implemented, Metal Samples' support, for the purposes of data evaluation, validation and integration with the site control system, helps users to realize the maximum value and benefit from the corrosion monitoring program.

References:

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