Avoiding Amine Foaming Issues Utilizing a Gas Chromatograph

Amine systems are widely used to remove CO_2 and H_2S from rich gas streams in natural gas processing. When foaming occurs in the amine system, the efficiency of the acid gas extraction dramatically decreases and operators need to reduce flow and sometimes inject foaming inhibitors to regain control of the amine system.

One of the principle causes of amine foaming is the introduction of hydrocarbon liquids into the amine contactor. When hydrocarbon liquids enter the contactor, they are highly soluble into the amine solution and reduce the surface tension of the aqueous solution. The reduced surface tension then aids in creating bubbles of gas in the amine solution, resulting in foaming.

The efficiency of amine systems to remove H_2S generally increases with lower operating temperatures, and the efficiency at removing carbon dioxide occurs at a specific temperature. However, lower temperatures in the contactor also increase the potential for liquid hydrocarbons to form in the inlet stream and thus increase the potential for foaming to occur.

Determining the hydrocarbon dew point (HCDP) of the inlet gas provides the opportunity to (1) avoid hydrocarbon liquids entering the contactor and (2) control the amine temperature to a set-point that optimizes the efficiency of the acid gas extraction while also avoiding the risk of liquid hydrocarbons forming in the contactor.

The theoretical HCDP of a gas mixture can be calculated from the gas composition using an equation of state. Typical gas chromatographs used in natural gas applications measure individual hydrocarbons up to n-pentane, and combine all the heavier components as a C6+ value. However, the components that drop out as liquids and cause the foaming issues are the components heavier than C6, so calculating the HCDP with a C6+ analysis (using assumed ratios of C6/C7/C8) will provide inaccurate results that will not be suitable for use in a control strategy. A C9+ gas chromatograph measures the ratio of C6, C7, and C8 components (with heavier components reported as C9+) and provides a much more accurate HCDP calculation that can then be used to optimize the control strategy.

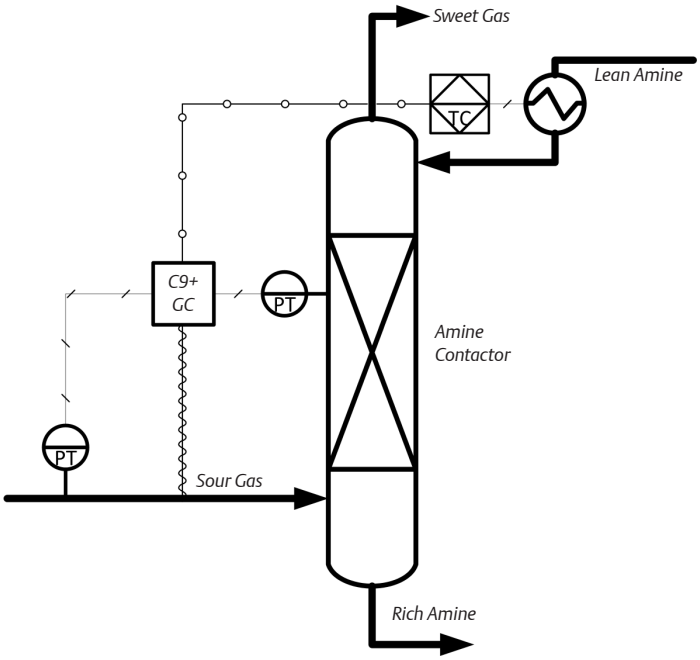

Figure 1 - Calculating the Hydrocarbon Dew Point of the inlet stream at the contactor pressure provides an early warning for liquid hydrocarbons in the inlet stream and defines a minimum temperature for the lean amine inlet stream to avoid amine foaming from liquid hydrocarbons.

Determining the Phase of the Inlet Gas

When the inlet gas temperature is below the HCDP, the flowing stream is a single phase vapor. As the gas becomes richer with heavy hydrocarbons, the calculated HCDP will approach the stream temperature. When the HCDP reaches the stream temperature, the heavier components will begin to drop out into the liquid phase, increasing the risk of foaming in the amine contactor. (Figure 2)

By calculating the HCDP at the line pressure with the C9+ gas chromatograph, the difference between the stream temperature and the HCDP can be monitored. As the HCDP approaches the stream temperature an alert can be triggered that enables the operator, or the control strategy, to take actions to reduce the HCDP before liquids form and enter the amine contactor.

EMERSON
Process Management

Such actions can include increasing the retention time in the inlet separator or modifying the recycle gas mix.

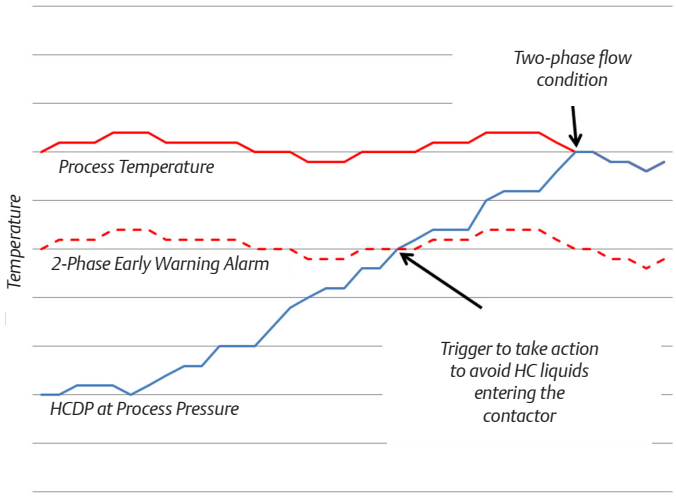

Figure 2 – The process pressure is used to calculate the HCDP at process conditions that provides a two-phase flow early warning for use in the control strategy to avoid foaming in the contactor.

Using HCDP for Amine Inlet Temperature Control

The temperature of the Amine contactor is typically controlled by cooling the lean amine prior to entry into the contactor to maximize the efficiency of the acid gas removal. However, if the temperature of the contactor is below the HCDP of the inlet gas at the contactor pressure, then liquid hydrocarbons will begin to form and the risk of amine foaming greatly increases.

As the HCDP varies with pressure, the HCDP of the inlet gas will change as it enters the contactor. By calculating the HCDP of the inlet gas at the pressure of the amine contactor, the minimum temperature of the inlet amine can be determined and used in the control strategy to minimize the risk of amine foaming.

If the detrmined minimum temperature is too high for the efficient acid gas removal, actions can be taken to reduce the HCDP of the inlet gas while also avoiding the risk of amine foaming.

The Rosemount 770XA C9+ HCDP Application

The C9+ HCDP calculation application has been available as an option in the Rosemount 570 and 770 natural gas chromatographs for many years. The recently released 770XA builds on this heritage by including the HCDP calculation as standard for all Rosemount C9+ applications and enabling the calculation pressures to be sourced from the analog inputs or through the Modbus communication link.

The single oven/dual detector design, integral controller, improved repeatability, expanded calculation and alarming capabilities, and increased operating temperature range provides an effective package for incorporating HCDP monitoring with the industry leading natural gas analysis capabilities that Rosemount is renowned for.

EmersonProcess.com/GasAnalysis

YouTube.com/user/RosemountAnalytical
Analyticexpert.com
Twitter.com/Rosemount_News
Facebook.com/Rosemount

Emerson Process Management
10241 West Little York, Suite 200
Houston, Texas 77040
USA
Toll Free + 866 422 3683
T + 713 396 8880
F + 713 466 8175
GC.CSC@Emerson.com

EMERSON™
Process Management