

Hydrocarbon Dew Point Measurement in Natural Gas

Process Overview

The need to determine the hydrocarbon dew point temperature in a natural gas pipeline network is critical because the formation of hydrocarbon liquids (condensate) due to the presence of heavier hydrocarbons in the gas stream can lead to increased pressure drops in the pipeline system. There are also safety hazards associated with liquids, such as hot spots on compressor turbine blades.

Hydrocarbon dew point is the temperature, at a defined pressure, at which hydrocarbon liquids begin to form. The determination of the hydrocarbon dew point (HCDP) for natural gas has become of greater importance because of the rapid expansion of interconnecting pipelines and the rise of non-traditional sources of natural gas. Hydrocarbon liquids in the gas stream can cause hydrate formation, increase compression costs, cause issues with pressure regulator freezing, and lead to damage to end-user equipment such as gas turbines. To reduce these risks, custody transfer agreements are increasingly specifying limits for the HCDP, which, in turn, requires a reliable method of reporting the HCDP at the custody transfer location.

Process Challenges

The traditional method of determining the hydrocarbon dew point online is to use a chilled-mirror device that reduces the temperature of a mirror in a measurement chamber filled with the natural gas. Other dedicated HCDP analyzers using different measurement techniques are also available; however, they all provide a HCDP only at a single pressure and are dedicated analyzers that provide a single measurement.

The theoretical HCDP can be calculated using the composition determined by a gas chromatograph (GC) based on industry accepted equations of state at multiple pressures, along with the cricondentherm (the maximum HCDP at any pressure.) By including the equation-of-state calculation capability in the gas chromatograph, the HCDP and cricondentherm can be calculated and reported using the same analyzer used for other custody transfer measurements, reducing the number of analyzers, associated equipment and cost.



Rosemount™ 770XA Gas Chromatograph

The Emerson Solution

A C6+ gas chromatograph (typically used for the natural gas custody transfer) calculates theoretical values for the hexanes, heptanes, and octanes used in the energy and physical properties calculations from fixed ratios of the measured C6+ concentration. However, it is these heavier components that will form the hydrocarbon liquid in the stream, so assuming the values results in large errors (Figure 1) when compared to a calculation performed with a full analysis up to C12. To overcome this limitation, Emerson developed the five-minute C9+ extended analysis application to quantify the heavier components found in natural gas and provide more accurate calculations with the Peng-Robinson (PR) or Soave-Redlich-Kwong (SRK) equations of state. This application uses two robust thermal-conductivity detectors (TCD) more suited to the typical custody transfer environment than the flame-ionization detector required for the C12 analysis, and provides results within ± 5 °F of the values calculated using a full C12 analysis. The calculation can be characterized further to match isomer ratios determined by detailed spot laboratory analysis.

Practical Applications

The principal purpose for the HCDP application is to calculate the cricondentherm or HCDP at a fixed pressure for reporting and gas quality monitoring. However, the ability to calculate the HCDP at up to four different pressures provides some further practical applications.

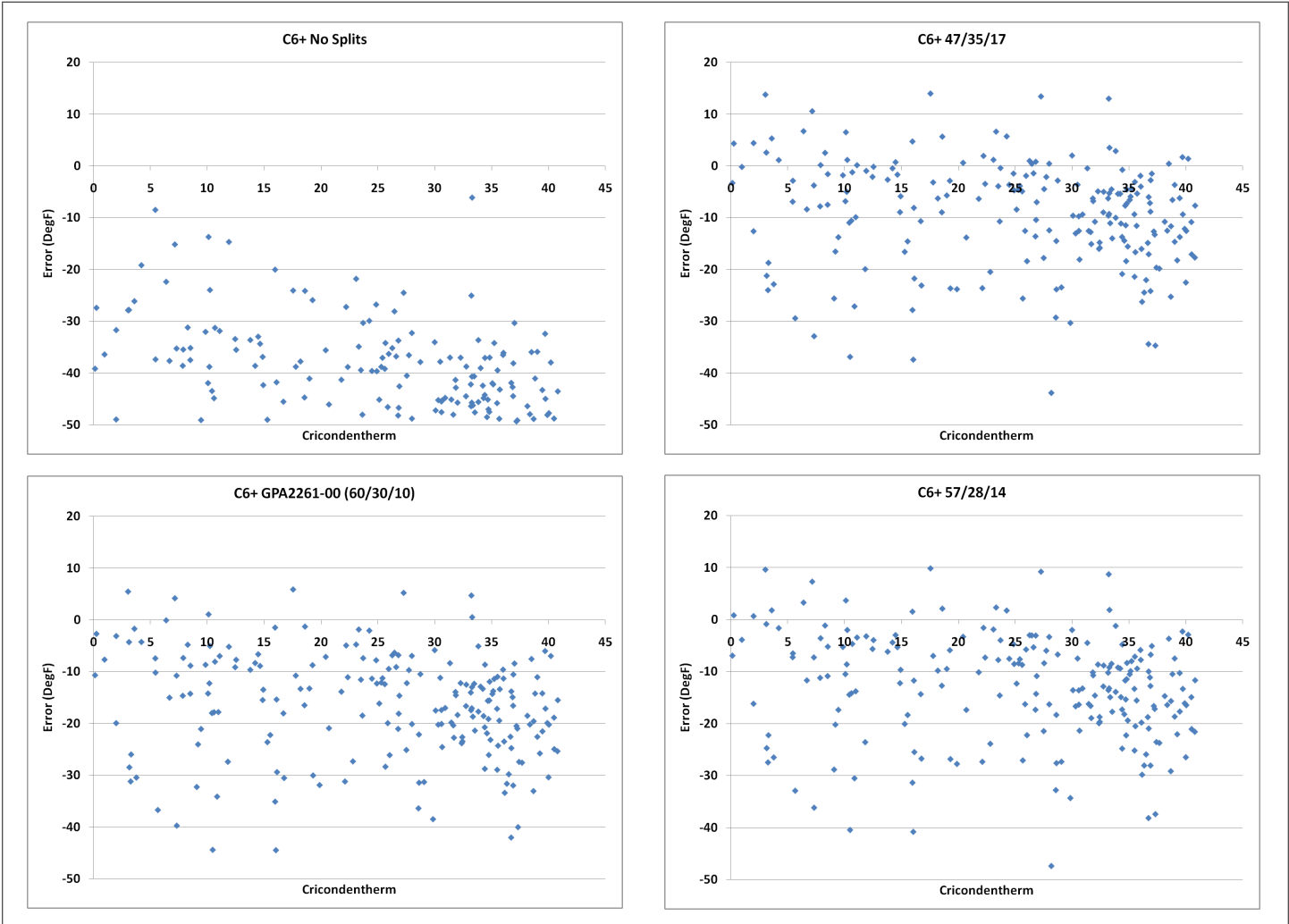


Figure 1. Calculation errors for various gas compositions when using common fixed ratios of C6+ to calculate the cricodentherm.

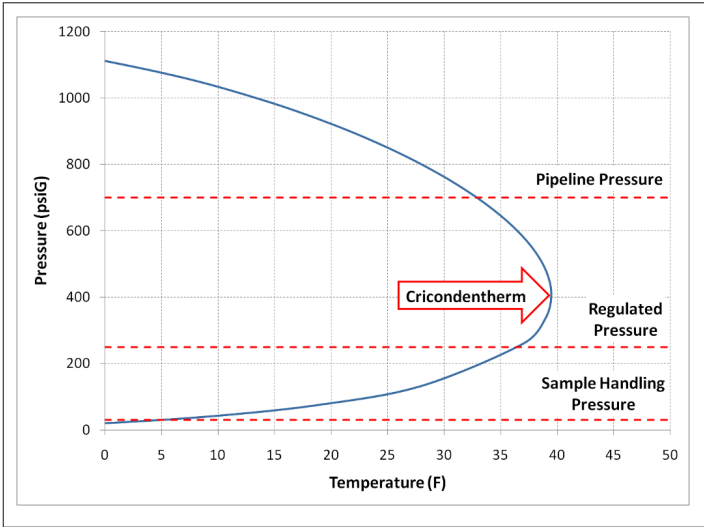


Figure 2. A typical phase curve showing the Cricodentherm and the hydrocarbon dew point calculated at three pressures for practical operational use.

Two-Phase Flow Early Warning

All of the flow measurement technologies will produce significant errors if there is two-phase flow (gas and liquid.) If there is two-phase flow in the pipeline, the HCDP (at the flowing pressure) of the gas that has been sampled and analyzed by the GC will be at the same as the flowing temperature. Therefore, calculating the HCDP at the flowing pressure and comparing to the flowing temperature can provide an alert if there is two-phase flow, providing an early alert that the flowing stream is approaching two-phase to enable mitigation efforts before it results in flow measurement errors.

Sample System Performance

The same principle can be used to compare the sample HCDP to the ambient temperature to determine if the sample handling system is working correctly, and is not being affected by ambient conditions.

The HCDP can be calculated at the regulated sample pressure (typically 20 PSIG/100 kPa) and compared to the ambient temperature. If the HCDP begins to track the ambient temperature, it can indicate that the heavy components are falling out in the sample lines.

Pre-heater Control

The calculated HCDP at the line pressure and the downstream regulated pressure can be used at regulator stations to determine the set-point of gas pre-heaters to optimize the heater performance, lower heater operating costs, and reduce the risk of regulator freezing or hydrate formation.

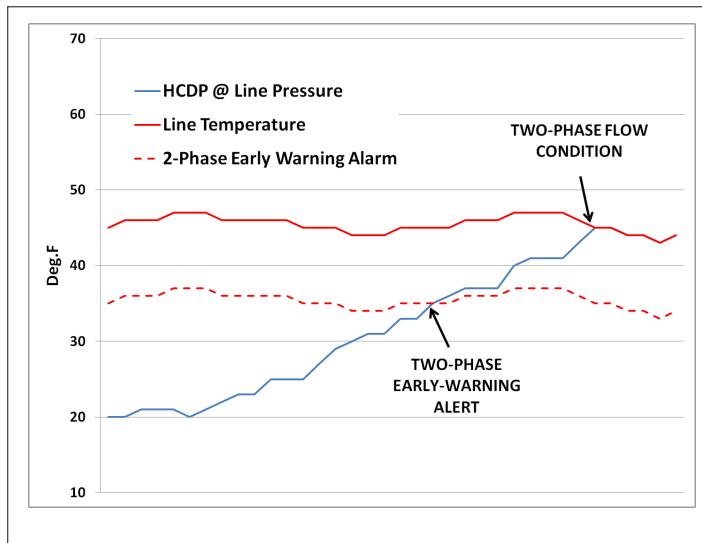


Figure 3. Flow Pressure used to calculate flowing HCDP and provide two-phase flow early warning. A hydrocarbon dew point within 10 °F of the flowing pipeline temperature indicates the immediate risk of a two-phase flow condition occurring.

The C9+ HCDP Calculation Application

The C9+ HCDP calculation application has been available as an option in the 570 and 770 chromatographs for many years. The Rosemount 770XA Gas Chromatograph builds on this expertise 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 and custody transfer capabilities that the Rosemount Gas Chromatograph is renowned for.

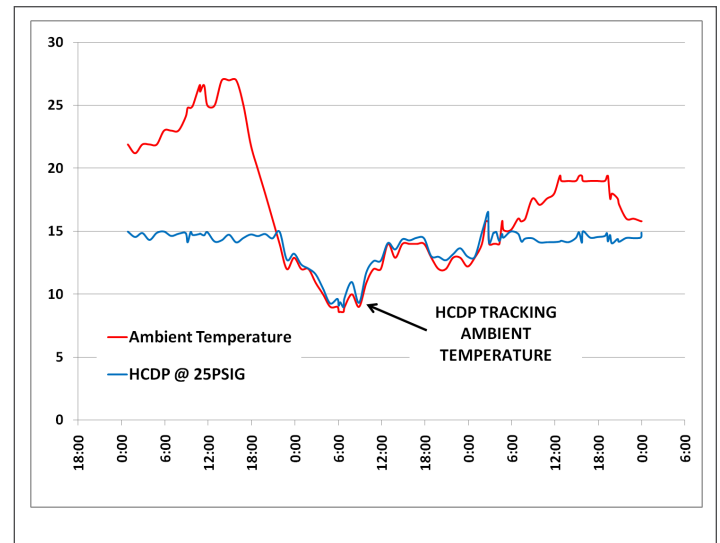


Figure 4. HCDP comparison with ambient temperature showing sample system heating issue resulting in the heavy (and high energy content) components dropping out in the sample lines.