White Paper
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Volumetric Measurement of Liquid Petroleum Gas (LPG)

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Introduction

The American Petroleum Institute (API) Manual of Petroleum Measurement Standards (MPMS) Chapter 14 Section 8 (Ch. 14.8) provides guidance on the volumetric measurement of LPG in a relative density range between 0.350-0.637. LPG is separated from Natural Gas Liquid (NGL) streams in processing units known as fractionators. Fractionation is a separation process that allows lighter stream components to vaporize and pass the other heavier liquids to the next stage for additional processing.

NGL and streams with varying concentrations of ethane like ethane/propane (E/P) mix are measured by mass. Micro Motion white paper WP-002037 discusses the mass measurement of NGL and explains how mass is converted to volume.

Some purity grade (90+%) LPG is measured on a volumetric basis which requires the calculation of correction factors for flowing temperature and pressure which are applied to the flowing liquid. This document will address which LPG products are measured volumetrically and how correction factors are determined and applied.

NGL Fractionation Overview

Figure 1 is a simplified NGL fractionation process flow diagram. An NGL feed stream enters the fractionator from the left-hand side. The first stage is a deethanizer that separates ethane from the NGL stream by exposing the NGL stream to a pressure and temperature that will vaporize the ethane component which is pressurized and condensed for transportation. The resulting liquid at the deethanizer outlet becomes a feedstock for the next fractionator (depropanizer). This process continues to separate lighter fluid components from the NGL mixture as shown in the process diagram until the remaining liquid is natural gasoline (C5+).

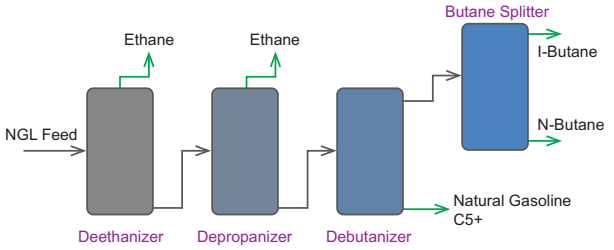

Figure 1

Fractionator outputs are shown by green lines in Figure 1. These outputs are often referred to as purity products which means >90% pure composition and typical measurement methods are summarized:

- Ethane – measured by mass
- Propane – measure by volume
- Iso-Butane – measured by volume
- Normal-Butane – measured by volume
- Natural Gasoline C5+ (sometimes called condensate or plant condensate) – measured by volume

Propane and butanes fall within the relative density range of API MPMS Ch. 11.2 while natural gasolines/condensates are within the scope of API MPMS Ch. 11.1.

Volumetric Flow Calculations

The API MPMS Ch. 14.8 provides a volumetric flow calculation for LPG:
Vb=Vf x MF x CTL X CPL

Where:
Vb = volume at base or standard conditions
Vf = volume at flowing conditions
MF = volumetric meter factor
CTL = correction for temperature on liquid (API MPMS 11.2.4 “E tables”)
CPL = correction for pressure on liquid (API MPMS 11.2.2)

Volume at base conditions for LPG, which exists as vapor at atmospheric pressure, is usually defined as 60 degrees Fahrenheit and the liquids equilibrium vapor pressure (at 60 degrees F).

API MPMS Ch. 11.2.2 requires an input for a fluid vapor pressure at flowing conditions and equations in API MPMS Ch. 11.2.5 provide the vapor pressure value.

Volumetric Measurement Systems

Volumetric flow measurement systems should be designed, installed and maintained per guidance found in the API MPMS Ch. 6. Meter temperature and pressure measurements are required for the determination of volume correction factors CTL and CPL. Coriolis meter online density measurement may be used for input to CTL and CPL calculations.

Conclusion

The API MPMS Ch. 14.8 provides guidance on the volumetric measurement of LPG. LPG is the result of fractionating NGL mixtures. Some of the purity LPG products (propane/butanes) are measured volumetrically by equations outlined in the API MPMS Ch. 14.8 and using volume correction factors from API MPMS Ch. 11.2.

Emerson Automation Solutions has expertise in the area of NGL/LPG measurement systems and has a wide variety of products and solutions to automate these measurement points. We have application expertise in the areas of flow computers/meters, gas chromatography and pressure/temperature measurement on NGL/LPG measurement systems. Contact a local Emerson Automation Solutions sales office for application assistance.

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