Documentation Report and Data Files for:

API *MPMS* Chapter 11.3.3 Miscellaneous Hydrocarbon Product Properties—Denatured Ethanol Density and Volume Correction Factors

API *MPMS* Chapter 11.3.4 Miscellaneous Hydrocarbon Product Properties—Denatured Ethanol and Gasoline Component Blend Densities and Volume Correction Factors

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Contents

Contents

Introduction

In 2008, API began a program to determine the appropriate corrections for adjusting gasoline plus ethanol fuel blend volumes from observed conditions to standard temperature and pressure. The existing standard, API *MPMS* Chapter 11.1, identified a temperature correction process for fuel with one sample of a gasoline ethanol blend but the needs of industry had changed to focus on a larger range of ethanol-blended fuels. For example, in the market, ethanol was being blended into gasolines in concentrations from 10 % up to 85 % ethanol. There were anecdotal reports from field operators of adiabatic temperature changes and volume changes resulting from mixing ethanol and gasoline.

Ethanol is a relatively polar molecule and its presence in predominately non-polar liquid leads to mixing effects that impact the expected density and volume-temperature behavior of the mixture.

A testing program was developed and executed to identify the extent of any effect and to characterize the effect in a manner that could be standardized.

That effort resulted in two API *MPMS* standards:

— API *MPMS* Chapter 11.3.3, *Miscellaneous Hydrocarbon Product Properties—Denatured Ethanol Density and Volume Correction Factors*

— API *MPMS* Chapter 11.3.4, *Miscellaneous Hydrocarbon Product Properties—Denatured Ethanol and Gasoline Component Blend Densities and Volume Correction Factors*

As described later in this report, the project can be divided into five parts: 1) laboratory measurement of the density/temperature behavior of gasoline and ethanol feedstocks and ethanol blends, 2) screening and organizing the data for consistency, 3) modeling of the non-ideality of the thermal expansion coefficient, 4) modeling of the non-ideality of the blend density, and 5) development of the standards.

The project was managed and overseen by a Project Group, consisting of oil and gas company technical experts and API. A laboratory was contracted by API to perform the actual blending and density measurements. Expert technical consultants were used for data verification, analysis, culling data, statistical analysis and to develop equations. The Project Group oversaw each activity.

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1 Scope

The purpose of this technical report is to assemble and make available the various foundational data and materials used in the development of API *MPMS* Chapter 11.3.3 and API *MPMS* Chapter 11.3.4. It includes the historical reports and spreadsheets used as is, without update or reconciliation for any later changes.

This document does not extend, modify, or otherwise change anything in the standards as published by API.

Users should not attempt to develop their own implementations of the standard calculations from this document. They should only reference the standards.

The spreadsheets used have been converted to “values only” to preserve them and to restrict changes. Macros that had been included to calculate functions such as volume correction factors or equations within the standards have been removed. The user is directed to the published implementations in the standards. This document contains only the background materials, not the standards, nor any computer implementation of the standards. Only the final versions of materials have been included. Some graphs within the spreadsheets may not appear the same as in published documents because the authors may have changed settings or data filters in the spreadsheets subsequent to copying the graphs for publication.

Annex A through Annex G materials are available in files for download from API Publications [1] for purchasers of this document. Annex H is included in this document.

2 Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

API *Manual of Petroleum Measurement Standards* (*MPMS*) Chapter 11.1, *Temperature and Pressure Volume Correction Factors for Generalized Crude Oils, Refined Products, and Lubricating Oils*, May 2004, including Addendum 1, September 2007

API *MPMS* Chapter 11.3.3, *Miscellaneous Hydrocarbon Product Properties—Denatured Ethanol Density and Volume Correction Factors*, Third Edition, December 2018

API *MPMS* Chapter 11.3.4, *Miscellaneous Hydrocarbon Product Properties—Ethanol-Blended Gasoline Density and Volume Correction Factors*, First Edition, December 2018

API *MPMS* Chapter 6.2, *Loading Rack Metering Systems*, Third Edition, February 2004

[1] API Publications available at https://www.api.org/products-and-services/standards/purchase#tab_catalog