Manual of Petroleum Measurement Standards Chapter 12.2

Calculation of Petroleum Quantities Using Dynamic Measurement Methods and Volumetric Correction Factors

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Foreword

API *MPMS* Chapter 12.2, 2nd Edition, *Calculation of Petroleum Quantities Using Dynamic Measurement Methods and Volumetric Correction Factors*, supersedes the following standards, all of which are withdrawn:

— API *MPMS* Chapter 12.2.1, 2nd Edition 1995, *Calculation of Petroleum Quantities Using Dynamic Measurement Methods and Volumetric Correction Factors—Part 1—Introduction*

— API *MPMS* Chapter 12.2.2, 3rd Edition 2003, *Calculation of Petroleum Quantities Using Dynamic Measurement Methods and Volumetric Correction Factors—Part 2—Measurement Tickets*

— API MPMS Chapter 12.2.3, 1st Edition 1998, *Calculation of Petroleum Quantities Using Dynamic Measurement Methods and Volumetric Correction Factors—Part 3—Proving Reports*

API *MPMS* Chapter 12.4.1, 1st Edition, *Calculation of Petroleum Quantities—Base Prover Volume Determination—Waterdraw Volumetric Method* supersedes API *MPMS* Chapter 12.2.4, 1st Edition 1997, *Calculation of Petroleum Quantities Using Dynamic Measurement Methods—Part 4—Calculation of Base Prover Volumes by Waterdraw Method* which is withdrawn.

Revision of other parts of API *MPMS* Chapter 12.2 is ongoing. It is anticipated that:

— API *MPMS* Chapter 12.2.5, 1st Edition 2001, *Calculation of Petroleum Quantities Using Dynamic Measurement Methods—Part 5—Calculation of Base Prover Volumes by Master Meter Method*, will be superseded by API *MPMS* Chapter 12.4.2, *Calculation of Petroleum Quantities—Base Prover Volume Determination—Master Meter Method*

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The verbal forms used to express the provisions in this document are as follows.

Shall: As used in a standard, "shall" denotes a minimum requirement to conform to the standard.

Should: As used in a standard, "should" denotes a recommendation or that which is advised but not required to conform to the standard.

May: As used in a standard, "may" denotes a course of action permissible within the limits of a standard.

Can: As used in a standard, "can" denotes a statement of possibility or capability.

This document was produced under API standardization procedures that ensure appropriate notification and participation in the developmental process and is designated as an API standard. Questions concerning the interpretation of the content of this publication or comments and questions concerning the procedures under which this publication was developed should be directed in writing to the Director of Standards, American Petroleum Institute, 200 Massachusetts Avenue, NW, Suite 1100, Washington, DC 20001. Requests for permission to reproduce or translate all or any part of the material published herein should also be addressed to the director.

Generally, API standards are reviewed and revised, reaffirmed, or withdrawn at least every five years. A one-time extension of up to two years may be added to this review cycle. Status of the publication can be ascertained from the API Standards Department, telephone (202) 682-8000. A catalog of API publications and materials is published annually by API, 200 Massachusetts Avenue, NW, Suite 1100, Washington, DC 20001.

Suggested revisions are invited and should be submitted to the Standards Department, API, 200 Massachusetts Avenue, NW, Suite 1100, Washington, DC 20001, standards@api.org.

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Introduction

This standard presents the calculation procedures for dynamic measurement tickets (meter tickets), and meter proving of devices with volumetric outputs.

Earlier versions of this standard were written when mechanical desk calculators and tabulated values were widely used for calculating measurement documentation. Rules for rounding and the choice of how many figures are required for each calculation step were often made on the spot, which could result in different operators obtaining different results from the same data. Introduction of computers and solid-state scientific desk calculators improved the process, but different manufacturers' machines often produced slightly different results. To address this problem, the previous version of this standard rigorously specified the equations for computing correction factors, rules for rounding, calculation sequence, and the discrimination levels employed with the purpose of standardizing calculations to produce the same unbiased answer from given data. The implementation procedures presented in this standard are designed to use computer technology, simplify the associated arithmetic operations, and incorporate current API *MPMS* Chapter 11 [4] standards.

This standard does not address the differences in the raw/measured data due to differences in the precision of the instrumentation and the collection of its data. Therefore, if a continuous data system is being used on the same stream and redundant with a discrete data system to collect and process measured quantities, it is not expected that they would necessarily produce identical results. It is expected that they both be in compliance with the guidelines in API *MPMS* Chapter 21.2 [10] and the requirements of this standard.

This standard presents two methods for data acquisition:

1) Discrete Method (Traditional Method)

2) Continuous Method (Dynamic Method)

In the Discrete Method, flow-weighted averages are used to correct the measured quantity at the end of the ticket period.

In the Continuous Method, real-time values are used to iteratively correct the measured quantity each scan cycle throughout the ticket period. Batch ticket quantities are essentially the summation of the results of each scan cycle.

In either data acquisition method, the same calculation routines are used. The only difference is intermediate rounding and the time in which the calculations are performed.

Calculations and process variable acquisitions in the Continuous Method are not continuous, but "near" continuous. As scan times in flow computers decrease, the process of variable acquisition increases and will be closer to continuous.

These two methods might yield slightly different results due to the different rounding routines employed and the way the data are acquired and processed.

Reporting discrimination is only applied to the measurement ticket reported values; thus, older computer processor technology or manual calculations may not reproduce the same exact results as modern machines or manual calculations using this revised standard. Unrounded numbers in no way imply measurement accuracies to those levels. Measurement accuracies are solely dependent upon each measurement device. Identical input data should give different users equivalent results.

The intent of this document is to serve as a rigorous standard. Examples are provided to aid the user in checking computations developed using the requirements of this standard.

Calculation of Petroleum Quantities Using Dynamic Measurement Methods and Volumetric Correction Factors

1 Scope

This document provides standardized calculation methods for the quantification of liquids from a meter generating a volumetric output, regardless of the point of origin or destination or the units of measure required by governmental customs or statute. The criteria contained in this document allow different entities using various computer languages on different computer hardware (or manual calculations) to arrive at output results within a defined tolerance within this document, using the same input data.

The document rigorously specifies the equations for computing correction factors, rules for rounding, calculation sequence, and discrimination levels to be employed in the calculations. No deviations from these specifications shall be permitted since the intent of this document is to serve as a rigorous standard. This document also covers multiple calculations as required by dynamic, online, integrated, continuous flow measurement.

2 Normative References

The following reference 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 applies (including any addenda or errata, or both).

API *MPMS* Chapter 11.5 (all sections), *Density/Weight/Volume Intraconversion Tables*

API *MPMS* Chapter 13 (all sections), *Statistical Aspects of Measuring and Sampling*

API *MPMS* Chapter 14.4/GPA 8173, *Converting Mass of Natural Gas Liquids and Vapors to Equivalent Liquid Volumes*

NIST[1] Handbook 44, *Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices*

3 Terms, Definitions, Abbreviations, and Symbols

3.1 Terms and Definitions

For the purposes of this document the following terms and definitions apply. Terms of more general use may be found in the API *MPMS* Chapter 1—Online Terms and Definitions Database.

3.1.1
absolute density
The mass of a substance per unit of volume at a specified temperature and pressure.

3.1.2
composite meter factor
CMF
A meter factor, adjusted at the time of proving, from assumed normal operating meter pressure during the ticket period to base pressure, when it is desired to not have to calculate the correction for compressibility at the time of the measurement ticket calculation, and where it is assumed that the pressure, temperature, and density are constant during the ticket period.

[1] National Institute of Standards and Technology, 100 Bureau Drive, Gaithersburg, MD 20899, www.nist.gov.