Manual of Petroleum Measurement Standards Chapter 19.4

Evaporative Loss Reference Information and Speciation Methodology

THIRD EDITION, OCTOBER 2012

ADDENDUM 1, NOVEMBER 2013

ADDENDUM 2, JUNE 2017

AMERICAN PETROLEUM INSTITUTE

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Measurement Coordination

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Summary of Changes to API MPMS Chapters 19.1, 19.2, and 19.4

The third edition of API Manual of Petroleum Measurement Standards (*MPMS*) Chapter 19.4 was published following a revision that was carried out concurrently with revisions to Chapter 19.1, published as the fourth edition, and Chapter 19.2, published as the third edition. Primary changes are:

1) Consolidation of common material in Chapter 19.4. Material that had previously been included in both Chapters 19.1 and 19.2 has been moved to Chapter 19.4. Chapter 19.4, which was previously *Recommended Practice for Speciation of Evaporative Losses*, now has the title *Evaporative Loss Reference Information and Speciation Methodology.* This Chapter had already contained reference information on the properties of chemicals and typical petroleum liquids, and this information has now been removed from Chapters 19.1 and 19.2. In addition, meteorological data have been moved from Chapters 19.1 and 19.2 to Chapter 19.4. In the revised documents:

   a) Meteorological data are found in Chapter 19.4,

   b) Calculation of storage tank temperatures is found in Chapters 19.1 and 19.2 (in that fixed-roof tanks involve calculation of the vapor space temperature in order to determine vapor density, whereas this step is not involved in estimating emissions from floating-roof tanks), and

   c) Calculation of true vapor pressure is found in Chapter 19.4 (in that this is now calculated in the same manner for both fixed- and floating-roof tanks).

2) Reconciliation of nomenclature. Chapters 19.1 and 19.2 previously had different nomenclature for the same variables. These revisions adopt a common set of symbols for both chapters.

3) Reorganization of the formats. In addition to common material having been removed from Chapters 19.1 and 19.2, the remaining text has been edited to remove unnecessarily verbose or repetitive language. The summary tables were deemed redundant, and have been deleted.

4) Appendices. Appendices have been redesignated as annexes.

5) SI units. An annex has been added to each chapter to address SI units.

Chapter 19.4, third edition

In addition to common reference material being moved to Chapter 19.4, the following changes have been made:

1) Solar absorptance factors. The former designations of Good and Poor have been replaced with the designations New and Aged, and a new category designated Average has been introduced.

2) Alternative methodology for calculating storage tank temperatures. An API study of storage tank temperatures concluded that a more sophisticated model for estimating storage tank temperatures has relatively little impact on estimated emissions, and thus the methodology now presented in Chapters 19.1 and 19.2 is the same as previously appeared in Chapter 19.1 (and in EPA AP-42). However, a more sophisticated model has been added as Annex I in Chapter 19.4.

3) No. 6 Fuel Oil. The default properties for No. 6 Fuel Oil have been revised, resulting in a significant increase in the estimated true vapor pressure. The former default properties are now presented as being suitable for vacuum residual oil. A new default speciation profile has also been added for No. 6 Fuel Oil. The study on which these changes are based has been added as Annex G.

4) Maxwell-Bonnell correlations. The annex presenting the Maxwell-Bonnell correlations has been edited with the conclusion that the separate correlations for predicting the normal boiling point from distillation data are not reliable.

5) Determination of true vapor pressure. Cautions have been added to section 4.2 of Chapter 19.4 with respect to the use of Reid vapor pressure to determine the stock true vapor pressure, and ASTM test methods D2879 and D6377 have been referenced for directly measuring the stock true vapor pressure.

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Addendum 2

Annex I has been updated in this addendum.

Contents

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Chapter 19.4—Evaporative Loss Reference Information and Speciation Methodology

1 Scope

This standard provides methodology to estimate emissions of individual hydrocarbon species using the total emissions of multicomponent hydrocarbon mixtures (such as crude oils and gasoline) estimated from API *MPMS* Ch. 19.1 for fixed-roof tanks, API *MPMS* Ch. 19.2 for floating-roof tanks, API *MPMS* Ch. 19.5 for marine vessels, and other methods used for total hydrocarbon emission estimates. This process is referred to as speciation.

Speciation of emissions from hydrocarbon mixtures accounts for the higher evaporation rate of the more volatile components, resulting in a different composition of the mixture in the vapor phase than in the liquid phase. The methodology presented in this standard assumes that there is sufficient liquid present such that the chemical composition at the liquid surface may be considered to not change as a result of the evaporative loss.

This standard also contains reference information used for estimating emissions in accordance with API *MPMS* Ch. 19.1, API *MPMS* Ch.19.2, and API *MPMS* Ch.19.5.

The methodology in this standard applies to:

a) liquids with vapor pressure that has reached equilibrium with ambient conditions at a true vapor pressure less than the ambient atmospheric pressure (i.e. not boiling);

b) liquids for which the vapor pressure is known or for which sufficient data are available to determine the vapor pressure;

c) liquid mixtures where Raoult's Law can be used to describe the vapor phase equilibria.

This methodology does not apply to:

a) emissions that result from leaks from piping components (e.g. valves, flanges, pumps, connectors etc.);

b) liquid mixtures where Raoult's Law cannot be used to describe the vapor phase equilibria (e.g. mixtures in which hydrocarbons are dissolved in water, or mixtures of hydrocarbons with alcohols).

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 19.1, *Evaporative Loss from Fixed-Roof Tanks*, 4th Edition, 2012.

API *MPMS* Chapter 19.2 *Evaporative Loss from Floating-Roof Tanks*, 3rd Edition, 2012.

API *MPMS* Chapter 19.5 *Atmospheric Hydrocarbon Emissions from Marine Vessel Transfer Operations*, 1st Edition, September 2009.

3 Symbols

Symbol	Description	Units	Source
A	vapor pressure constant	dimensionless	Table 2, 3
B	vapor pressure constant	°C or °R	Table 2, 3
C	vapor pressure constant	°C or °R	Table 3
H_i	Henry's law constant for component i	psia	7.3.4.2
I	daily total insolation on a horizontal surface	Btu/(ft^2 day)	Table 1
K_i	vapor-liquid equilibrium constant of component i	dimensionless	7.2
L_i	emissions of component i	lb	5.1.3
L_t	total emissions of all components	lb	User
M_i	molecular weight of component i	lb/lb-mole	Ref. [35]
M_L	stock liquid molecular weight	lb/lb-mole	Table 2, 3
M_V	stock vapor molecular weight	lb/lb-mole	Table 2, 3
P_A	atmospheric pressure at the tank site	psia	User
P_i	partial pressure of component i in the vapor	psia	5.1.3
P_i^o	saturated vapor pressure of component i	psia	4.3
P_T	total system pressure	psia	User
P_V	stock true vapor pressure	psia	4.2
RVP	stock Reid vapor pressure	psi	User
S	stock ASTM D86 distillation slope at 10 volume % evaporated	°F/vol. %	Table 2
T_{LA}	daily average liquid surface temperature	°R	19.1, 19.2
T_{MAX}	maximum ambient temperature	°F	Table 1
T_{MIN}	minimum ambient temperature	°F	Table 1
V	average ambient wind speed at the tank site	mi/hr	Table 1
w_i	weight fraction of component i in the liquid	dimensionless	4.7
W_L	density of stock liquid	lb/gal	Table 2, 3
W_{VC}	density of condensed stock vapor	lb/gal	Table 2
x_i	mole fraction of component i in the liquid	dimensionless	5.1.3
y_i	mole fraction of component i in the vapor	dimensionless	5.1.3
z_i	weight fraction of component i in the vapor	dimensionless	5.1.3
α	tank surface solar absorptance	dimensionless	Table 7
α_R	tank roof surface solar absorptance	dimensionless	Table 7
α_S	tank shell surface solar absorptance	dimensionless	Table 7

NOTE 1 "19.1" and "19.2" refers to API *MPMS* Ch. 19.1 and API *MPMS* Ch.19.2 respectively.
NOTE 2 Symbols used in Annex I are listed in Section I.1.

4 Variables

4.1 Meteorological Data

Meteorological data may be used to determine vapor space, liquid bulk, and liquid surface temperatures for storage tanks and can be obtained from local weather records or from historical averages given in Table 1. Data for this table are 30-year averages for the years 1961 through 1990, and are available at *http://rredc.nrel.gov/solar/old_data/nsrdb/redbook/sum2/state.html*

API *MPMS* Ch. 19.1 provides methods for determining tank temperatures for fixed-roof tanks. API *MPMS* Ch. 19.2 provides methods for determining tank temperatures for floating-roof tanks. Annex I of this standard documents these methods.