

Manual of Petroleum Measurement Standards Chapter 14—Natural Gas Fluids Measurement

Section 1—Collecting and Handling of Natural Gas Samples for Custody Transfer

SEVENTH EDITION, MAY 2016

ADDENDUM, AUGUST 2017

ERRATA, AUGUST 2017



AMERICAN PETROLEUM INSTITUTE

Special Notes

API publications necessarily address problems of a general nature. With respect to particular circumstances, local, state, and federal laws and regulations should be reviewed.

Neither API nor any of API's employees, subcontractors, consultants, committees, or other assignees make any warranty or representation, either express or implied, with respect to the accuracy, completeness, or usefulness of the information contained herein, or assume any liability or responsibility for any use, or the results of such use, of any information or process disclosed in this publication. Neither API nor any of API's employees, subcontractors, consultants, or other assignees represent that use of this publication would not infringe upon privately owned rights.

API publications may be used by anyone desiring to do so. Every effort has been made by the Institute to assure the accuracy and reliability of the data contained in them; however, the Institute makes no representation, warranty, or guarantee in connection with this publication and hereby expressly disclaims any liability or responsibility for loss or damage resulting from its use or for the violation of any authorities having jurisdiction with which this publication may conflict.

API publications are published to facilitate the broad availability of proven, sound engineering and operating practices. These publications are not intended to obviate the need for applying sound engineering judgment regarding when and where these publications should be utilized. The formulation and publication of API publications is not intended in any way to inhibit anyone from using any other practices.

Any manufacturer marking equipment or materials in conformance with the marking requirements of an API standard is solely responsible for complying with all the applicable requirements of that standard. API does not represent, warrant, or guarantee that such products do in fact conform to the applicable API standard.

All rights reserved. No part of this work may be reproduced, translated, stored in a retrieval system, or transmitted by any means, electronic, mechanical, photocopying, recording, or otherwise, without prior written permission from the publisher. Contact the Publisher, API Publishing Services, 1220 L Street, NW, Washington, DC 20005.

Copyright © 2016 American Petroleum Institute

Foreword

Nothing contained in any API publication is to be construed as granting any right, by implication or otherwise, for the manufacture, sale, or use of any method, apparatus, or product covered by letters patent. Neither should anything contained in the publication be construed as insuring anyone against liability for infringement of letters patent.

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, 1220 L Street, NW, Washington, DC 20005. 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, 1220 L Street, NW, Washington, DC 20005.

Suggested revisions are invited and should be submitted to the Standards Department, API, 1220 L Street, NW, Washington, DC 20005, standards@api.org.

Contents

	Page
1	Scope 1
2	Normative References 1
3	Terms and Definitions 1
4	Hydrocarbon Dew Point 5
4.1	General 5
4.2	Initial Sampling of a Gas Stream of Unknown Hydrocarbon Dew Point and Composition 5
5	General Considerations for the Design of a Natural Gas Sampling System 6
5.1	The Components of Typical Sampling Systems 6
5.2	Flow Characteristics 6
5.3	Causes of Gas Sample Distortion 7
5.4	Revaporization 11
5.5	Cleanliness 12
5.6	General Discussion of Heating 12
6	Sample Probes 14
6.1	General Design Considerations 14
6.2	Application 15
6.3	Types 15
6.4	Probe Installation 16
7	Sample Loops/Lines 19
7.1	General Design Considerations 19
7.2	Pressure Drop in a Sample Loop 19
7.3	Tubing Materials 19
7.4	Pressure Regulators 20
7.5	Pumps 20
7.6	Filters 20
7.7	Separators 20
8	Sample Containers 21
8.1	General Design Considerations 21
8.2	Types of Sample Containers 21
9	Materials for Sweet and Sour Gas Service 23
9.1	General Considerations 23
9.2	Carbon Steel 24
9.3	Dissimilar Materials 24
10	Other Apparatus 24
10.1	Timers 24
10.2	Flow Computers 24
10.3	Power Supplies 24
10.4	Pressure Gauges 24
11	Spot Sampling Methods 25
11.1	General 25
11.2	Evacuated Container Method 25
11.3	Reduced Pressure Method 25
11.4	Helium Pop Method 26
11.5	Floating Piston Cylinder Method 26

Contents

	Page
11.6 Water Displacement Method	27
11.7 Glycol Displacement Method	27
11.8 Purging—Fill and Empty Method	27
11.9 Purging—Controlled Rate Method	27
11.10 Vacuum-gathering System Method	29
11.11 Use of Thermal Isolation and Throttling Devices	29
12 Automatic Sampling	32
12.1 Composite Samplers	32
12.2 Continuous Sampling Systems for On-line Analyzers	32
13 Sampling Intervals	33
13.1 General Considerations	33
13.2 Composite Sample Intervals	33
13.3 Spot Sampling Intervals	33
14 Safety, Labeling, Handling, and Transportation of Cylinders	33
14.1 Safety	33
14.2 Labeling	34
14.3 Handling and Transportation of Cylinders	36
15 Guidance for Laboratory Analysis	36
15.1 Use and Handling of Calibration Gas Standards	36
15.2 Accuracy Requirements for Preparation of Calibration Standard Gas Blends	37
15.3 Best Practices for Preparation of Calibration Standard Gas Blends	38
16 Auto-ignition of Natural Gas	38
Annex A (informative) The Phase Diagram	40
Annex B (informative) Fluid Mechanical Considerations In Gas Sampling	46
Annex C (informative) Lessons Learned during Sampling in Hydrocarbon-saturated and Two-phase Natural Gas Streams	49
Annex D (informative) Hydrogen Sulfide Warning	51
Annex E (informative) API Laboratory Inspection Checklist	52
Annex F (informative) New Spot or Composite Sample Method Performance Verification Procedure	57
Annex G (informative) Method for Measuring Hydrocarbon Dew Point Temperatures using a Bureau of Mines Manual Chilled Mirror Dew Point Apparatus	62
Annex H (informative) Gas Sampling Checklists	71
Bibliography	75

Figures

1a Typical Spot Sampling System	7
1b Typical Composite Sampling System	7
2 Typical Continuous (On-line) Sampling System/Mobile Sampling System	8
3 Examples of Thermodynamic Processes Associated with Sampling System Design and Sampling Methods	9
4 Straight Tube Sample Probe	15
5 Typical Regulated Sample Probe	16
6 Probe Dimensions Used to Determine Maximum Recommended Probe Length	17
7 Typical Double-valve Sample Cylinder	21
8 Typical Floating Piston Cylinder	23

Contents

Page

9	API Recommended Spot Sampling Apparatus for Fill and Empty Method Close-coupled and Direct Mount	28
10a	Vacuum Gathering System Model	30
10b	Alternate Method of Sampling from a Vacuum-gathering System	31
11	Typical Sample Form	35
A.1	Pressure—Volume and Pressure—Temperature Diagrams for a Pure Component	42
A.2	Pressure—Volume and Pressure—Temperature Diagrams for a Mixture	43
A.3	Retrograde Condensation	44
A.4	Examples of Thermodynamic Processes of Natural Gas	45
B.1	Laminar Flow in the Entrance Region of the Pipe	48
B.2	Comparison of Laminar and Turbulent Velocity Profiles for Flow in a Pipe	48
G.1	Diagram of a Typical Bureau of Mines Chilled Mirror Dew Point Apparatus	63

Tables

1	Maximum Recommended Probe Lengths	17
E.1	Laboratory Repeatability and Reproducibility Criteria	56
G.1	Examples of Hydrocarbon Dew Formations on a Chilled Mirror Surface	67
G.2	Examples of Other Condensations on a Chilled Mirror Surface	68

Introduction

This standard concentrates on proper sampling systems and procedures. It recognizes the critical impact of hydrocarbon dew point consideration to the overall accuracy and success of these practices and procedures. Analyses of gas samples are used for many purposes and are applied to various calculations, some of which have an impact on the accuracy of custody transfer calculations (quantity and quality).

Inaccuracies can result from using:

- a) inappropriate sampling techniques and/or equipment,
- b) inappropriate sample conditioning and handling,
- c) samples collected from non-representative locations and/or under non-representative operating conditions, and/or
- d) inappropriate analytical methods.

Analyses from samples can be utilized in many different ways, including the following:

- a) calculations to determine the heating value, volumetric flow rate, total energy, density, viscosity, hydrocarbon dew point, and compressibility;
- b) calculations to determine the gallons per thousand standard cubic feet (liters per cubic meter) of recoverable liquid product from the stream;
- c) identification of contaminants contained in the gas stream;
- d) compositional information used for process design and to determine whether the stream meets contractual specifications.

This standard incorporates guidelines and recommendations for obtaining representative samples safely. It should be useful as a resource document for training programs as well. This standard attempts to consider both sweet and sour gas streams as well as high- and low-pressure applications. Streams at or above the hydrocarbon dew point temperature, and streams that may contain water vapor up to the point of saturation are addressed.

It is not the intent of this standard to recommend particular equipment suppliers or manufacturers.

Although economic, regulatory, compositional, and contractual considerations must always be evaluated and identified, samples should be collected on a flow-proportional or flow-weighted basis whenever practical. Spot samples, by their nature, cannot fully represent a gas stream of varying composition. Time proportional samplers, particularly if they continue to sample even when flow has stopped, are not capable of accurately characterizing natural gas streams that have variable compositions.

Sampling systems and procedures not in compliance with this guideline may result in errors. Upgrading existing facilities and practices to comply with this standard is strongly encouraged but shall be at the discretion of the parties involved.

Chapter 14—Natural Gas Fluids Measurement

Section 1—Collecting and Handling of Natural Gas Samples for Custody Transfer

1 Scope

The purpose of this standard is to provide a comprehensive guideline for properly collecting, conditioning, and handling representative samples of natural gas that are at or above their hydrocarbon dew point.

The standard considers spot, composite, continuous, and mobile sampling systems. This standard does not include sampling of liquid streams.

This standard includes comments identifying special areas of concern or importance for each sampling method included. It is intended for custody transfer measurement systems and may be applicable to allocation measurement systems.

The accuracy of moisture determinations from samples collected using the recommendations in this standard has not been determined.

This standard does not include sampling multi-phase flow (free liquid and gas) or supercritical fluids.

2 Normative References

The current editions of the following standards, codes, and specifications are cited in this standard:

ASTM¹ D1142 *Standard Test Method for Water Vapor Content of Gaseous Fuels by Measurement of Dew-Point Temperature*

DOT 49 *Code of Federal Regulations*

EEMUA 138:1988 *Design and Installation of On-Line Analyser Systems*

GPA Std 2166 *Obtaining Natural Gas Samples for Analysis by Gas Chromatography*

GPA Std 2261 *Analysis for Natural Gas and Similar Gaseous Mixtures by Gas Chromatography*

NACE MR-01-75 *Sulfide Stress Cracking Resistant Metallic Materials for Oilfield Equipment*

3 Terms and Definitions

For the purposes of this document, the following definitions apply.

3.1

absorption

Occurs when natural gas constituents are dissolved into a liquid or solid that is not considered to be the mixture's liquid phase.

3.2

adsorption

Occurs when a thin film of molecules adheres to a liquid or solid surface.

¹ASTM International, 100 Bar Harbor Drive, West Conshohocken, Pennsylvania 19428-2959, www.astm.org.