

Manual of Petroleum Measurement Standards Chapter 5—Metering

Section 6—Measurement of Liquid Hydrocarbons by Coriolis Meters

FIRST EDITION, OCTOBER 2002

REAFFIRMED, NOVEMBER 2013



AMERICAN PETROLEUM INSTITUTE

Currently in preview, click buy full version

Manual of Petroleum Measurement Standards Chapter 5—Metering

Section 6—Measurement of Liquid Hydrocarbons by Coriolis Meters

Measurement Coordination

FIRST EDITION, OCTOBER 2002

REAFFIRMED, NOVEMBER 2013



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.

API is not undertaking to meet the duties of employers, manufacturers, or suppliers to warn and properly train and equip their employees, and others exposed, concerning health and safety risks and precautions, nor undertaking their obligations under local, state, or federal laws.

Information concerning safety and health risks and proper precautions with respect to particular materials and conditions should be obtained from the employer, the manufacturer or supplier of that material, or the material safety data sheet.

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.

Generally, API standards are reviewed and revised, reaffirmed, or withdrawn at least every five years. Sometimes a one-time extension of up to two years will be added to this review cycle. This publication will no longer be in effect five years after its publication, unless as an operative API standard or, where an extension has been granted, upon republication. Status of the publication can be ascertained from the API Upstream Segment [telephone (202) 682-8000]. A catalog of API publications and materials is published annually and updated quarterly by API, 1220 L Street, N.W., Washington, D.C. 20005.

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 standard or comments and questions concerning the procedures under which this standard was developed should be directed in writing to the standardization manager, American Petroleum Institute, 1220 L Street, N.W., Washington, D.C. 20005. Requests for permission to reproduce or translate all or any part of the material published herein should also be addressed to the general manager.

API standards are published to facilitate the broad availability of proven, sound engineering and operating practices. These standards are not intended to obviate the need for applying sound engineering judgment regarding when and where these standards should be utilized. The formulation and publication of API standards 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, 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, N.W., Washington, D.C. 20005.

FOREWORD

This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

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 federal, state, or municipal regulation with which this publication may conflict.

Suggested revisions are invited and should be submitted to Measurement Coordination, American Petroleum Institute, 1220 L Street, N.W., Washington, D.C. 20005.

Currently in preview, click buy full version

CONTENTS

	Page
0 INTRODUCTION	1
1 SCOPE	1
2 FIELD OF APPLICATION	1
3 DEFINITIONS	1
4 REFERENCED PUBLICATIONS	2
5 ABBREVIATIONS	2
6 SYSTEM DESCRIPTION	4
6.1 Flow Sensor Considerations	4
6.2 Coriolis Transmitter Considerations	6
6.3 System Design Considerations	6
7 SAFETY	9
7.1 Tube Failure	9
8 OPERATIONS/PERFORMANCE	11
8.1 Start-up of Metering Systems	11
8.2 Effects of Fluid Properties, Operating and Installation Conditions on Coriolis Meter Performance	11
8.3 Considerations for Changing the Stored Zero Value in the Flowmeter (Rezeroing)	12
8.4 Maintenance	13
9 PROVING	13
9.1 Proving Considerations	14
10 AUDITING AND REPORTING REQUIREMENTS	18
10.1 Confirmation Log	18
10.2 Quantity Transaction Record (QTR)	18
10.3 Event Log	18
10.4 Alarm and Error Log	18
APPENDIX A PRINCIPLE OF OPERATION	19
APPENDIX B FACTORY CALIBRATION	21
APPENDIX C PROVING FORMS FOR METERS WITH MASS OUTPUTS	23
APPENDIX D PROVING FORMS FOR METERS WITH VOLUME OUTPUTS	31
APPENDIX E CALCULATIONS	39
Tables	
1 Typical Number of Proving Runs	16
C-1 Density Conversion Factors	23
C-2 Buoyancy Correction Factors (Not applicable to closed, pressurized vessels) ..	23
E-1 Coriolis Meter—Proving Overview	39
E-2 Mass Discrimination Table	41
E-3 Density Discrimination Table	41
E-4 Correction Factor Discrimination Table	41

Figures

1	Typical Coriolis Meter Accuracy Specification	6
2	Schematic for Coriolis Meter Installation	8
3	Factors Affecting Coriolis Meter Outputs	10
A-1	Coriolis Force Illustration	19
B-1	Calibration System Schematic.	21
C-1	Proving Calculations: Conventional Pipe Prover—Coriolis Meter Mass	24
C-2	Proving Calculations: Small Volume Prover—Coriolis Meter Mass	25
C-3	Proving Calculations: Gravimetric Tank Prover—Coriolis Meter Mass	26
C-4	Proving Calculations: Volumetric Tank Prover—Coriolis Meter Mass	27
C-5	Proving Calculations: Volumetric Master Meter—Coriolis Meter Mass	28
C-6	Proving Calculations: Mass Master Meter—Coriolis Meter Mass	29
D-1	Proving Calculations: Conventional Pipe Prover—Coriolis Meter Volume.	32
D-2	Proving Calculations: Small Volume Prover—Coriolis Meter Volume	33
D-3	Proving Calculations: Gravimetric Tank Prover—Coriolis Meter Volume	34
D-4	Proving Calculations: Volumetric Tank Prover—Coriolis Meter Volume	35
D-5	Proving Calculations: Volumetric Master Meter—Coriolis Meter Volume	36
D-6	Proving Calculations: Mass Master Meter—Coriolis Meter Volume.	37

Chapter 5—Metering

Section 6—Measurement of Liquid Hydrocarbons by Coriolis Meters

0 Introduction

0.1 This standard is intended to describe methods to achieve custody transfer levels of accuracy when a Coriolis meter is used to measure liquid hydrocarbons.

0.2 Coriolis meters measure mass flow rate and density. It is recognized that meters other than the types described in this document are used to meter liquid hydrocarbons. This publication does not endorse or advocate the preferential use of a Coriolis meter nor does it intend to restrict the development of other types of meters. Those who use other types of meters may find sections of this publication useful.

1 Scope

1.1 This standard is applicable to custody transfer applications for liquid hydrocarbons. Topics covered are:

- Applicable API standards used in the operation of Coriolis meters.
- Proving and verification using both mass- and volume-based methods.
- Installation.
- Operation.
- Maintenance.

1.2 The mass- and volume-based calculation procedures for proving and quantity determination are included in Appendix E.

1.3 Although the Coriolis meter is capable of simultaneously determining density, this document does not address its use as a stand-alone density meter. See API *MPMS* Chapter 14.6 for this type of application. The measured density from the Coriolis meter is used to convert mass to volume.

2 Field of Application

The field of application of this document is any division of the petroleum industry where dynamic flow measurement of applicable fluids is desired. The use of Coriolis meters for alternative applications or fluids may be addressed within other chapters of the API *MPMS* and are not precluded by this standard.

3 Definitions

3.1 accessory equipment: Any additional electronic or mechanical computing, display, or totalization equipment used as part of the metering system.

3.2 base conditions: Defined pressure and temperature conditions used in the custody transfer measurement of fluid volume and other calculations. Base conditions may be defined by regulation or contract. In some cases, base conditions are equal to standard conditions, which, within the U.S., are usually 14.696 psia and 60°F, and in other regions 101.325 kPa (absolute) and 15°C.

3.3 base density: The density of the fluid at base conditions.

3.4 calibration: The process of utilizing a reference standard to determine a coefficient which adjusts the output of the Coriolis transmitter to bring it to a value which is within the specified accuracy tolerance of the meter over a specified flow range. This process is normally conducted by the manufacturer.

3.5 cavitation: Phenomenon related to and following flashing if the pressure recovers and the vapor bubbles collapse (implode). Cavitation will cause a measurement error and can damage the sensor.

3.6 Coriolis meter: Also referred to as Coriolis mass meter or Coriolis force flowmeter. A Coriolis meter is a device which by means of the interaction between a flowing fluid and the oscillation of a tube(s), measures mass flow rate and density. The Coriolis meter consists of a sensor and a transmitter.

3.7 Coriolis meter factor, mass or volume (MF , MF_m , MF_v): A dimensionless number obtained by dividing the actual quantity of fluid passed through the meter (as determined by proving), by the quantity registered by the meter. For subsequent metering operations, the actual quantity is determined by multiplying the indicated quantity by the meter factor.

3.8 Coriolis transmitter: The electronics associated with a Coriolis meter which interprets the phase shift signal from the sensor, converts it to a meaningful mass flow rate (represented in engineering units or a scaled value), and generates a digital or analog signal representing flow rate and/or quantity. Most manufacturers also use it to drive the sensor tubes, determine fluid density, and calculate a volumetric flow rate.

3.9 flashing: A phenomenon which occurs when the line pressure falls to or below the vapor pressure of the liquid, often due to local lowering of pressure because of an increase in the liquid velocity.