AGA Report No. 5

Natural Gas Energy Measurement

Prepared by Transmission Measurement Committee

March 2009

AGA

American Gas Association

AGA Report No. 5

Natural Gas Energy Measurement

Prepared by

Transmission Measurement Committee

Copyright 2009 © American Gas Association
All Rights Reserved

Catalog # XQ0901

DISCLAIMER AND COPYRIGHT

The American Gas Association's (AGA) Operations and Engineering Section provides a forum for industry experts to bring collective knowledge together to improve the state of the art in the areas of operating, engineering and technological aspects of producing, gathering, transporting, storing, distributing, measuring and utilizing natural gas.

Through its publications, of which this is one, AGA provides for the exchange of information within the gas industry and scientific, trade and governmental organizations. Each publication is prepared or sponsored by an AGA Operations and Engineering Section technical committee. While AGA may administer the process, neither AGA nor the technical committee independently tests, evaluates or verifies the accuracy of any information or the soundness of any judgments contained therein.

AGA disclaims liability for any personal injury, property or other damages of any nature whatsoever, whether special, indirect, consequential or compensatory, directly or indirectly resulting from the publication, use of or reliance on AGA publications. AGA makes no guaranty or warranty as to the accuracy and completeness of any information published therein. The information contained therein is provided on an "as is" basis and AGA makes no representations or warranties including any expressed or implied warranty of merchantability or fitness for a particular purpose.

In issuing and making this document available, AGA is not undertaking to render professional or other services for or on behalf of any person or entity. Nor is AGA undertaking to perform any duty owed by any person or entity to someone else. Anyone using this document should rely on his or her own independent judgment or, as appropriate, seek the advice of a competent professional in determining the exercise of reasonable care in any given circumstances.

AGA has no power, nor does it undertake, to police or enforce compliance with the contents of this document. Nor does AGA list, certify, test or inspect products, designs or installations for compliance with this document. Any certification or other statement of compliance is solely the responsibility of the certifier or maker of the statement.

AGA does not take any position with respect to the validity of any patent rights asserted in connection with any items that are mentioned in or are the subject of AGA publications, and AGA disclaims liability for the infringement of any patent resulting from the use of or reliance on its publications. Users of these publications are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, is entirely their own responsibility.

Users of this publication should consult applicable federal, state and local laws and regulations. AGA does not, through its publications intend to urge action that is not in compliance with applicable laws, and its publications may not be construed as doing so.

This report is the cumulative result of years of experience of many individuals and organizations acquainted with the measurement of natural gas. However, changes to this report may become necessary from time to time. If changes to this report are believed appropriate by any manufacturer, individual or organization, such suggested changes should be communicated to AGA by completing the last page of this report titled, **"Form for Proposal on AGA Report No. 5"** and sending it to: **Operations & Engineering Section, American Gas Association, 400 North Capitol Street, NW, 4th Floor, Washington, DC 20001, U.S.A.**

Copyright 2009, American Gas Association, All Rights Reserved.

ACKNOWLEDGEMENTS

AGA Report No. 5, *Natural Gas Energy Measurement,* was revised by a Task Group of the American Gas Association's Transmission Measurement Committee under the joint chairmanship of **Warren Peterson** with TransCanada Pipelines Limited and **James Witte** with El Paso Corporation with substantial contributions from **Eric Lemmon** with the National Institute of Standards and Technology.

Individuals who made considerable contributions to the revision of this document are:

Kenneth Starling, Starling Associates, Inc.
Paul LaNasa, CPL & Associates
Paul Kizer, Formerly with ABB, Inc.

Other individuals who also contributed to the revision of the document are:

Stephen Hall, TransCanada Pipelines Limited
Thanh Phan, Spectra Energy Corp.
Joe Bronner, Pacific Gas and Electric Company
Hank Poellnitz, Southern Natural Gas Company
Eric Kelner, Formerly with Southwest Research Institute
Ed Bowles, Southwest Research Institute
Mark Maxwell, Instromet, Inc.
Frank Brown, Consultant

AGA acknowledges the contributions of the above individuals and thanks them for their time and effort in getting this document revised.

Christina Sames
Vice President
Operations and Engineering

Ali Quraishi, Staff Executive
Engineering Services Director
Operations and Engineering

FOREWORD

This report is published to foster consensus among parties conducting energy-based measurement of natural gas.

The report addresses methods, assumptions and criteria relevant to the determination of heating value and heat energy.

Gas property measurement has a history of continual refinement. A goal of this report is to provide stabilizing influence through the stewardship of the Transmission Measurement Committee of the American Gas Association.

This revision was triggered by technology advancement and heightened industry attention to gas quality issues.

This version of AGA Report No. 5 supersedes all prior versions of this document. Users of previous editions are advised to upgrade to this edition.

Programs in Excel Spreadsheet for AGA 5 related calculations including heating values both in Imperial and SI units are provided with this report.

TABLE OF CONTENTS

1. Scope of Application

1.1 General

This report applies specifically to energy-based custody transfer measurement of natural gas. It may or may not be suitable to other applications, as determined by the user.

Heating value measurement is used in tandem with volume flow or mass flow measurement, the use of which is guided by other reports and industry standards. This report is not intended to supersede, extend or duplicate the content of flow measurement documents.

For ease of use, this report supports two approaches to estimating heating value from composition: simplified 'table look-up' or full calculation. The approaches are functionally equivalent because the look-up tables were produced with the calculation methods.

The tables A.1.1 and A.1.2 provide pre-calculated heating values of common gas constituents for a range of common reference conditions. The detailed methods and data elsewhere in this report are primarily for traceability.

Report No. 5 differs in scope from other documents concerning energy measurement. In addition to technical data and formulas, this report recommends performance criteria.

The physical property data reproduced in this report were drawn from widely-accepted industry sources, including NIST[1] and CODATA[12]. Results obtained using this report will agree closely with results from methods sharing its lineage.

In keeping with gas industry practice, this report supports both SI and Imperial units of measure.

1.2 Range Of Application

This report is focussed on methods for predicting the heat energy resulting from complete combustion of commercially acceptable natural gas.

1.2.1 Inclusion Criteria for Fuel Gas Mixtures

This report is valid only for fuel gas mixtures meeting the following criteria:

- the fuel must be in the gas phase at the specified reference conditions.
- air/fuel mixtures must be capable of ignition followed by self-sustaining, exothermic combustion reactions.
- hydrocarbon combustion reactions must reach stoichiometric completion, resulting in product water and carbon dioxide.
- trace products of combustion, such as NOx and CO, are negligible in the context of heat production

Not in the scope of this report are:

- combustion characteristics such as flame geometry and air/fuel ratio
- determination of emissions or the products of incomplete combustion
- natural Gas Interchangeability indices, other than Wobbe Number, Methane Number (MN) and Motor Octane Number (MON)