Gas Measurement Manual
Part 4

Turbine Meter
(Revised February 2017)

Prepared by the
Transmission Measurement Committee

AGA
American Gas Association

GAS MEASUREMENT MANUAL

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FOREWORD

This 2017 edition of Gas Measurement Manual, Part 4, *Turbine Meter*, is the revision of the 1985 edition. Substantial changes have been made to incorporate the latest industry knowledge on turbine meter technology.

This document is primarily a training manual for engineers, technicians, and other personnel who are new to gas flow measurement. This is not intended for use as a standard or for reference in contracts, tariff or other regulatory documents.

Information on the topics covered by this publication may be available from other sources, e.g., manuals produced by turbine meter manufacturers, which the reader may wish to consult for additional view or information not covered by this publication. Always consult with the particular meter's manufacturer for guidance in cases where the information supplied by the manufacturer is not consistent with information presented in this manual and a professional in the field of expertise.

Numerous problems and examples have been included to cover the many principles of Turbine meter measurement. They will help provide users of this document with a more complete understanding of these principles and how to incorporate them into real world applications:

- Enhanced and Updated Turbine Meter Drawings reflecting Single Rotor Turbine Meters, and Dual Rotor Turbine Meters
- Examples of Manufacturers' Calibration Documentation and Curves
- Example Problems for Computing Flow
- Example Equations for Meter Rangeability
- Example Problems for Minimum Flow Rate and Rangeability
- Spin Time Test Example(s) and Procedures
- Example of Calibration Report
- Examples of K Factors Established by Calibration
- Examples of Single K Factor Calibration
- Examples of Individual K Factor Calibration
- Examples of Meter Factor
- Example of Polynomial Curve Fit an Errors
- Example of Linear Interpolation Curve Fit and Errors
- Example of Piecewise Curve Fitting
- Example of Final Meter Factor

In this document the words shall, should and recommended are to be used to mean as follows:

Shall means a requirement to conform to the specific task.

Should and recommended are used synonymously to indicate good practices to follow.

ACKNOWLEDGEMENT

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1. Introduction

1.1 Scope

This manual is intended to describe the theory of operation, typical operating characteristics and applications of turbine meters as well as installation specifications, calibration, testing and maintenance procedures, and computations used in the calculations of flow by axial flow turbine meters, typically two-inch and larger bore diameter.

Typical applications include measuring single-phase gas flow in production, processing, transmission, storage, distribution and end-use systems. This manual is primarily meant for measurement of fuel grade natural gas and associated gases either as pure hydrocarbons, or as a mixture of pure hydrocarbons and diluents. Although not covered in this manual, turbine meters are used to measure a broad range of fluids other than natural gas.

Reference to other documents have been made for information on accessory equipment – mechanical and/or electronic – used to measure pressure, temperature, etc. of the flowing gas to convert meter outputs from flowing conditions to any standard, base, contract or other reference conditions. This document does contain the equations establishing the mathematical basis for such conversions, which may also be used for conversion of flowing volume registered by any other type of meter.

Characteristics of electronic pulse signal generating devices within or attached to the meter are not covered, although it does address the use of their outputs. In addition to providing guidance on the use of turbine meters for gas flow measurement, this manual provides practical formulas for reference and training of new entrants to the industry as well as back office and non-technical individuals unfamiliar with turbine meter for gas flow measurement.

Information covered in this publication may be complimented with AGA Report No.7, *Measurement of Natural Gas by Turbine Meters,* and manuals produced by turbine meter manufacturers. Consult with the particular meter's manufacturer for guidance in cases where the information supplied by the manufacturer is not consistent with information presented in this manual and AGA 7.

1.2 History

The history of turbine meters for gas flow measurement goes back for longer than a century. In 1901 Thomas Thorpe applied for a British patent for an inferential gas meter based on a turbine principle. In 1903 he also received a U.S. patent. In Thorp's meter, the axis of the turbine rotor was perpendicular to the inlet/outlet connections. Since then the meter design has been improved significantly. Thorp's company also made a small house meter based on the same principal of operation. Thorp's turbine meters continued in production into the 1980's.

In 1936, Hans Gehre of Elster, Germany, designed a turbine meter to measure manufactured gas. In 1950, Elster introduced a redesigned turbine meter with a nozzle type inlet and a low friction bearing system. The Elster design became the standard for future gas meters. Rockwell Manufacturing Company introduced the first U.S. produced turbine gas meter in 1962.