Manual of Petroleum Measurement Standards Chapter 22—Testing Protocol

Section 2—Differential Pressure Flow Measurement Devices

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

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Introduction

This document defines a testing and reporting protocol for flow measurement devices based on the detection of a pressure differential that is created by the device in a flowing stream. The overall objectives of this testing protocol are to facilitate the introduction of new technologies, provide a standard method for validating manufacturer's performance specifications, and define the minimum requirements needed to determine relative performance characteristics of differential pressure metering devices under a standardized testing protocol. This protocol applies to both liquids and gases.

This protocol achieves these objectives by testing representative meters provided by the manufacturer in order to:

— Quantify the discharge coefficient uncertainty and the meter's sensitivity to flow profile over a range of Reynolds numbers, sizes, area ratios, upstream and downstream piping installations and differential pressure to static pressure ratios;

— Test the gas expansion factor equation provided by the manufacturer and the manufacturer's method of determining the individual discharge coefficient for each meter to determine if they are statistically similar;

— Report the results of the testing and disclose any results that are not statistically similar as discovered during the testing process.

Performance characteristics such as discharge coefficient uncertainty, installation effects, the gas expansion factor equation, and the method of determining the discharge coefficient, can be performed as a type test under this protocol. For these characteristics, the results obtained from the tests described in this protocol can be applied to all meters of the same design that are used within the limits of the parameters tested under this protocol (e.g. size, area ratio, Reynolds number, differential pressure to static pressure ratio).

This is not a type-testing protocol for those meters that use a standard discharge coefficient equation for all meters of the same model, size, and area ratio. This standard requires the discharge coefficient or discharge coefficient equation to be determined for each individual meter. Quantifying the uncertainty of a standard discharge coefficient equation based on the statistical variation of dimensions in the manufacturing process is beyond the scope of this protocol. This protocol assumes that the influence of dimensional variation is quantified by individually testing each meter to determine its discharge coefficient under baseline conditions.

Examples of flow meters covered in this standard include, but are not limited to, orifice plates, Venturis, nozzles, cone-type meters, wedge meters and multiport averaging Pitot tubes. However, this protocol does not cover differential devices for which an API standard has been published (the flange-tapped orifice plate per API *MPMS* Ch. 14.3, for example).

Chapter 22—Testing Protocol
Section 2—Differential Pressure Flow Measurement Devices

1 Scope

1.1 General

The testing protocol is limited to single-phase Newtonian fluid flow, and no consideration is given to pulsation effects. Further revisions of this document may include the testing of such meters in wet gas or multi-phase service and the effects of pulsation. This standard does not address testing protocols of those devices that operate on the principle of critical or choked flow condition of fluids.

The testing protocol covers any flow meter operating on the principle of a local change in flow velocity caused by the meter geometry, giving a corresponding change of pressure between two reference locations. There are several types of differential pressure meters available to industry. It is the purpose of this standard to illustrate the range of applications of each meter design and not to endorse any specific meter. The basic principle of operation of the flow measuring devices follows the physical laws relating to the conservation of energy and mass for the fluid flows through the device.

Any API *MPMS* document addressing a specific type or design of differential pressure flow measuring device will supersede the requirements of this document for that type or design. An example of such standards are all parts of API *MPMS*, Chapter 14.3, Concentric, Square-Edged Orifice Meters.

1.2 Differential Pressure or Head-type Flow Meters

The operating principle of a differential pressure flow meter is based on two physical laws - the conservation of energy and conservation of mass, where changes in flow cross-sectional area and/or flow path produce a differential pressure, which is a function of the flow velocity, fluid path, and fluid properties.

This testing protocol applies to all types of differential pressure meters. The examples presented below illustrate some of the applicable meter designs; however, this protocol is not limited to these meter types.

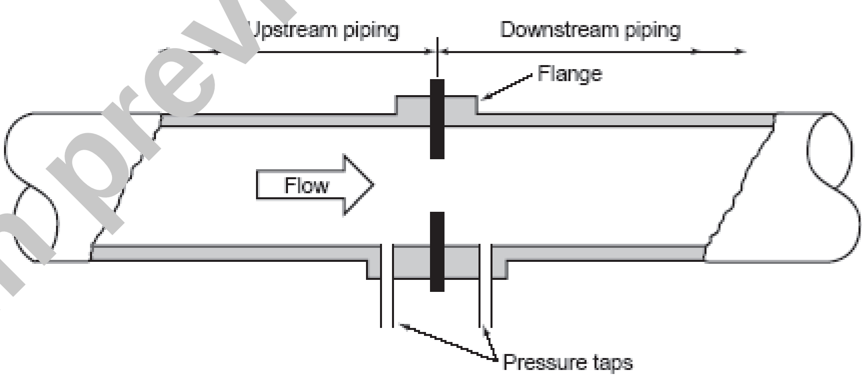

Figure 1—Concentric Orifice Flow Meter

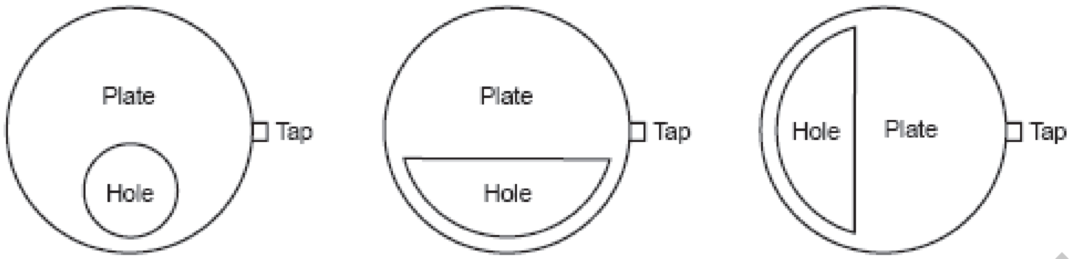

Figure 2—Eccentric and Segmental Orifice Flow Meters

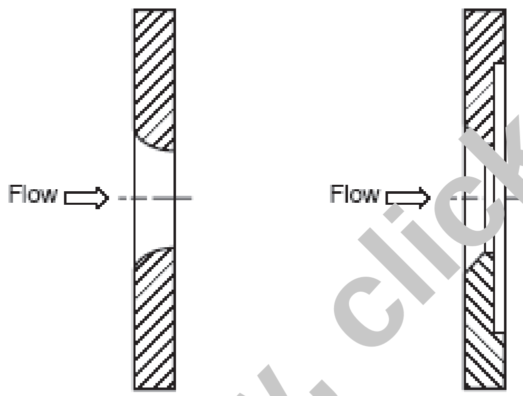

Figure 3—Quadrant Edge and Conical Orifice Plates

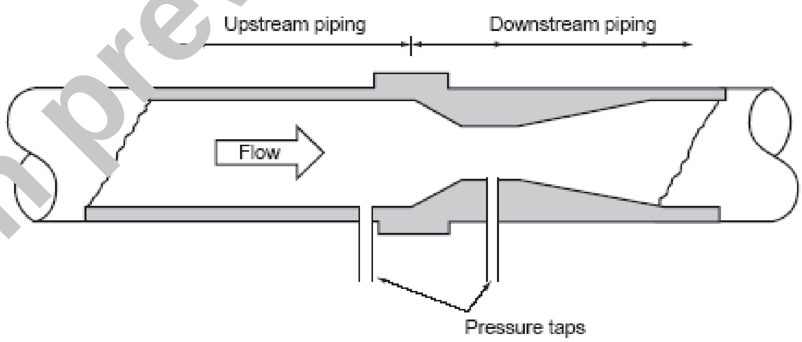

Figure 4—Venturi Flow Meter