

Addendum 1
July 2009

**Manual of Petroleum
Measurement Standards
Chapter 5—Metering**

**Section 3—Measurement of Liquid
Hydrocarbons by Turbine Meters**

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Addendum to *MPMS* Chapter 5.3 Measurement of Liquid Hydrocarbons by Turbine Meters

1. *Replace the entire Section 5.3.5 with the following:*

5.3.5 Flow Conditioning

5.3.5.1 The performance of turbine meters is affected by swirl and non-uniform velocity profiles that are induced by upstream and downstream piping configurations, valves, strainers, pumps, fittings, joint misalignment, protruding gaskets, welding projections, or other obstructions. Flow conditioning shall be used to overcome the adverse effects of swirl and non-uniform velocity profiles on turbine meter performance.

5.3.5.2 Flow conditioning typically requires the use of a combination of straight pipe and flow conditioning elements that are inserted in the meter run upstream (and downstream, if flow through the meter is bidirectional) of the turbine meter (e.g. Figure 2).

5.3.5.3 When only straight pipe is used for flow conditioning, the liquid shear, or internal friction between the liquid and the pipe wall, shall be sufficient to accomplish the required flow conditioning. Appendix A should be referred to for guidance in applying the technique.

- a) Experience has shown that in some installations (e.g. downstream of a simple elbow or tee, without a strainer close by) a straight pipe length of 20 meter-bore diameters upstream of the meter and 5 meter-bore diameters downstream of the meter may provide effective flow conditioning.
- b) For severe swirl, such as generated by two close coupled elbows out-of-plane (i.e. non-symmetrical swirl) or by a header (i.e. dual symmetrical swirl), a straightening element (i.e. swirl breaker) type of flow conditioner is required. These types of swirl are slow to dissipate in straight pipe, often existing after 100+ diameters of straight pipe.
- c) Research testing on water carried out by API in 2005 to 2006 demonstrated that a strainer, located immediately upstream of various types of flow conditioners and a 4-in. diameter turbine meter having a multi-bladed rimless rotor, can cause meter factor shifts when the amount and location of debris on the strainer screen changes; however, the observed shifts were significantly greater in magnitude with the 20 diameter straight pipe flow conditioner. It is unknown how far upstream of the turbine meter run the strainer needs to be located to minimize or eliminate this problem. Thus, it is preferable to use a flow conditioning element, rather than just straight pipe, for more effective turbine meter flow conditioning.
- d) Furthermore, this limited research testing found that, unless a positive strainer basket positioning and locking mechanism is utilized, changing the amount and location of debris on the strainer basket screen caused significant meter factor shifts, when using a tube bundle type or high performance plate type flow conditioning element.

5.3.5.4 A straightening element or swirl-breaker type of flow conditioner usually consists of a cluster of tubes, vanes, or equivalent devices that are inserted longitudinally in a section of straight pipe (e.g. Figure 2). Straightening elements effectively assist flow conditioning by eliminating swirl. Straightening elements may also consist of perforated plates or vortex generating devices, but these forms may cause a larger pressure drop than do tubes or vanes.

5.3.5.5 Proper design and construction of the straightening element is important to ensure that swirl is not generated by the straightening element since swirl negates the function of the flow conditioner. The following guidelines are recommended to avoid the generation of swirl:

- a) the cross-section should be as uniform and symmetrical as possible,

- b) the design and construction should be rugged enough to resist distortion or movement at high flow rates,
- c) the general internal construction should be clean and free from welding protrusions and other obstructions.

5.3.5.6 Isolating or high performance type flow conditioners, which theoretically produce a swirl-free, uniform velocity profile, independent of upstream piping configurations, may provide a performance advantage and should be considered.

5.3.5.7 Flanges and gaskets shall be internally aligned, and gaskets shall not protrude into the liquid stream. Meters and the adjoining straightening section shall be concentrically aligned.

2. Section 5.3.6, 1st paragraph, add to the 1st sentence:

“to prevent cavitation (see Figure 3)”

so that the complete sentence reads:

“In the absence of a manufacturer’s recommendation, the numerical value of the minimum back pressure at the outlet of the meter to prevent cavitation (see Figure 3) may be calculated with the following expression, which has been commonly used.”

3. Section 5.3.7.2, 2nd paragraph, replace:

“See Figure 2 above.”

with

“See Figure 4.”

4. Change Appendix A, “Flow Conditioning Technology without Straightening Elements” by replacing A.1, “Scope,” with the following:

A.1 Scope

Effective flow conditioning may be obtained by using adequate lengths of straight pipe upstream and downstream of the meter. Appendix A presents an empirical method for computing the length of upstream straight pipe required for various installation configurations and operating conditions. Experience has shown that a nominal length of 20 diameters of meter-bore piping upstream of the meter and 5 diameters of meter-bore piping downstream of the meter may provide effective flow conditioning in some installations (e.g. downstream of a simple elbow or tee, without a strainer close by). However, the required length of upstream piping should be verified for each installation, using the method presented in this appendix. This technique does not predict the length of straight pipe required downstream of the meter. A minimum of 5 diameters of meter-bore piping should be provided downstream of the meter unless a different length is supported by the manufacturer’s recommendations or tests.



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