Title: Developments on Orifice Meter Standards by R.G. Teyssandier

DEVELOPMENTS ON ORIFICE METER STANDARDS

by
Dr. R. G. Teyssandier
Daniel Industries, Inc.
Houston, Texas

INTRODUCTION:

Standards in the United States are voluntary standards which means that they become effective only at the "consent of the governed". This consent is derived from the technical content, practicality, need, and past experience with the methods or devices which are the subject of a given standard. This system of voluntary standards has worked extremely well for us and is due primarily to the fact that in many standards writing bodies the users are the driving force. Outside of the U.S., however, standards in many countries are mandatory. This has the effect that a given standard must be implemented regardless of the actual benefit or the cost to the user. This condition is brought about due to complete governmental control over their standards which fortunately has not come to pass in our country.

In the U.S. the American National Standards Institute (ANSI) acts somewhat like a clearinghouse for U.S. standards. It is also the point of contact for standards developed by the International Standards Organization (ISO). ANSI has no tech-nical expertise per se but relies upon other organizations such as the American Gas Association (AGA), the American Petro-leum Institute (API), the American Society of Mechanical Engineers (ASME), etc., to prepare and submit documents for eventual standardization. Technically speaking, any organization or person can submit a document to ANSI for standardization, however, technical societies such as those named above are the most obvious and important sources of these documents. ANSI procedures and hence those of organizations submitting documents to ANSI are such that all interested parties have the opportunity to participate in the development of standards. Interested parties are: manufacturers; users, consumers; and independents. The latter three being legalistic terms rather than realistic definitions in this author's opinion.

Over the past few years there has been considerable activity in the area of orifice flow measurement standards and related research. This paper will present a general summary of this activity and its conclusions (if any) to date.

AGA/API

Since ANSI/API-2530 (AGA-3) was published in 1978 as a standard it is currently up for revision or reaffirmation. Its revision is being handled under the very able leadership of Mr. Paul Hoglund with Washington Natural Gas. For this enormous undertaking he has assembled a substantial task force of experts from related fields both within the industry and the academic world. The document has been circulated widely amongst the buyers and sellers of the various fluids which will be within its scope and will probably be in its ANSI voting stage when this paper is published. With new data forthcoming (see below) there are no substantive changes since there is little agreed to proof that there should be. The new version will look different from the old version in anticipation of the

research results, however, a flow calculation by either version will essentially match. The most notable differences between the new and the old versions will be as follows:

1. The scope of the document has been expanded. Its new title will be "Orifice Metering of Natural Gas and Other Related Hydrocarbon Fluids". This extended scope will essentially be changed from a de facto to a de jure situation since AGA-3 in modified form has been used for as long as it has been published to measure fluids other than Natural Gas.
2. The document has clarified the term "meter tube" and has returned to previous editions of AGA-3 in instances where revisions (e.g. 1969) had no basis for changes.
3. Equations rather than tables are the rule. Many users were "married" to the tables without realizing that they were derived from equations. The classic example is that of pipe diameter. If the pipe in use did not meet the tolerance on diameter (but met the out--of-roundness) some users rejected meter tubes. This of course was not justified. If the pipe was out of tolerance the Fb table could of course not be used, however, an Fb could be calculated using the equations in the Appendix. Tables will appear in the Appendix so that computer programs can be checked.
4. A new constant for Fb has been derived. This value is now 338.178 while before it was 338.17. The change being due to use of 519.67R as the base temperature (60 F) rather than 520.
5. A further expansion of the document includes calculation of heating values.

ISO

The international standard for orifice flow measurement is designated as ISO-5167. It also covers nozzles and venturi's. This document was first published in 1980 with the United States voting against it for technical reasons and also the fact that it was in conflict with our own ANSI standard. This document is currently approaching the end of its five-year life-cycle so it too is up for reaffirmation or revision. Within TC-30 (the ISO Group responsible for the document) there is an editing committee which will be revising the document. This committee has both U.S. and Western European members. It is theoretically supposed to complete its work prior to 1985 and then submit this document to the governing subcommittee and then to the main body for international voting.

It is too early to predict what the eventual outcome of the document will be. One can expect some liberalization of tolerances in some areas (there is finally some data). Concurrently, there will be tightening of tolerances in others. How the U.S. will view the document when it is finally completed is another matter. ASME's committee has changed and tends to favor significant parts of the current document.

ASME

The course of action within ASME has been interesting to say the least. It started out about two years ago dropping the document similar to ANSI/API-2530 as its potential orifice standard and moved to have ISO-5167 adopted (which it had voted against). Through the efforts of a minority of the members (those most knowledgeable about orifice metering) substantial changes were made to the ASME's ISO like document. The next version of this document (9th revision) has not been sent out for vote within the committee as of the time of the writing of this paper, however, it is expected that it will be similar to the new AGA/API document with two important exceptions. These exceptions will be:

1. The use of the Stolz orifice equation.
2. Longer meter tube lengths.

There has been a considerable effort by both AGA and API to resolve the conflict between themselves and ASME with regard to the document on orifice meters. ASME's position appears to be cast in concrete. With the current and past success of orifices to measure flows of all types with ANSI/API-2530 requirements and the new data being generated at this time the motivation behind ASME's current position is unclear.

RESEARCH ACTIVITIES

Standards should initially be based on the best available research that all parties concerned have had the opportunity to evaluate. This tack was the initial thrust behind the joint AGA/ASME test work, which had been sponsored in the past. Once a standard is established it becomes even more critical that any changes be based on good hard evidence that all parties concerned evaluate and agree upon. At the present time new data on orifice meters is being obtained through the efforts of API, GPA and GRI. ASME as an organization is not participating in the research; it's only desire is to make changes. The other three organizations see that because we base our standard on orifice metering on old data, there is a need for reevaluation. Likewise, the Europeans are also in the midst of research programs, which will be useful to the modern day user. One hopes that once these programs are completed there will have been significant interchange of not only data but also of the test devices so that a truly international standard can be written based upon mutually agreeable analyses.

NBS BOULDER (GRI)

These tests are being (and have been) conducted at the National Bureau of Standards flow facility in Boulder, Colorado. All of these tests have been conducted using nitrogen as the working fluid when it is in the gaseous state. Coefficient tests have been conducted for line sizes from 2 inch to 6 inch and beta ratios from 0.1 to 0.75. The test runs are summarized in Table 1.

The data itself is quite scattered, which is unlike any data this author has seen from steady flow tests using gases on orifices. Typically, the scatter is about 1% but it varies up to 1.5% on many test runs. This scatter makes it virtually impossible to start an analysis since there is no clue as to where the mean value is. Tighter precision (repeatability) would be required prior to any analysis. Data from these tests are shown in Figures 1 and 2. All of this test work is being sponsored by the Gas Research Institute.

NX-19 STUDY (GRI)

Of importance to orifice users and of more importance to users of turbine meters is the compressibility (i.e., supercompressibility factor) for natural gases. At the University of Oklahoma, the Gas Research Institute is sponsoring a program to restudy and extend the current NX-19 tables. From this study it is expected that the following goals will be met:

1. Extension to lower temperatures.
2. Extension to higher pressures (e.g., 10,000 psia).
3. Extension to higher relative densities.
4. Wider ranges of diluents (C02, Na, H2S, etc.).

5. Accurate process calculations (other thermodynamic properties).
6. Change of pressure base to 0 psia rather than 0 psig.
7. Development of a computer program for uniform calculation of the properties of interest.

All of the above will result in a new equation of state which will have little or no change for most major custody transfer points.

This program is on schedule and significant milestones have been passed.

NBS GAITHERSBURG (API, GPA)

At the National Bureau of Standards in Gaithersburg the same meter runs used at NBS Boulder are undergoing tests on water. These tests are sponsored by both the API and GPA. In addition to these sizes tested at Boulder, 10-inch meters will also be run. Currently, this program is in the data acquisition stage so no data has been released. These tests are only part of the overall scheme of tests. Two others are planned; one on natural gas and the other on a fluid of higher viscosity than water. Data from these tests should be available starting about 1985.

CONCLUSIONS

For the oil and gas industry in the United States the new API/AGA orifice metering document will be more useful than it has been In the past. At some future date perhaps five years from now a Revised Version based on the new data will be published. At that point some changes will be required to conform to the new document. The ISO document will probably be required for many operations overseas. The new version will be based more on data than the present version.

TABLE 1
ORIFICE PLATE-METER RUN TEST COMBINATIONS

ORIFICE #
SIZE:1A
.49981B
.49952A
.74992B
.74983A
.99953B
.99944A
1.12484B
1.12485A
1.37515B
1.37466A
1.50006B
1.5003
RUNXXXXXX
FE 1
2.0679XXXX
FE 2
2.0701XXXXXXX
FE 3
3.0665XXXXXXXXXX
FE 4
3.0715XXXXXXXXXX
FE 5

4.026XXXXXXXXX
FE 6
4.025XXXXXXXXXX
FE 7
6.0698XXXXXXXX
FE 8
6.0693XXXXXXX