

RECOMMENDED PRACTICES FOR FLOWMETER USE AND CALIBRATION

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In this age of heightened quality awareness and ISO 9000 it is more important than ever before that all physical quantity measurements which are part of an industrial process are accurate and reliable. Flowmeters are no exception. When in use, flowmeters must be in good working condition and have a valid calibration if they are to produce reliable and accurate readings. Good working condition is a matter of proper use and maintenance. However, in order for the calibration of any flowmeter to be valid, a number of important criteria must be met:

The calibration must be done under conditions representative of the actual operation of the flowmeter.

It is always recommended that flowmeters are calibrated under conditions resembling as close as possible those of actual operation. Care should be taken to match the properties of the fluid, Pressure (especially for gases), Temperature and piping configuration among others.

When it is not practical to match all important parameters, appropriate compensations must be applied to insure that the flowmeter performance under operation will be predictable and reliable.

In order to apply appropriate corrections, the user must have a good understanding of the process and follow the manufacturer's recommendations regarding the use of the flowmeters. Caution should be exercised however, since some marketing literature tends to exaggerate the flowmeters' ability to perform properly under challenging conditions. One should therefore also review independently published information or seek advice from sources such as consultants or calibration facilities which are not associated with manufacturers. And most importantly, it should be kept in mind that despite occasional marketing literature claims to the contrary, all flowmeters require periodic recalibrations.

Flowmeters which are not periodically performance checked (the best way to do this is by calibration) can produce grossly inaccurate results.

The calibration must be performed by a certified and traceable laboratory.

Accreditation and documented traceability help insure that the accuracy claims made by a calibration laboratory are indeed met.

Once a laboratory is identified which adheres to these standards, the laboratory's specifications must be reviewed to determine if they cover the needed range of measurement with the required accuracy.

It should be kept in mind that Traceability by itself does not offer any assurances of accuracy. Traceability is remarkably easy to achieve and maintain, but the number of "measurement transfers" involved in attaining traceability to National Laboratories (PTB, BNM, NIST, etc.) can erode its usefulness as a measure of precision to the point where it is essentially worthless. Respectable calibration laboratories will be able to supply upon request uncertainty analyses which document their claims for traceability and overall accuracy.

The calibration of a flowmeter must be valid at the time of use.

This is the most difficult criterion to meet and the main focus of this paper. The first and most important question is:

How often should flowmeters be calibrated?

HOW OFTEN SHOULD FLOWMETERS BE CALIBRATED?

It is indeed a question that is often asked. And one for which no easy answer exists. All flowmeters, regardless of type, construction, manufacture or age, must be periodically recalibrated. But how often?

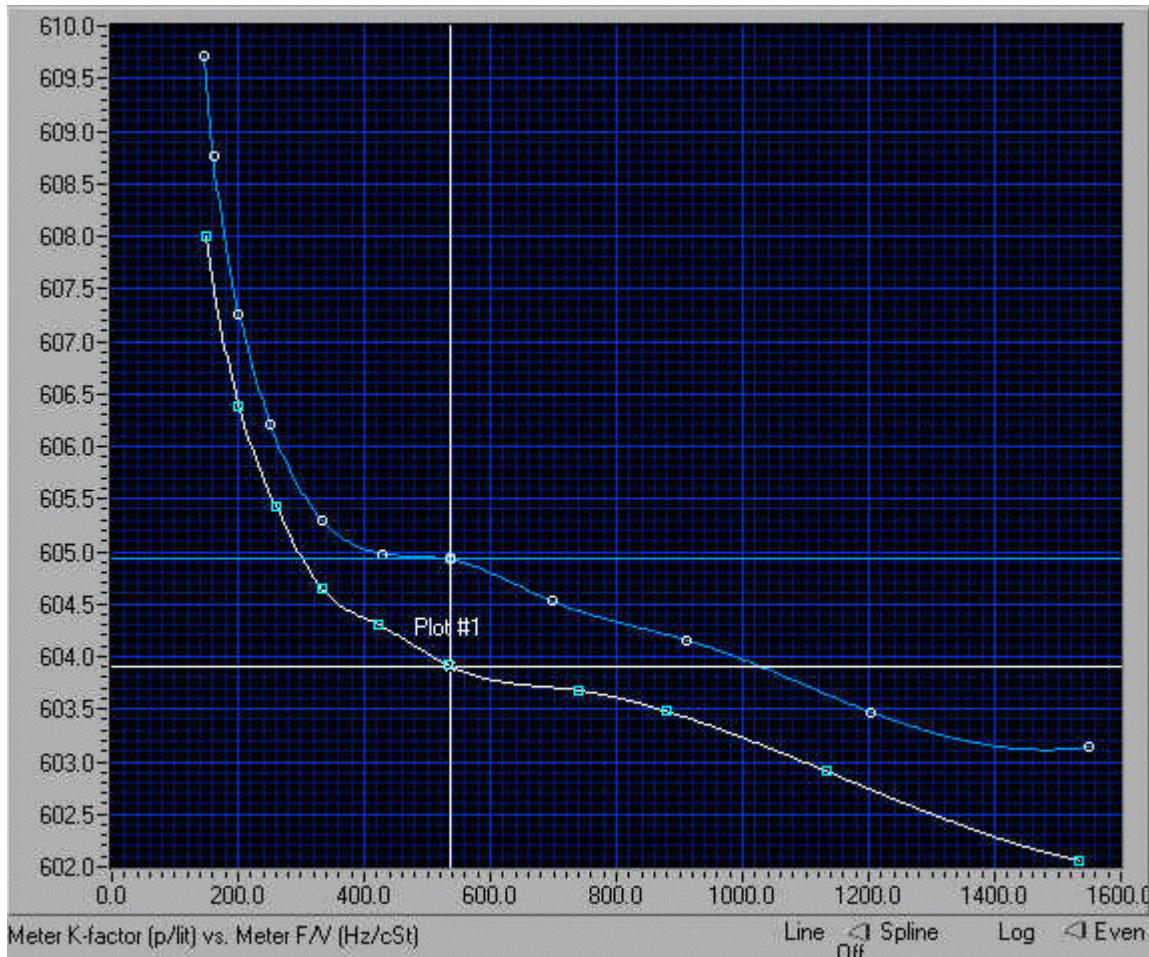
Time plays a big part in flowmeter performance. Flowmeters tend to drift with time due to the gradual and sometimes imperceptible effects of their environment. Changes occur even if no visible damage to the internal parts has occurred. This is the most compelling reason why periodic re-calibration is required. Figure 1 shows such a change for a flowmeter that was recalibrated in 12 month intervals without showing any signs of deterioration or damage between calibrations.

A usual recommendation is that new flowmeters and flowmeters used in unfamiliar applications or environments be put on a 6 month recalibration schedule. Then, as new subsequent calibrations are performed, the shift from calibration to calibration must be evaluated.

Based on that data, a decision can be made about decreasing, increasing or leaving the calibration interval unchanged.

A calibration laboratory which adheres to auditable quality standards will be able to help you define the required recalibration interval. Laboratories which follow adequate metrological and record keeping procedures will be able to search their data base and produce historical data on any flowmeter that has been calibrated at the laboratory more than once (ISO 9000 procedures dictate that such record keeping is practiced).

An evaluation of flowmeter performance change over time can then be conducted and based on the application accuracy requirements, a recommendation can be issued for the proper recalibration interval.



REASONS WHY FLOWMETER PERFORMANCE MAY CHANGE:

Deposits on internal surfaces. Layers of salts, minerals, oxidation, etc. can have a measurable effect in performance even if the meter seems to be operating properly. All types of flowmeters are affected, even ones without moving parts, such as Coriolis, Vortex, Ultrasonic, etc.

Contamination can have a severe effect on flowmeters with moving parts as well as ones without moving parts. It can for example affect the by-pass path of Thermal Mass meters, or partially block the flow paths of LFEs (Laminar Flow Elements).

Chemical attack even of the smallest scale has an effect on flowmeters, especially ones with moving parts. Any change in the geometry of the turbine meter rotors for example, will affect performance.

Abuse (such as shock, over speeding, etc), accidental or otherwise, even if it does not visibly damage the flowmeters, it will most likely change their performance characteristics.

Aging of the flowmeters causes changes, sometimes even improvements in flowmeter performance. Electrical changes occur as a result of aging or gradual burn-in of components affecting the output quality of flowmeters.

Mechanical changes to meter performance due to bearings, usually occur soon after manufacture of the meters or bearing replacement and are the result of bearing run-in (as the bearings are exercised, they run smoother) and continue at a much slower pace for the life of the meter (see figure above).

As a result, it is recommended that whenever bearings are changed on any turbine flowmeter smaller than 1" (25 mm), a run-in be performed before calibration. In fact, performance changes due to bearing improvement have been observed on new flowmeters as well, after they have been calibrated by their manufacturer. This has led some flowmeter users to request a special run-in procedure performed before calibration or simply run the meters in and recalibrate them after receiving them from the manufacturer.

Fluid property differences can be a major factor. If a meter has been calibrated in one type of fluid and used in another, significant performance changes may occur. All types of flowmeters are affected by changes in fluid properties to some extent or another. In many cases, corrections can be applied to flowmeters to compensate for the effects of such changes. The performance characteristics of most of the popular types of flowmeters have been intensely studied. Consequently, information and recommendations are usually available from manufacturers as well as other independent sources. In the case of Turbine flowmeters for example, fluid change (viscosity) effects can be at least partially compensated by using "Universal Viscosity" Calibration methods.

Improper Installation is a major contributor to flowmeter inconsistencies between calibration performance and actual operation. This subject has been covered extensively in the literature. Examples of improper (or careless) installation range from irregular upstream piping configurations, gaskets or other protrusions into the line, incorrect orientation of a flow sampling sensor into the flow stream, etc.

External influences have an effect on all flowmeter types to some extent or another. Some such as Coriolis meters are affected by vibration, others by temperature or pressure. Electromagnetic interference has the potential of affecting the performance of all types of flowmeters, save the ones with visual output (Rotameters, etc.).

Fluid property differences, improper installation and external influences do not fit into the category of gradual changes in flowmeter performance over time. They are often however the cause of unpredictable performance shifts once a flowmeter is installed in its operating location because they are usually not present in the controlled environment of a calibration laboratory.

SUMMARY

Selecting and applying the proper flowmeter for a given job is not a trivial undertaking and requires effective cooperation between flowmeter users, manufacturers and calibration facilities. In all cases, independent information should be sought about both the type of flowmeter in question and the intended application.

There are three major requirements for the proper calibration and use of flowmeters.

They must be calibrated as close as possible to the actual conditions of use and proper compensations should be applied for any deviations from ideal conditions.

The accuracy requirements for the intended measurement must be defined based on the needs of the application. Consequently, it must be confirmed that the flowmeter is calibrated by a laboratory which is capable of producing calibrations with such precision.

And finally, the greatest care should be taken to insure that at the time of use, the flowmeter possesses a valid calibration according to the guidelines outlined above.