DIFFERENTIAL TESTING OF ROTARY METERS

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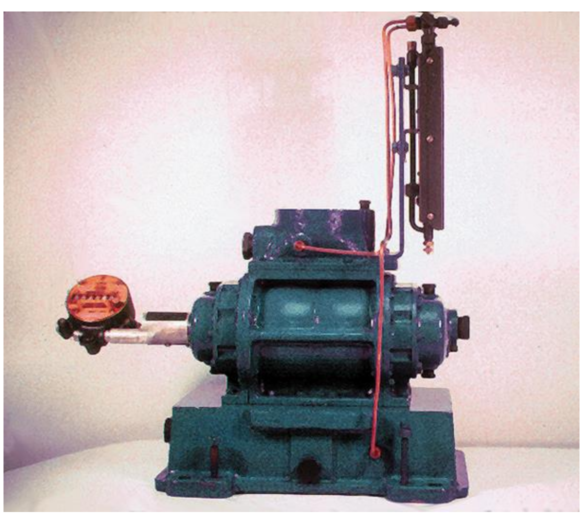
INTRODUCTION

Since the introduction of rotary meters in the 1920's, gas distribution companies have used the differential pressure across the meter as an indication of meter condition and performance. Using manufacturers' recommendations in concert with industry and regulatory standards differential testing is a cost effective method to verify the condition of a rotary meter while in service.

With acceptance by many U.S. public utility commissions, differential testing has been used by gas distribution companies for many years. This paper will discuss the traditional methods used for differential testing as well as the most recent developments that improve the efficiency and effectiveness of a differential pressure testing program.



BACKGROUND

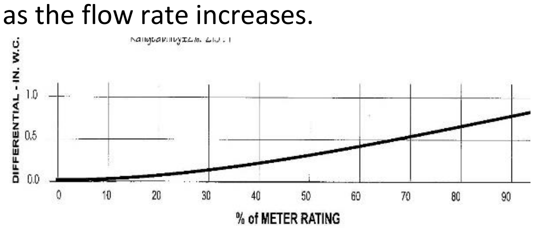
Early models of rotary meters were often sold with built-in manometers to offer constant differential pressure readings. This practice was necessitated by the conditions of commonly used manufactured gas. As the deposits from the manufactured gas accumulated, the gas company would flush the meters with solvent and often the differential pressure would lessen or return to normal. Over time, the gas companies recognized the value of monitoring and addressing the differential pressure across their rotary meters. As manufactured gas was displaced with natural gas, the local distribution companies continued to use differential pressure testing as a guide to the general condition of their rotary meters.

In 1946 the U.S. Department of Commerce National Bureau of Statistics published Research paper 1741 titled "Testing Large Capacity Rotary Gas Meters". This report validated and quantified twenty-five years of gas industry experience with differential testing of rotary meters. Report 1741 found that one could reliably estimate the condition of a meter in the field to the pressure drop recorded at initial installation. The report found that the pressure drop across the meter, when measured under similar flow rate and line pressure would highlight whether meter accuracy had changed.

CONVENTIONAL DIFFERENTIAL TESTING

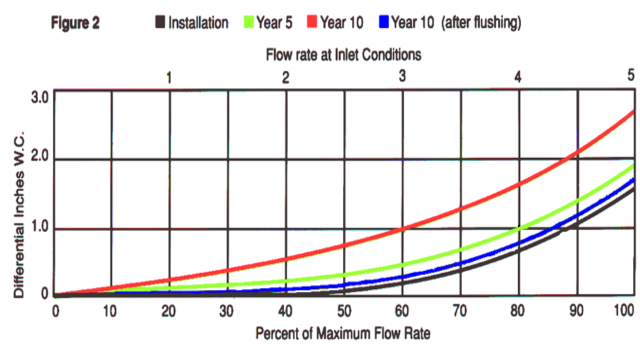
Since the publication of Report 1741, natural gas distribution companies – with extensive support from rotary meter manufacturers – fine-tuned their differential policies and procedures. From this experience, the following became common practice:

1. Perform a differential test upon the initial installation of a rotary meter when line pressure exceeds 15 PSIG. This line pressure measurement reflects the effect of line pressure on meter differential. Three flow rates between 25% and 100% of meter capacity were recommended to ensure data for a broad range of operating conditions was available for future reference.
2. Record the initial differential pressure at the associated flow rates as well as the metering pressure. This information was usually plotted on a graph to set the performance when newly installed. A characteristic differential curve rises as the flow rate increases.



3. When metering pressure is lower than 15 PSIG it is common for gas companies to use the typical differential data available from the meter manufacturer illustrated above.
4. At intervals of as much as ten years the gas company will retest the meter and plot those results against the previous data. The interval between tests is set by the gas company or its regulatory agency to ensure the tests are effective while not onerous.
5. If the differential pressure measured across the meter has not increased by 50%, the meter accuracy will not have dropped more than 1%. It is important to recognize that rotary meter accuracy is affected only negatively by increased differential. Thus, as a preventive maintenance method, differential testing can protect the utility’s investment in metering equipment and reduce unmeasured gas.

When the differential pressure change exceeds 50% often a meter flush cleaning will correct the situation, as illustrated below.



Implementation of an effective differential pressure testing program includes regular training and consistent record keeping. While there is an accuracy component to differential testing, it does not offer an accuracy result, per se. Likewise; the differential pressure test provides a snapshot of the condition of the meter body but does not address any of the instrumentation that might be mounted on the meter.

CHALLENGES WITH CONVENTIONAL DIFFERENTIAL TESTING

While conventional differential testing programs are effective and efficient for the most part, there are some challenges in today's environment.

Initial (Baseline) Installation Data

On new installations it may be difficult to coordinate the start-up of the gas burning equipment to the presence of the utility technicians responsible for the differential pressure base line data. It is also often impossible to obtain more than one flow rate while on-site.

It can also be difficult to maintain records through many industry mergers and relocations. The lack of baseline data negates any means to compare the current meter condition to its "as new" condition.

Interpretation of Data

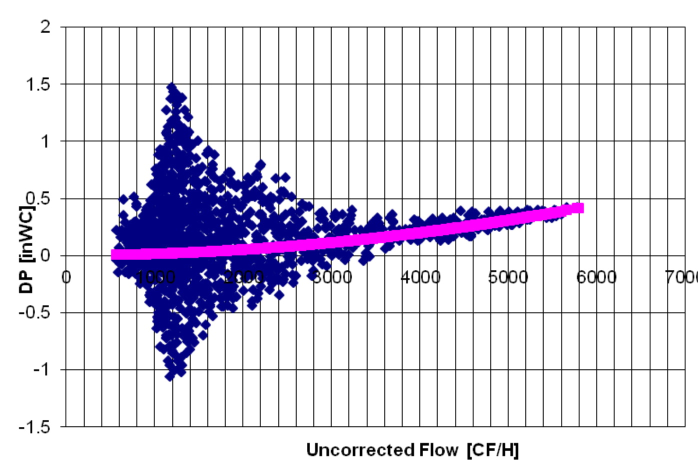
The differential pressure across a rotary meter can be affected by four factors

i. Line pressure
   a. As the line pressure increases the differential across the meter also increases
ii. Flow rate
   a. As illustrated previously, the differential across a meter will rise with an increase in flow rate
iii. Specific Gravity
   a. Meters tested on shop air will have a higher differential pressure than those field tested on natural gas when all other factors are equal
iv. Internal Friction
   a. This is the measure of external factors such as wear and tear, old bearings, old oil, line debris etc. that is the target for preventative maintenance.

Tests performed over many years will have wide variances in the first three *quantifiable* factors and plotting the results of a test against these wide variances can be confusing.

Low Flow (or No Flow) at Time of Testing

It is common to perform differential testing and other regularly scheduled maintenance during the warmer months. As a result, the flow rates at the meter site are often below the recommended minimum of 25-30%. There also a variety of intermittent loads, such as grain dryers and asphalt plants, which have zero flow for long periods of time. Coordinating the timing of the gas company tests with the operation of these intermittent loads is near impossible. The following illustrates the effect low flow can have on differential pressure reading:



CONSEQUENCES OF NOT HAVING CURRENT DIFFERENTIAL TESTS

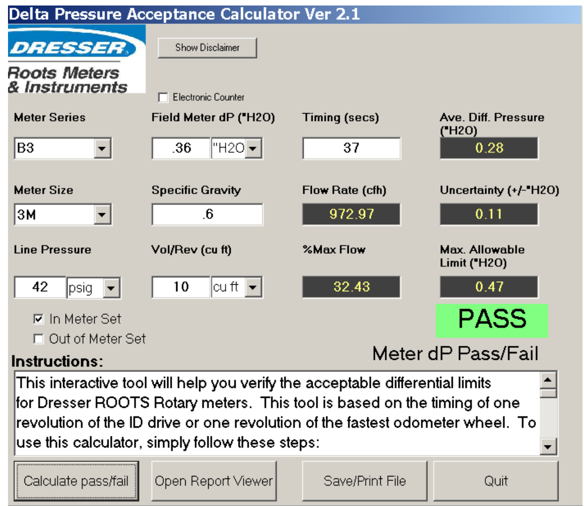
If it has been unable to maintain solid differential testing data, the gas utility faces pressure on:

- Its capital budget dollars
    - Meters may fail in the field when differential testing might have identified the meter as being in need of a basic cleaning or low level repair. Differential testing can also identify gas conditions that may have changed and are detrimental to the meter and other meter set equipment.
- Its LAUF gas
    - As the differential rises across a meter, the accuracy slows. The unmeasured gas is then lost and unaccounted for and a factor in regulatory discussions.
- Regulatory compliance
    - Every district is different, but many state and federal agencies have increased their oversight of all areas of the gas industry
- Customer complaints
    - Again varying by district, customers of the gas utility are increasingly looking for well documented test routines and certifications of accuracy

There are solutions to most of the challenges we have discussed.

Electronic Differential Test Calculator Software

A software program is available that allows the meter tester to enter current differential pressure test results and have those results compared to the meter manufacturer's historical data for new meters. The technician gathers the field meter data as usual, noting the meter size and type, the on-site flow rate variables and line pressure. The calculator compares the field meter data with an approximate "like new" table and offers a pass/fail result based upon whether the meter has exceeded the "like new" by more than the traditional 50%.



The calculator includes a report function for input of site and technician information.

ON-BOARD METER SELF-DIAGNOSTICS

The advance and acceptability of electronic gas measurement has allowed for the creation of on-board rotary meter self-diagnostics.

The addition of a differential pressure transducer to an integral electronic meter corrector allows the meter to measure its own

- Flow rate
- Differential Pressure

- Metering (line) pressure
- Flowing temperature

The integral corrector also allows for configurable fixed specific gravity factor. The corrector features advanced data collection and reporting functions.

This results in the meter corrector measuring and storing the most recent test that meets the recommended flow rate of 30% of meter capacity. Thus the technician can obtain a valid test result whether there is any gas flow during their visit or not.

The integral DP corrector can also be programmed to send an alarm when high differential levels are present. This allows a quicker response and further protects local gas utility revenue streams.

The other benefits of the integral DP meter corrector can include lower overall testing costs as return visits are no longer needed. Further, when sites are difficult to access, either structurally or geographically, the integral DP meter corrector can communicate problems remotely and initiate site visits only when needed.

CONCLUSION

At a time when meter site data is increasingly required to fulfill regulatory, internal and other external needs gas utilities are often challenged to gather this information reliably or effectively. Basic differential testing can meet many of these needs. When individual company and site factors dictate, new technology allows the utility to meet these requirements.

ACKNOWLEDGEMETS

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ABOUT THE AUTHOR

Ron Walker is President and Founder of Walker Technical Sales Inc. Ron has been involved in the North American Gas Industry for over 35 years and the Appalachian Gas Measurement Short Course since 1994.