INTRODUCTION TO GAS METERING
Principles of Gas Metering

• Natural Gas
  – Compressible substance
    • One quantity of gas can occupy different volumes at different temperatures and pressures
  – *Quantity* of gas is what is important
  – Standard Volume vs Actual Volume

• Gas Meters
  – Only capable of measuring Actual Volumes
  – If pressure and temperature are known, actual volume can be converted to standard volume
• Three different Actual Volumes
• Three identical Standard Volumes
  – A SCF is defined as 1 actual cubic foot of gas at 60°F and 14.73 PSI
Standard Volume

\[ V_S = V_A \times F_P \times F_T \times F_{FPV^2} \times F_M \]

- **Supercompressibility Factor**
- **Meter Factor**
- **Pressure Factor**
- **Temperature Factor**
- **Actual Volume**
Ideal Gas Law \( (PV = nRT) \)
- Pressure and Temperature Factors
- \( F_P \) is much more significant than \( F_T \)

\[
V_S = V_A \times F_P \times F_T \times F_{FPV^2} \times F_M
\]

Supercompressibility
- Required when \( P > 100 \) PSI
- Corrects for differences between real and ideal gasses
- Gas composition needs to be known

Meter Factor
- Corrects for individual meter performance
- Determined via proving test
- Typically ignored in custody transfer applications
\[ V_S = V_A \times F_P \times F_T \]

- **Temperature Factor**
  - Corrects the actual volume at a measured temperature to a standard volume at the base temperature (typically 60°F)
  - Absolute temperature units required (Rankin/Kelvin)

\[ F_T = \frac{T_{base}}{T_{absolute}} = \frac{459.67+60°F}{459.67+T_{gas}} \]

- **Pressure Factor**
  - Corrects the actual volume at pressure to a standard volume at the base pressure (typically 14.73 PSI)

\[ F_P = \frac{P_{absolute}}{P_{base}} = \frac{P_{atmosphere} + P_{gauge}}{P_{base}} = \frac{P_{atm} + P_g}{14.73 \text{ PSI}} \]
Cost = \( V_{\text{Standard}} \times E_{\text{Density}} \times P_{\text{Energy}} \)

\[ \$ = \text{SCF} \times \frac{\text{GJ}}{\text{SCF}} \times \frac{\$}{\text{GJ}} \]
Meter Types
• Diaphragm Meters
  • Low Pressure (0-100 PSI)
  • Low Flow rates
  • Excellent Turndown (~100:1)

• Rotary Meters
  • Medium Pressure (0-175 PSI, 0-1480 PSI in HP Models)
  • Medium to High Flow rates
  • Good Turndown (~50:1)

• Turbine Meters
  • Highest Pressure (up to 1480 PSI)
  • High flow rates
  • Poor Turndown (~20:1)
Diaphragm Meters

- Most appropriate for intermittent or low flow gas with low pressure

- Typically Temperature Compensated

- Small Diaphragm
  - 200 Series to 400 Series Meters (AC250 to AL425 e.g.)
    - ~0 CFH to ~500 CFH (actual volume)
    - Typical “House” meter

- Large Diaphragm
  - 600 Series and larger (AC630 to AL5000 e.g.)
    - ~0 CFH to ~5000 CFH (actual volume)
    - Commercial/Large Residential application
Diaphragm Meter Anatomy

- 1” MNPT
- Hand Hole Cover
- Top Cover
- Index
- Meter Body
- Front Cover (Transparent)
- Meter Connection Set
- 20 LT Connection Thread
- Seal Plug

Diagram showing parts of the diaphragm meter with labels pointing to each component.
Diaphragm Meter Sizing

• All meters are sized based on actual gas volume flowrate
  – Typical example: Requirements are “300,000 BTU at ¼ PSI”
  – The BTU corresponds to the standard volume of gas, we generally assume 1000 BTU per SCF of natural gas. This example equates to ~300 SCF/hr
  – We cannot exceed a meter’s maximum capacity, so we would select the smallest meter that is capable of measuring ~300 SCF/hr
  – The best meter for this application would probably be an AL425
    • The “425” corresponds to the maximum ACF/hr that the meter can measure at ¼ PSI (see table)
  – Meters have limited connection size options – gas line may need to be swaged up/down to accommodate the proper meter
Diaphragm Meter Sizing

- Diaphragm meters are sized empirically using delivery pressure and required flow to select the appropriate meter

<table>
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<th>Gauge Pressure (psi)</th>
<th>Differential Pressure (&quot;WC&quot;)</th>
<th>New Meters</th>
<th>Discontinued: Rebuilds may be available</th>
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(in scf/h of 0.6 SG Natural Gas)
Diaphragm Meter Options

• All Diaphragm meters available in m³ or ft³
• Most only have one possible connection size
  – Some meters have two top cover options
• Small Diaphragm Options
  – Pressure Taps
    • Allows for live pressure measurement at the meter
  – Pulsers
    • Allows for wired transmission of meter index counts
  – Electronic Radio Transmitters (ERTs)
    • Allows for wireless reporting of meter index reads
• Large Diaphragm Options
  – Pulsers
  – ERTs
  – Electronic Volume Correctors (Instruments)
    • Live correction of variable pressure/temperature
    • For LD meters, EVCs will typically only correct for pressure
Diaphragm Pulser Options

• Pulse weight (i.e. volume/pulse) will depend on the specific meter and pulser combination.

• Small Diaphragm Pulsers
  – Elster Small Diaphragm Pulser (RVP-VI)
    • (1 pulse/revolution)
    • Measurement Canada (MC) Approved
  – Riotronics Small Diaphragm Pulser
    • (2 pulses/rev)
    • For Non-Elster Meters

• Large Diaphragm Pulsers
  – Elster Large Diaphragm Pulser (RVP-FI)
    • (1 pulse/rev)
    • MC Approved
  – Riotronics Large Diaphragm Pulser
    • (2 pulses/rev)
    • For Non-Elster Meters
Rotary Meters

- Most appropriate for consistent gas flow at 0-175 PSI
- Available with or without temperature compensation
- High Pressure models available (up to 1480 PSI)
- Mostly used for industrial or large-scale commercial applications
Rotary Meter Anatomy

- **Meter Body**
- **Index (Head)**
- **Sight Glasses**
Rotary Meter Sizing

• Rotaries are sized based on actual gas volume flowrate
  – For Dresser rotaries, roman numerals are used to describe maximum flowrate (ex. 8C = 800 CFH, 11M = 11000 CFH)

• Turndown ratio is worse on rotaries than diaphragms
  – There is a minimum flowrate required in order for gas to be measured. This is why constant gas flow is important.

• Since meters are sized based on actual volume, a smaller meter at a higher pressure can often be used to save costs
  • Ex. An 8C175 at 100 PSI can handle ~6000 SCFH
  • Ex. A 5M175 at 2PSI can handle ~5200 SCFH
Rotary Meter Options

• The rotary meter bodies are all entirely fixed. Adjustments to the meter configuration are external to the meter body.

• Index Options
  – The index is what displays the meter read. Mechanical indexes can be imperial (ft³) or metric (m³)
  – Mechanical temperature compensation is available

• Pulsers
  – Can be installed on index to provide wired reporting of index read

• Instrument Drive
  – 90° addition to the end of the index
  – Allows for installation of EVC or RA-100 via mechanical wiggler

• Microcorrector
  – Functionally identical to an EVC, but in a smaller body
  – Integrated pulse output capabilities
  – Versatile programming options (units, multipliers, pulse output options, fixed pressure factors, T-only option, PTZ correction, etc)
Rotary Pulser Options

- Rotary Pulsers
  - Riotronics Rotary Pulser
    - (2 pulses/rev)
    - Mounts directly to mechanical rotary indexes
  - RA-100
    - (100 pulses/rev)
    - Mounts to an instrument drive on a rotary meter
    - MC Approved
  - Barchard Veeder Root Custom Explosion Proof pulser
    - (10 pulses/rev) or (100 pulses/rev)
    - Mounts directly to mechanical rotary indexes
Electronic Volume Correctors (EVCs)
Instruments/Microcorrectors

- Functionally identical
- Highly configurable and customizable
- Precise measurement of gas pressure and temperature
- Live calculation converts actual volume to standard volume
- Pulsing options allow for easy integration of ERTs or output pulse cable
Measurement
Canada and Other Regulations
Regulations

- Depending on application and location, many different regulations can come into place. The Electricity and Gas Inspection Act, Measurement Canada, Boilers Branches (ABSA), Local Building Codes, ASTM, ASME, and others can have a say in what is required.

- Many, but not all, meters do have CRN numbers, MTRs and other certificates. If there are any specific documentation or certification requirements, it is important to collect that information upfront because it will limit the applicable options. If certifications are not available for a product, generally speaking manufacturers will not pursue additional certifications for sales less than a million dollars.

- Measurement Canada has a large impact on metering Canada. They are responsible for insuring all devices used to sell goods based on a measurement are accurate.
Measurement Canada

- Measurement Canada enforces many laws, acts, requirements, and bulletins. It is the responsibility of the contractor to know and meet all requirements. General Concepts to keep in mind are:

- Any time gas is sold off a meter, or a bill is divided using meters, that meter must be sealed under Measurement Canada.

- To sell gas using a meter, the meter owner must be registered with Measurement Canada and obtain a contractor registration number. When meters are sealed they are issued a certificate which detail meter information, test results, and seal period. The meter owner (contractor) is responsible for insuring all the criteria within the Electricity and Gas Inspection Act are met, including that meters are re-verified after their seal period has expired.
Pressure Correction

- Measurement Canada: Pressure correction is required for pressures greater than ½ PSI
- Atmospheric pressure must always be accounted for
- Only EVCs are capable of live pressure correction
- Elevation or atmospheric pressure needs to be programmed into the instrument
  - Many pressure transducers measure gauge pressure, so the atmospheric pressure needs to be known in order to properly calculate the pressure factor
- Pressure Factor Metering (PFM) is another option for measuring standard gas volumes
  - The use of a regulator keeps the pressure constant, and the pressure factor is therefore known and standard volumes can be calculated manually
Temperature Correction

- Measurement Canada: temperature correction is required
- EVCs, mechanical rotary TC indexes, and diaphragm meters are all capable of live temperature correction
  - Diaphragm meters correct for temperature internally
  - Mechanical TC indexes correct for temperature via internal temperature probe
  - EVCs precisely measure the temperature via temperature probe, and then calculates the temperature factor electronically
FAQs

• What is required to choose the correct meter?
  – Expected flow rate (BTU/hr, SCF/hr)
  – Expected and Max Pressures (PSI, kPa)
  – List of special requirements (pulsers, etc)

• How do I ensure my meter is properly installed and functioning correctly?
  – Refer to IOM for specific installation requirements
  – Review meter is sealed and correct documentation is valid
  – Clock the meter to ensure its maximum flow rate is not exceeded

• See more FAQ at barchardengineering.com/faq
For more information including IOM manuals, product information and other literature please visit BarchardEngineering.com/resources

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