Flow Measurement Fundamentals (Instructor-Led Training)

Course Description

This Course introduces you to the fundamentals of flow measurement and provides and overview measurement equipment used in the natural gas pipeline industry.

Course Prerequisites

- GTA Web-Based Training
  - Core WBT
  - Flow Measurement Fundamentals
  - Gas Properties 1
- GTA Instructor-Led Training
  - Drawing Sets and Print Reading
  - Basic Measurement

Course Objectives

Upon completion of this course, the student will have received instruction designed to assist him/her in the following:

- Describe the history behind flow measurement.
- Explain the fundamental units of measurement used in the natural gas industry.
- Define the properties of natural gas.
- Describe the basic gas laws that pertain to natural gas and perform calculations for pressure, temperature, and volume.
- Describe the different types of meters used for measurement.
- Explain the three Rs in flow measurement.
- Explain meter station drawings.
- Explain SCADA.

Course Outline

1. Flow Measurement
    a. Why We Need Flow Measurement
    b. Pioneers of Flow Measurement
2. Units of Measurement
    a. Pressure
        i. Atmospheric Pressure
        ii. Gauge Pressure
        iii. Absolute Pressure
        iv. Differential Pressure
        v. Vacuum
        vi. Head Pressure
    b. Temperature
        i. Fahrenheit and Celsius Scales
        ii. Rankine and Kelvin Scales
    c. Viscosity, Volume, Mass, Molecular Weight, and Density
    d. Compressibility
    e. Water Dew Point
    f. Hydrocarbon Dew Point
    g. Sound Speed
    h. Specific Gravity
    i. Ideal Specific Gravity
    j. Flow Rate
    k. British Thermal Unit
    l. Heating Value
    m. Standard Cubic Foot
3. Chemical Properties of Natural Gas
4. Gas Laws
    a. Introduction to Gas Laws
    b. Boyle's Law

c. Charles' Law
d. Ideal Gas Law

5. Flow Measurement Devices
    a. Orifice Flow Meter's Operating Principle
        i. Orifice Meters Advantages
        ii. Orifice Meters Disadvantages
        iii. Orifice Meters Precautions
        iv. Orifice Meter Measurement Components
            1. Meter Tube
            2. Orifice Plate-Holding Device
                a. Flanged Fitting
                b. Single-Chamber Orifice Plate Holder ("Simplex")
                c. Single-Chamber Orifice Fitting ("Junior")
                d. Dual-Chamber Orifice Fitting ("Senior")
            3. Orifice Plate
    b. Pressure Taps
        i. Flange Taps
        ii. Corner Taps
        iii. Vena Contracta Taps
        iv. Radius Taps
        v. Pipe Taps
    c. Flow Conditioning Devices
        i. Straightening Vanes Type Flow Conditioners
        ii. Plate Type-Flow Conditioners
    d. Effects of Abnormal Conditions on Orifice Meters
        i. Orifice Plate Installed Backward
        ii. Orifice Plate Edge Sharpness
        iii. Notches or Groves on the Sharp Edge
        iv. Bent or Warped Orifice Plate
        v. Rough Orifice Plate

vi. Grease Deposits on the Orifice Plate
vii. Liquid Film on the Orifice Plate and in the Meter Tube
viii. Free Liquids

e. AGA 3 Recommendations
   i. Meter Tube Internal Diameter
   ii. Diameter Ratio
   iii. Tap Holes
   iv. Meter Tap Location
   v. Roughness Average
   vi. The Three Rs for Meter Tube Gas Flow Measurement
      1. Reliability (Uncertainty/Accuracy)
      2. Rangeability
      3. Repeatability

f. Orifice Plate Faces
   i. Flatness
   ii. Roughness
   iii. Cleanliness

g. Bore Edge
   i. Bore Diameter (dm dr)
   ii. Bore Thickness

h. Plate Thickness

i. Plate Bevel

j. Orifice Plate Eccentricity

k. Linear Meters
   i. Turbine Flow Meters
      1. Turbine Meter Construction and Operation
      2. Body
      3. Nose Cone
      4. Label Plates
      5. Measuring Mechanism

6. Output and/or Readout Device
7. Turbine Meter Advantages
8. Turbine Meter Disadvantages

ii. Effects of Abnormal Conditions on Turbine Meters

1. Swirl Effect
2. Velocity Profile Effect
3. Fluid Drag Effect
4. Non-fluid Drag Effect
5. Pulsation Effects

iii. Mechanical Defects

iv. Grease Deposits or Contaminants

v. Free Liquids

l. Positive Displacement Meters

i. Multi-Rotor Meters

ii. Diaphragm Meters

iii. Linear Meter Equations

1. Pressure
2. Temperature
3. Specific Gravity

iv. Effects of Abnormal Conditions on Positive Displacement Meters

1. Pulsation Effects
2. Mechanical Defects

v. Grease Deposits or Contaminants

vi. Free Liquids

m. Summary of Abnormal Conditions

n. Coriolis Meter

o. Averaging Pitot Meters

p. Vortex Meter

q. V-Cone Meter

r. Mcf and the Positive or Turbine Meter Index

s. Ultrasonic Flow Meters
t. Ultrasonic Meter Flow Calculation
u. Ultrasonic Meter Transit Time Calculation
v. General Requirements for Accurate Ultrasonic Flow Measurement
w. Advantages of Ultrasonic Flow Meters
x. Disadvantages

6. Meter Station Drawings
    a. Introduction to SCADA
    b. SCADA
    c. RTU
    d. Analog Inputs
    e. Digital Inputs
    f. High-Speed Counter Inputs
    g. Analog Outputs
    h. Discrete Outputs
    i. RTU Functions
    j. EGM
    k. Run Switching
    l. Gas Sampling and Totalization
    m. Gas Odorization
    n. PID Regulator Control
    o. Customer Interfaces
    p. Flow/Pressure Control
    q. PID Control Basics
    r. Proportional or Gain (P)
    s. Integral or Reset (I)
    t. Derivative (D)
    u. PID Process
    v. Set point
    w. Error Signal Calculated

x. Proportional Action (Gain)
y. Integral Action
z. Output
aa. Feedback Loop
bb. Communication and Gas Property Downloads and Zoning
cc. Polling and Updating Frequencies

Recommended Resources

- GTA Flow Measurement Fundamentals Participant Guide
- GTA Measurement Fundamentals Instructor Presentation.
- AGA Reports 3, 5, 7, 8, 9, 10, GPA Standards 2145, 2166, and API MPMS Chapter 14.1.
- Internet sites related to flow measurement, fluid properties or flow meter types.
- Textbooks or other publications related to flow measurement, fluid properties or flow meter types.