

Course 275: Flow Measurement

Covers principles of fluid flow and how primary devices affect fluid flow. Describes flow measurement using several kinds of secondary devices. Discusses rotameters and other variable-area instruments. Explains how weirs, flumes, and other arrangements measure open-channel flow. Compares many kinds of positive-displacement meters and explains the operation of several kinds of turbine and magnetic flowmeters. Describes less-common flowmeters (including vortex-precession, mass flow, and ultrasonic devices) and instruments that meter the flow of solids. Provides guidelines for safe installation and maintenance of flow devices.

TPC Training is accredited by IACET to offer **1.0 CEU** for this program.

**Lesson 1: Properties of Fluid Flow***Topics*

Importance of Flow Measurement; Basic Properties of Fluids; Fluids in Motion; Getting Fluids to Flow; Establishing a Pressure Difference; Ways of Indicating Fluid Flow Rate; Conditions Affecting Flow Rate; Reynolds Number

Objectives

- Explain the difference between density and relative density (specific gravity).
- Define fluid velocity, viscosity, and volume flow rate.
- Describe laminar flow and turbulent flow.
- Explain how static head, friction head, and velocity head differ from each other.
- Explain how pipe size, pipe friction, and fluid viscosity affect the measurement of fluid flow.

Lesson 2: Primary Measuring Devices*Topics*

Flow Classification; Flow Measurement Methods; Flow Measurement in Completely Filled Pipes; Restricting the Flow; Pressure Drop; The Orifice Plate; Orifice Plate Design Features; Special Kinds of Orifice Plates; Annular Orifice and Wedge Element; The Flow Nozzle; Turndown and Rangeability; Location of Pipe Taps; Straight Pipe Requirements

Objectives

- Describe direct and indirect flow measurement methods.
- Describe how a primary device creates a differential pressure.
- Give at least three examples of common primary devices and explain how each works.
- Describe the significant features of orifice plates and explain their functions.
- Discuss the conditions that determine the length of straight pipe required for each kind of primary flowmeter.

Lesson 3: Secondary Measuring Devices*Topics*

Secondary Measuring Devices; Basic Manometer Design; Liquid Pressure Measurement; Reading the Meniscus; Wet and Dry Manometers; Calibrating a Manometer; Hazards of Mercury; Bellows Meter; ΔP Transmitter; Integral-Orifice Transmitter; Vibrating-Wire Transmitter; Target Meter; Elbow-Mounted Measuring Device; Deadweight Tester

Objectives

- Explain why both accuracy and precision are required in a secondary measuring device.
- Describe how an inclined manometer differs from a conventional U-tube manometer.
- Explain how to calibrate dry and wet manometers.
- Give examples of secondary measuring devices and explain how they work.
- Explain how to calibrate a differential pressure transmitter and discuss the different outputs available.

Lesson 4: Variable-Area Instruments*Topics*

The Rotameter; Reading a Rotameter; Conditions Affecting Rotameter Performance; Measuring Gas Flow; Relative Density, Pressure, and Temperature; Float and Tube Shapes; Special Uses for Rotameters; Piston and Vane Variable-Area Meters; Special-Purpose Variable-Area Meters

Objectives

- Discuss the similarities and differences between rotameters and orifice instruments.
- Compare the benefits of linear and nonlinear scales and explain how a square-root extractor is used.
- Explain how calibration, relative density, viscosity, and temperature affect rotameter readings.
- Describe how changes in the pressure, temperature, and relative density of a gas affect the ability of a rotameter to measure its flow rate.
- Discuss the operation of piston- and vane-type flowmeters and explain why armored rotameters and orifice-plug flowmeters are used.

Lesson 5: Open-Channel Flow Devices*Topics*

Principles of Open-Channel Flow; The Weir; Shapes of Notches; Choice of Notch Shape; Design of a Weir; Weir Plate; Weir Precautions; Weir Maintenance; Using Nomographs to Calculate Flow; Flumes (Parshall Flume); Flume Terms; Flume Uses; Flume Maintenance; Ultrasonic and Capacitance Level Sensors

Objectives

- Describe the structure and function of a weir.
- Identify various weir components—notch, crest, pond, bulkhead, and head gauge.
- Describe the construction and function of a Parshall flume.
- Identify the parts of a Parshall flume—crest, throat, stilling well, and diverging and converging sections.
- Explain how ultrasonic and capacitance-level measuring devices are used to detect open-channel flow rates.

Flow Measurement

Lesson 6: Positive-Displacement Meters

Topics

Operation of Positive-Displacement Meters; Advantages and Disadvantages of Positive-Displacement Meters; Piston Meters; Reciprocating Piston Meter; Oscillating Piston Meter; Rotating-Vane Meter; Nutating-Disk Flowmeter; Lobed Impeller and Oval Flowmeters; Helix Flowmeters; Dry-Gas Bellows Meter; Calibrating Positive-Displacement Meters; Comparison of Positive-Displacement Meters

Objectives

- Describe the advantages and disadvantages of positive-displacement meters.
- Describe the operation of the reciprocating piston meter and the oscillating piston meter.
- Describe the operating principles of the sliding-vane rotary meter and the nutating-disk meter.
- Identify the elements in lobed impeller, oval, and helical flowmeters.
- Explain the operation of a dry-gas bellows meter.
- Discuss the calibration of positive-displacement meters.

Lesson 7: Turbine and Magnetic Flowmeters

Topics

Turbine Flowmeter Operation; Turbine Flowmeter Construction; Magnetic Pickups and Readout Instruments; Kinds of Turbine Flowmeters; Paddlewheel Flowmeters; Installation of Turbine Flowmeters; Advantages and Disadvantages of Turbine Flowmeters; Magnetic Flowmeters—Principle of Operation; Magnetic Flowmeter Construction; Magnetic Flowmeter Outputs; Installation Tips; Advantages and Disadvantages of Magnetic Flowmeters

Objectives

- Describe the operating principles governing turbine flowmeters.
- Discuss the construction of turbine flowmeters.
- Discuss the advantages and disadvantages of turbine flowmeters.
- Describe the operating principle governing magnetic flowmeters.
- Describe significant advantages and disadvantages of magnetic flowmeters.

Lesson 8: Specialized Flowmeters

Topics

Vortex-Precession Meters; Output System for Vortex-Precession Meters; Features of Vortex-Precession Meters; Vortex-Shedding Meters; Features of Vortex-Shedding Meters; Mass Flow; Mass Flowmeters; Thermal Flowmeters; Heat-Transfer Meter; Immersion-Probe Meter; Hot-Wire Meter; Ultrasonic Flowmeters; The Doppler-Shift Method; The Beam-Deflection Method; The Frequency-Difference Method; Characteristics of Ultrasonic Flowmeters

Objectives

- Discuss in detail the operation of a vortex-precession meter.
- Define the term vortex-shedding and describe vortex-shedding meters and their output system.
- Explain mass flow and describe a Coriolis meter.
- Describe three kinds of thermal flowmeters.
- Describe the Doppler-shift, beam-deflection, and frequency-difference methods used by ultrasonic flowmeters.

Lesson 9: Metering the Flow of Solid Particles

Topics

Measuring Volumetric and Mass Flow Rate of Solids; Volumetric Solids Flowmeter; Mass Flowmeter for Solids; Belt-Style Solids Meter; Belt-Speed Sensing and Signal Processing; Slurries; Constant-Weight Feeders

Objectives

- Define the term meter factor and explain how it is obtained.
- Explain the operation of a mass flowmeter.
- Discuss the operation of the belt-type solids meter.
- Describe how a slurry is made, transported, and metered.
- Discuss the continuous measurement and control of the flow of solid material in a process.

Lesson 10: Installation and Maintenance of Flow Instruments

Topics

Components of Flow-Measurement Systems; Primary Flow Elements; Pressure Taps; Piping and Fittings; Valves; ΔP Instrument; Miscellaneous Items; Installation of the Flow-Measurement System; Pressure Tap Installation; Instrument Piping Installation; Electrical Hookup—The Final Step; Maintenance Precautions; Preventive Maintenance; Calibration; A ΔP Instrument Calibration Procedure

Objectives

- Describe components of a differential flow measurement system.
- List guidelines for correct installation.
- Discuss the principles of thorough and safe instrument maintenance.
- List the steps in instrument calibration.
- Discuss the basic rules of safety in instrument servicing.