



OPEN CHANNEL FLOW MEASUREMENT

BASIC DESIGN OF OPEN CHANNEL FLOW MEASUREMENT

A flume is the simplest and most reliable tool available for open channel flow measurement. The formulas for determining head to flow relationships are simple, well established and based on basic physics of water flowing through a channel. Verification of flow measurement can be completed with a visual comparison.

There are three basic criteria for any open channel primary device (i.e. flume) to function properly:

1. Flow entering the flume must be laminar, non-turbulent and have subcritical velocity.
2. The flow range of the stream to be measured must fit within the recommended operating range of chosen flume.
3. Water must exit the flume in a free-flow manner. Submerged flow conditions should be avoided whenever possible.

Open channels and natural waterways are normally designed to be wider than the flume entrance, and require an inlet transition to eliminate sharp corners and other irregularities. The inlet pipe or floor can be no higher than the floor of the flume, and is oftentimes lower to produce additional upstream head to aid in velocity control.

The exit pipe or channel must be at or below the outlet elevation of the flume. The channel or pipe must slope away from the flume, and be sized to handle the expected peak flows. Outlet transitions are normally only required to help redirect flow back into a pipeline where entrance losses can create submergence. This is especially important when peak flows are expected to be more than 75% to 80% of the pipe's capacity and/or the outlet slope is relatively flat. In new construction, the outlet pipeline can often be set 1" -2" lower than the flume outlet, or sometimes a larger diameter pipe can be used to help carry the flow away from the flume.

When Transitioning From
Channel to Rectangular Flume
Pipe to Rectangular Flume
Channel to U-Shape or Trapezoidal
Oversized pipe to U-Shape or Trapezoidal

Use
Curved Wing Wall
End adapter
Flared Transition
Flared Transition

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BASIC DESIGN OF OPEN CHANNEL FLOW MEASUREMENT (CONT.)

Entrance Conditions:

Critical Velocity - Critical Velocity for a flume is determined by the water depth at a specific flow rate. Charts are available to convert flow rates to head depth and for determining critical velocity at the throat and measuring point for a given water depth. Flows above critical velocity may pass through the flume with no hydraulic effect, making measurement inaccurate and undeterminable.

Water behavior - The water entering the flume needs to be non-turbulent, with a smooth water surface at the measurement point for accuracy. There should be no swirls or eddies that could distort the measurement readings.

Exit Conditions:

Discharge - The flow should discharge from the flume in a free flow condition with no obstructions, reverse slopes or restrictions that limit the flow exiting the flume, resulting in submergence.

Suggested Installation Guidelines:

- Upstream Channel or Pipe with slope of 1% or less, up to 2% may be tolerated in certain circumstances
- A curved wing wall extending from the channel wall to the flume entrance is the most effective method to achieve a smooth transition. A somewhat longer flared straight wall transition can be used if space permits.
- Entrance ramp to flume of 4:1 slope if the pipe or channel is lower than the floor of the flume, should be grouted in to properly transition the flow and prevent solids build-up.
- Upstream straight run of 10x pipe diameter or channel width, may vary depending on flow behavior. Fluid behavior is the critical component in the installation, straight run may be more or less than 10x as is needed for a specific application.

Troubleshooting - Typical problems seen in the field.

False High Readings

- a. Water can not get out of the flume so it backs up creating a false high reading.
- b. The meter or calibration has an error or the wrong equation is being used.
- c. The flume is out of level.
- d. In a Palmer-Bowlus flumes when a measurement is taken to the floor of the flume at the measurement point rather than the throat elevation which is the correct zero point.

False Low Readings

- a. The water is going too fast through the flume (above critical velocity).
- b. The meter or calibration has an error or the wrong equation is being used.
- c. The flume is out of level.

CONTACT US FOR MORE INFORMATION

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