Flow Element Sizing

30 common interview questions and answers

Part 1: Fundamental Sizing Concepts

1. What is the primary goal of "sizing" a flow meter?

The primary goal is to select the **optimal meter diameter** and trim (if applicable) that will provide an accurate, repeatable, and reliable measurement over the entire range of the process flow rates, without causing an unacceptable pressure drop.

2. What happens if a flow meter is oversized?

An oversized meter will have a **low fluid velocity** passing through it. This leads to several problems:

- **Poor Accuracy:** The signal generated by the meter (e.g., DP, voltage, frequency) will be too weak to measure accurately, especially at lower flow rates.
- **Poor Turndown:** The meter will not be able to measure the low end of the process flow range.
- **Solids Drop-Out:** In slurry service, low velocity can cause solids to settle out and plug the meter.

3. What happens if a flow meter is undersized?

An undersized meter will have an **excessively high fluid velocity**. This causes:

- **High Permanent Pressure Loss:** This wastes energy and increases pumping costs. 💰

- **Erosion:** High velocity can erode the meter's internal components, especially with abrasive fluids.
- **Noise and Vibration:** High velocity can cause significant operational noise.
- **Limited Capacity:** The meter will act as a bottleneck and may not be able to pass the maximum required process flow.

4. What are the essential process data needed to size any flow meter?

You need a complete set of process conditions for the **minimum, normal, and maximum** flow cases:

- **Fluid Properties:** Fluid name, density, viscosity, vapor pressure.
- **Flow Rates:** The minimum, normal, and maximum flow rates (in units like GPM, lb/hr, etc.).
- **Process Conditions:** Operating pressure and temperature.
- **Pipe Information:** Pipe size, schedule (wall thickness), and material.

5. What is the difference between line size and meter size?

- **Line Size:** The nominal diameter of the process pipeline (e.g., 4-inch pipe).
- **Meter Size:** The nominal diameter of the flow meter itself. It is very common for the optimal **meter size** to be **smaller** than the **line size**. In this case, concentric reducers are used to transition from the pipe to the smaller meter.

Part 2: Sizing DP Meters & Orifice Plates

6. What are you actually "sizing" when you size an orifice plate?

You are calculating the optimal **bore diameter** of the orifice hole. This is the primary variable that determines the differential pressure (DP) produced for a given flow rate.

7. What is the "beta ratio" (β), and why is it the most important parameter in orifice sizing?

The **beta ratio** is the ratio of the orifice bore diameter (d) to the pipe's internal diameter (D).

- $\beta = d/D$

It is the key design parameter. A **low beta ratio** (e.g., 0.3) means a small hole, which creates a high DP signal but also a high permanent pressure loss. A **high beta ratio** (e.g., 0.7) means a large hole, which creates a low DP signal but has low pressure loss.

8. What is a typical target range for a beta ratio?

For the best accuracy and performance, the beta ratio should typically be between **0.4 and 0.7**. Beta ratios outside of this range can lead to increased measurement uncertainty.

9. What is the target differential pressure you aim for when sizing a DP meter?

You typically size the orifice bore to produce a specific, standard full-scale DP at the maximum flow rate. A very common target is **100 inches of water column (inH_2O)**, which corresponds to the standard range of many DP transmitters.

10. What is the Reynolds number, and why is it important in DP meter sizing?

The **Reynolds number (Re)** is a dimensionless number that indicates whether the flow is smooth (**laminar**) or chaotic (**turbulent**). The accuracy of an orifice plate relies on the flow being turbulent (typically Re > 10,000). The sizing software calculates the Reynolds number to ensure the flow is in the correct regime and to calculate the correct discharge coefficient.

Part 3: Sizing Other Flow Technologies

11. How do you size a magnetic flow meter?

Sizing a magmeter is primarily based on **fluid velocity**. The goal is to choose a meter size that keeps the velocity within an acceptable range, typically:

- **Minimum:** 1.5 ft/s (0.5 m/s) to prevent solids from dropping out.
- **Maximum:** 10 ft/s (3 m/s) to prevent erosion and noise. The meter is often one size smaller than the line to ensure adequate velocity at low flow rates.

12. How do you size a vortex flow meter?

Sizing a vortex meter is also based on **velocity**, but for a different reason.

- **Minimum Velocity:** The flow must be fast enough to create stable vortices (typically requires a Reynolds number > 20,000). If the velocity is too low, the meter will stop reading (the "low-flow cutoff").

- **Maximum Velocity:** Limited by pressure drop and mechanical stress on the shedder bar. Sizing software is used to ensure the entire operating range of the process falls within the meter's measurable velocity range.

13. What is the primary sizing criterion for a Coriolis meter?

The primary criterion is to select a meter that can handle the **mass flow rate** of the application while not exceeding the maximum allowable **pressure drop**. Sizing software is used to balance the flow capacity against the pressure loss for a given model.

14. Can a Coriolis meter be oversized?

Yes. While they have a very high turndown ratio, extreme oversizing is still bad practice. It leads to a very small Coriolis effect (tube twist), which can be harder to measure accurately. A meter that is one or even two sizes smaller than the line size is very common to ensure a good signal.

15. What are you sizing for when selecting an ultrasonic flow meter?

You are ensuring that the **fluid velocity** is within the meter's operating range. Because ultrasonic meters have a very wide rangeability and no pressure drop, their size often matches the line size unless the velocity at minimum flow is extremely low.

16. How do you size a thermal mass flow meter?

Sizing is based on ensuring the **gas velocity** and **mass flow rate** are within the meter's calibrated range. It's critical that the sizing is done using the correct gas properties, as the meter's heat transfer principle is dependent on the gas composition.

Part 4: Key Sizing Phenomena

17. What is "turndown ratio," and why is it critical for sizing?

Turndown ratio is the ratio of the maximum to the minimum flow the meter can accurately measure. During sizing, you must ensure that the process's **required turndown** (Max Process Flow / Min Process Flow) is less than the **meter's specified turndown**.

18. What is "permanent pressure loss" (PPL)?

PPL is the unrecoverable pressure drop (energy loss) caused by the flow meter. You must calculate the PPL at the maximum flow rate to ensure it is acceptable for the system and that the pump has enough head to overcome it.

19. What is "flashing"?

Flashing occurs when a liquid flows through a restriction and the pressure drops **below** its vapor pressure, causing it to boil. This creates a two-phase (liquid/vapor) flow that is highly erosive and will cause an inaccurate measurement.

20. What is "cavitation"?

Cavitation is a two-step process: flashing occurs first, but then the downstream pressure recovers to a point **above** the vapor pressure, causing the vapor bubbles to violently collapse. This is extremely destructive and can quickly destroy a valve or meter. Sizing software calculates and warns if these conditions are likely to occur.

21. How do you check for flashing or cavitation during sizing?

The sizing software will calculate the pressure at the **vena contracta** (P_{vc}) within the meter. It will then compare this pressure to the fluid's **vapor pressure** (P_v). If $P_{vc} \leq P_v$, then flashing or cavitation is predicted.

22. What is "choked flow"?

Choked flow (or critical flow) is a condition, primarily in gas and steam service, where the velocity reaches the speed of sound within the meter's restriction. At this point, lowering the downstream pressure will **not** increase the flow rate. The flow is "choked." Sizing software will warn of this condition.

Part 5: Practical Sizing & Software

23. Why is it essential to use sizing software?

Flow sizing involves complex thermodynamic equations (especially for gases and steam) and iterative calculations. Sizing software is essential because it:

- Performs these calculations accurately and instantly.
- Contains a database of meter geometries and fluid properties.
- Automatically checks for problems like high velocity, cavitation, and choked flow.
- Generates a professional data sheet documenting the results.

24. You've sized a meter and it's smaller than the line. What must you install?

You must install **concentric reducers and expanders** to transition from the larger pipe down to the smaller meter and then back up to the pipe size.

25. Does using reducers affect the straight pipe run requirements?

Yes. Reducers are a source of turbulence. The straight pipe run requirement specified by the manufacturer begins **after** the reducer, at the inlet of the flow meter itself.

26. The sizing software shows the noise level will be over 85 dBA. What does this mean?

An estimated noise level above 85 dBA indicates that the fluid velocity is very high, likely causing significant turbulence or even cavitation. This is a warning that the meter may be undersized or that a low-noise trim is required. It is also a personnel safety concern.

27. The software gives you a choice between two sizes that could both work. How do you decide?

You look at the trade-offs:

- The **smaller** option will likely have better accuracy at the low end of the flow range but will have a higher permanent pressure loss.
- The **larger** option will have a lower pressure loss but may be less accurate at the minimum flow rate. You choose based on which factor (low-flow accuracy or energy cost) is more important for the application.

28. How does viscosity affect sizing?

High viscosity requires a **viscosity correction factor** in the sizing calculation, especially for DP and turbine meters. For DP meters, it can significantly change the discharge coefficient. For turbine meters, it increases drag. Sizing software will perform these corrections, but it's critical to input the correct viscosity value.

29. What is a "fluid property database"?

Modern sizing software includes a database with the physical properties (density, viscosity, vapor pressure, etc.) of hundreds of common fluids. This saves the engineer from having to look up and manually enter this data, reducing the chance of errors.

30. In your opinion, what is the most common sizing mistake?

The most common mistake is using **inaccurate or incomplete process data**. Sizing is a "garbage in, garbage out" process. If the designer is given incorrect maximum or minimum flow rates, or the wrong fluid density, the calculation will produce a perfectly sized meter for the wrong conditions, which will then perform poorly in the real world. Verifying the process data is the most critical step. 🔧