# Flow Measurement Techniques

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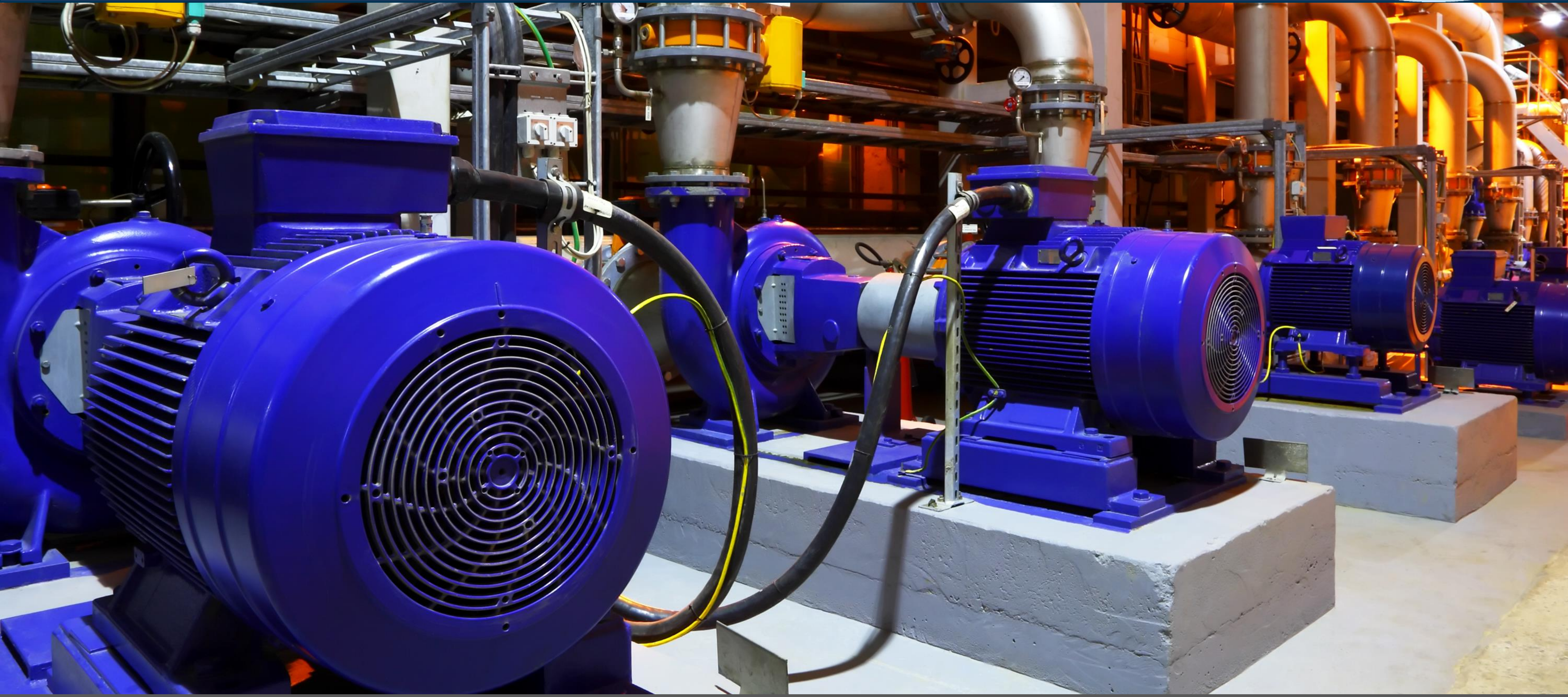

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# Flow Measurement Techniques

Various flow measurement techniques have been employed to accurately monitor flow rates within a site's piping systems for an essentially incompressible fluid such as water.

- Flow Meters in Existing Pipelines
- Ultrasonic Flowmeters
- Computational Fluid Dynamics (CFD)
- Orifice Plate Installation
- Pump Data Analysis
- Pressure Drop Analysis

- Many users opt for flow meters, such as magnetic flowmeters, rotameters, or venturi flowmeters, which are commonly installed in the existing piping system to measure flow rates accurately.

**Flow Meters in Existing Pipelines**

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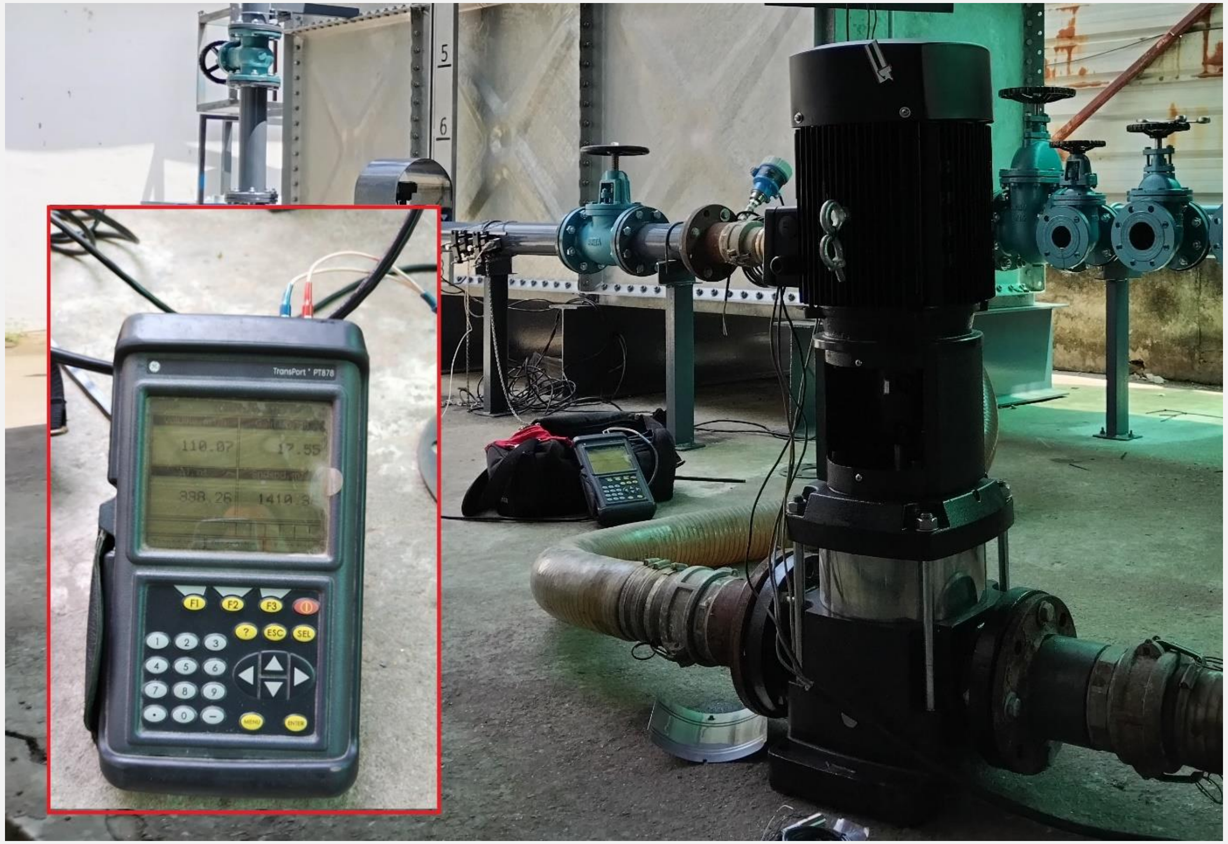
- Ultrasonic flowmeters are preferred for their non-intrusive nature during flow measurement.

- The correct installation location, initial parameter settings, and sufficient pipe length are crucial for achieving accurate readings without modifying the piping.

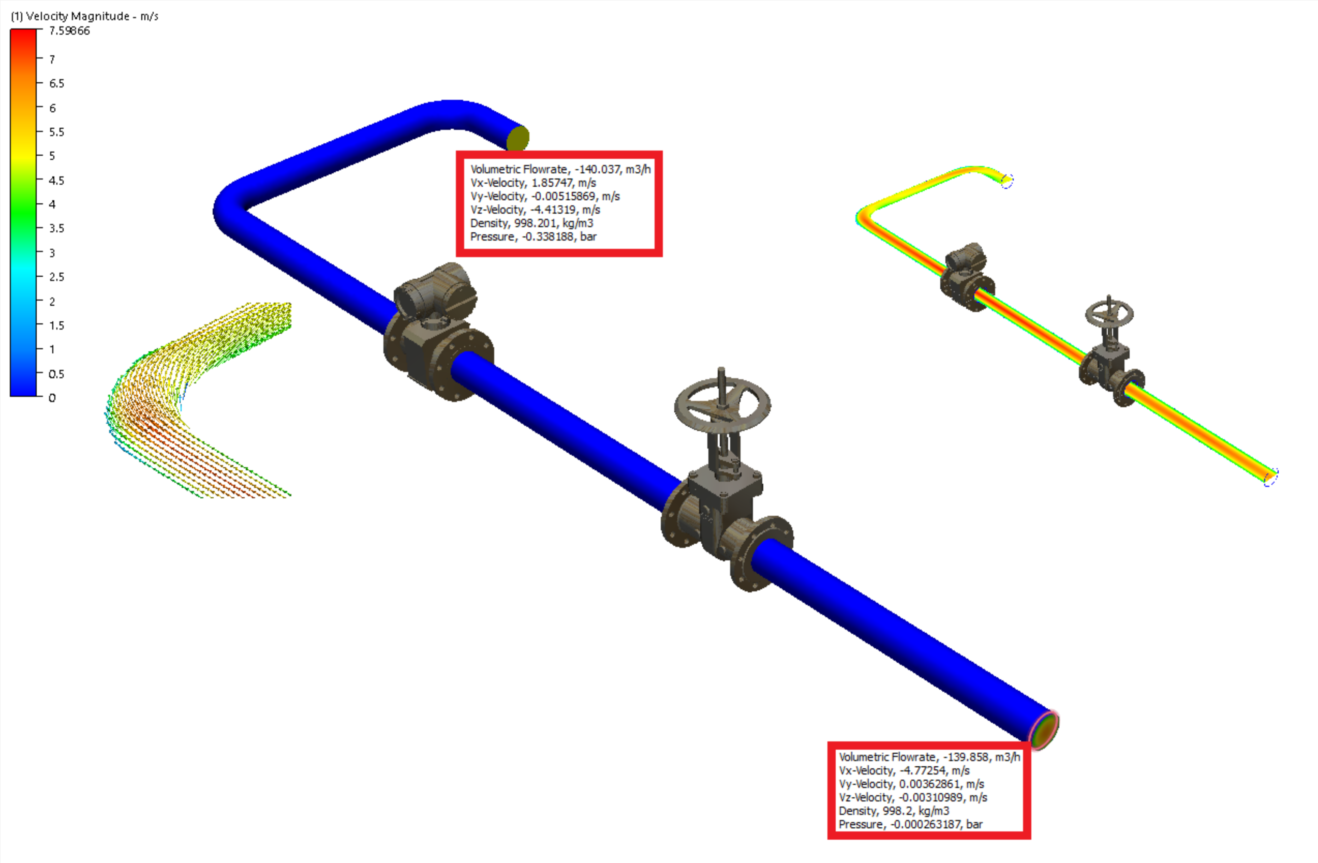


**Ultrasonic Flowmeters**

- Modeling the current piping system to conduct a virtual flow study acts like an X-ray machine.

- CFD provides insights into flow patterns and enabling optimization to reduce swirling flows within the piping.

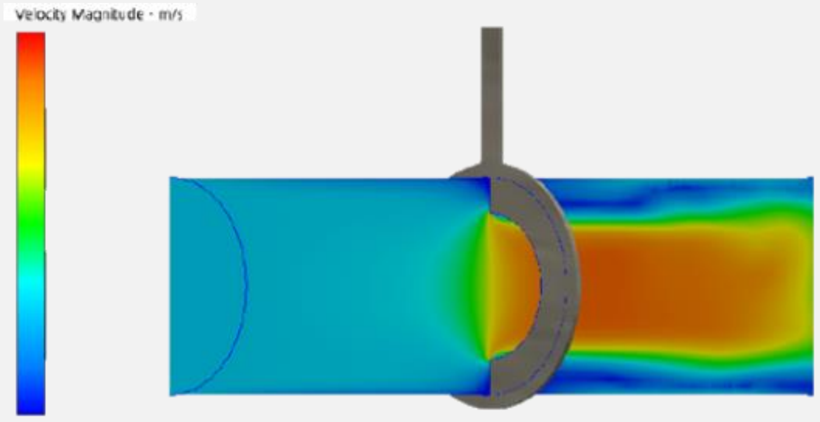
- Applying correct boundary conditions allows us to estimate the flow rate accurately.




## Computational Fluid Dynamics (CFD)

- Utilizing an orifice plate in the piping system helps estimate flow rates by measuring pressure drop effects.

- The manufacturer provides necessary orifice plate data based on the opening ratio for accurate estimation.




CFD Simulation of flow through an orifice plate


**Orifice Plate Installation**

- Monitoring the running current, pump speed, inlet and outlet pressure of the pump on-site, and comparing this data with the pump manufacturer's datasheet allows for an accurate estimation of the flow rate.

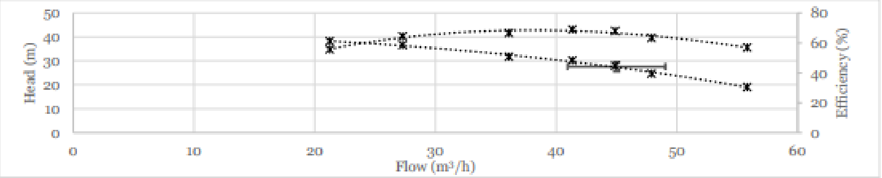
- However, the effectiveness of this method relies on the comprehensiveness of the manufacturer's provided pump datasheet.

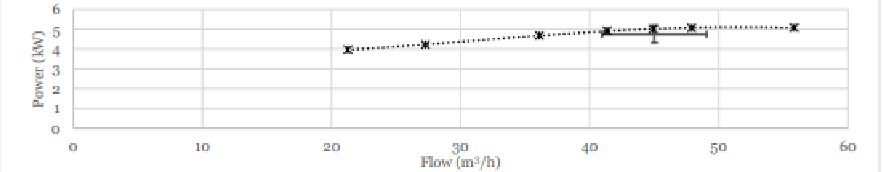
- If possible, it is preferable to request the Factory Acceptance Test Report for that specific pump installed.

## Pump Performance Test Report

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Model | [redacted] | S/N | [redacted] | Test No. | PT-230001 | | |
| Manufacturer | [redacted] | PO | | Test Date | 31-Jul-23 | | |
| Capacity ($m^3/h$) | 45.0 | Impeller Dia. (mm) | - | Suction Dia. (mm) | 80 | Pump Eff. (%) | 71.1 |
| Head (m) | 27.6 | Motor Power (kW) | 5.5 | Discharge Dia. (mm) | 80 | Density ($kg/m^3$) | 998.2 |

| Item | Test Speed Values | | | | | | | | | Values at Guaranteed Speed 2900 RPM | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Speed (RPM) | Flow ($m^3/h$) | Pin (Bar) | Pout (Bar) | $v^2/2g$ (m) | $H_{total}$ (m) | Voltage (V) | Current (A) | Power (kW) | Flow ($m^3/h$) | $H_{total}$ (m) | Power (kW) | Pump Eff. % |
| 1 | 2935 | 56.50 | 0.16 | 2.07 | 0.00 | 19.50 | 409.1 | 10.21 | 5.26 | 55.8 | 19.0 | 5.07 | 57.0 |
| 2 | 2936 | 48.50 | 0.17 | 2.64 | 0.00 | 25.28 | 409.1 | 10.21 | 5.26 | 47.9 | 24.7 | 5.06 | 63.4 |
| 3 | 2931 | 45.38 | 0.17 | 2.96 | 0.00 | 28.52 | 407 | 10.11 | 5.17 | 44.9 | 27.9 | 5.01 | 68.0 |
| 4 | 2932 | 41.80 | 0.17 | 3.20 | 0.00 | 30.94 | 408.9 | 9.91 | 5.09 | 41.3 | 30.3 | 4.92 | 69.1 |
| 5 | 2933 | 36.50 | 0.18 | 3.35 | 0.00 | 32.43 | 408.7 | 9.46 | 4.84 | 36.1 | 31.7 | 4.67 | 66.6 |
| 6 | 2934 | 27.60 | 0.18 | 3.85 | 0.00 | 37.53 | 409.2 | 8.64 | 4.37 | 27.3 | 36.7 | 4.22 | 64.5 |
| 7 | 2934 | 21.50 | 0.18 | 4.01 | 0.00 | 39.13 | 409.2 | 8.20 | 4.11 | 21.3 | 38.2 | 3.97 | 55.7 |
| | | | | | | | | **Design Point** | | **44.1** | **25.0** | | |
| Judgement | Flow at Rated Head (m3/h) | | | | | 44.6 | | Rated Point | | 45.0 | 27.6 | 4.75 | 71.1 |
| | Head at Rated Flow (m) | | | | | 27.3 | | Intersection | | 44.8 | 27.5 | 5.02 | 66.7 |
| | Results | | | | | **PASS** | | Tolerance | | -0.4% | -0.4% | 5.7% | -6.3% |
| ISO9906:2012 Grade 3B: Q=±9% H=±7% η=-7% | | | | | | | | | | | | | |




## Pump Data Analysis

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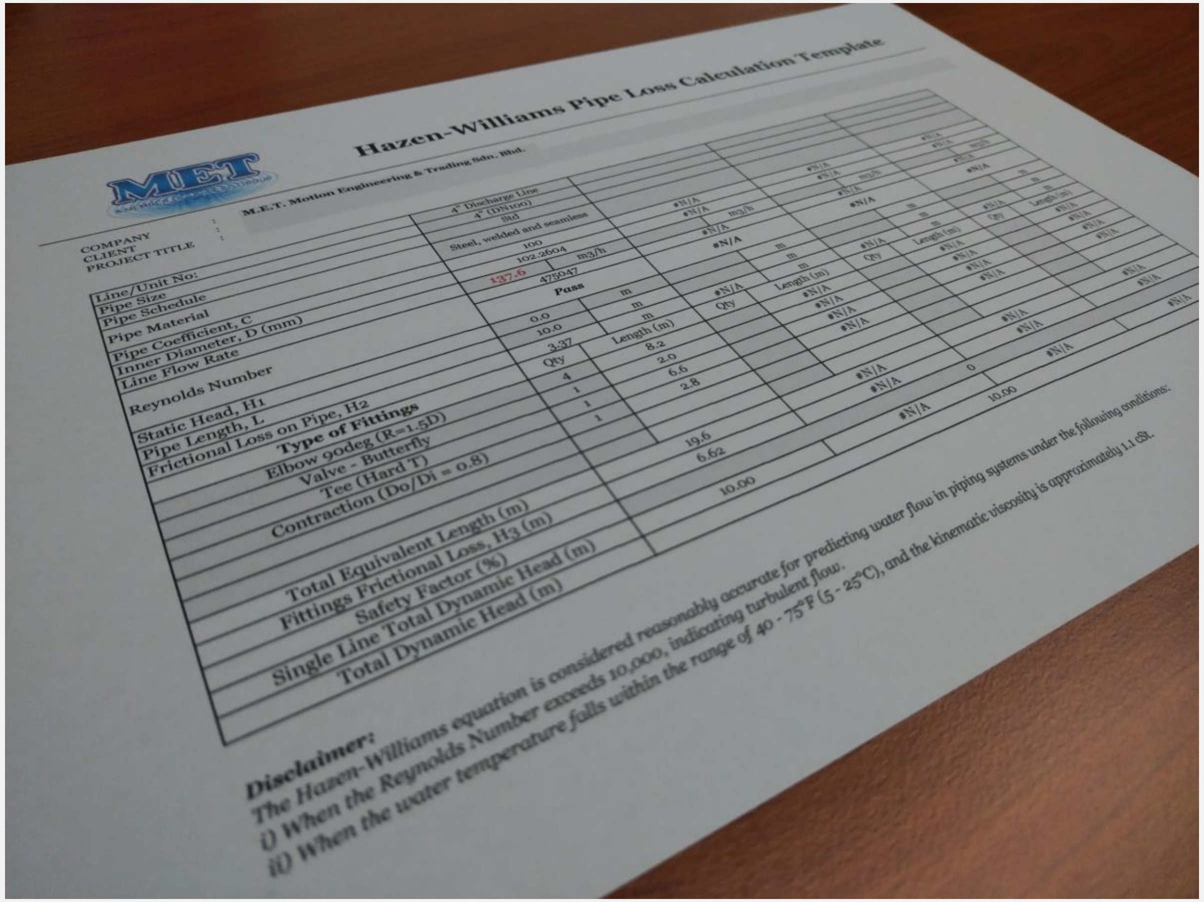
- Estimating flow rates after pump discharge involves analyzing pressure drops at multiple points across the piping.

- By using the Darcy–Weisbach or Hazen–Williams equations, we can estimate the flow rate that aligns with these pressure drop values.




**Pressure Drop Analysis**

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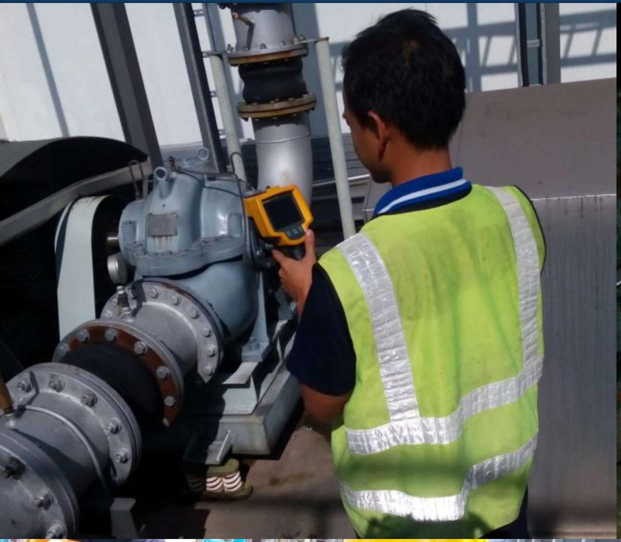





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