

Overview of Piping Systems

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Designed for quick reference and easy study

1. What Is a Piping System?

- **Definition:** An assembly of pipes, fittings, valves, and supporting hardware that transports fluids (liquids, gases, slurries) from one point to another.
 - **Primary purposes**
 - Convey process fluids safely and efficiently.
 - Maintain pressure, temperature, and flow rate specifications.
 - Isolate, control, and measure fluid streams.
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2. Core Components

Component	Function	Typical Materials
Pipe	Main conduit for fluid flow	Carbon steel, stainless steel, PVC, HDPE, copper, alloy steels
Fittings	Change direction, size, or combine streams	Elbows, tees, reducers, couplings
Valves	Start/stop flow, regulate pressure, isolate sections	Gate, globe, ball, butterfly, check, safety relief
Flanges & Gaskets	Provide detachable, leak-tight connections	Cast iron, steel, elastomeric gaskets
Supports & Anchors	Carry weight, control thermal expansion	Hangers, guides, spring supports, anchors
Instrumentation	Monitor and control process variables	Pressure transducers, flow meters, temperature sensors
Expansion Devices	Absorb thermal growth/shrinkage	Expansion loops, bellows, flexible joints

3. Design Fundamentals

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3.1. Design Codes & Standards

- **ASME B31.1** – Power Piping
- **ASME B31.3** – Process Piping
- **API 5L, 5CT** – Line pipe specifications
- **ISO 14692** – Flexible pipe systems
- Local codes (e.g., EN, JIS) may also apply.

3.2. Key Design Parameters

Parameter	Typical Considerations
Design Pressure (P_d)	Max allowable working pressure (MAWP) + safety margin
Design Temperature (T_d)	Highest/lowest operating temperature; influences material selection
Fluid Properties	Density, viscosity, corrosiveness, toxicity
Flow Rate (Q)	Determines pipe diameter via Darcy-Weisbach or Hazen-Williams equations
Velocity Limits	Prevent erosion, noise, and excessive pressure drop (e.g., ≤ 10 ft/s for water)
Thermal Expansion	$\Delta L = \alpha \cdot L \cdot \Delta T$; dictates need for expansion loops or flexible joints
Stress Analysis	Verify hoop, longitudinal, and combined stresses against allowable limits

3.3. Pipe Sizing (Brief Procedure)

1. **Select fluid, Q , and allowable velocity (V_{max})**
2. **Calculate required cross-sectional area:**
[$A = \frac{Q}{V_{max}}$]
3. **Choose the nearest standard pipe size** (schedule/nominal diameter).
4. **Check pressure drop** using friction factor (Darcy-Weisbach) and adjust size if necessary.

4. Materials Selection

Material	Advantages	Typical Applications	Limitations
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Carbon Steel (e.g., ASTM A53)	Low cost, good strength	Oil & gas, water, steam	Corrosion in acidic environments
Stainless Steel (304/316)	Excellent corrosion resistance	Food,	