SECTION 1

WATER PIPING AND PUMPS

Introduction
Objectives

- Compare the 3 types of piping systems
- Identify the 4 types of water distribution systems
- Differentiate between direct return and reverse return systems
- Identify the various valves and hydronic accessories available for use in piping systems
- Diagram typical piping hookups for chillers, pumps, and cooling towers
- Size the piping for a closed loop and an open recirculating loop system
- Identify the types of water pumps, their features, and the selection process
WATER PIPING AND PUMPS

Types of Piping Systems
Closed-Loop System

Includes:

- A chiller and/or a boiler
- Coils that produce cooling or heating
- Two or three-way valves to control the coils
- Piping and pump to circulate water
- An expansion tank (insignificant water contact with air)

Section 2 – Types of Piping Systems
Copyright © Carrier Corp. 2005
The water-cooled condenser is typically part of a water-cooled chiller or water-cooled package unit.

A cooling tower rejects the condenser heat to the atmosphere.

Flow rates and temperatures are industry standards for North America.

Piping and pumps circulate water.

Water is reused and exposed to the ambient conditions in the cooling tower.
Once-Thru Water System

- Much less common due to environmental concerns
- Water is sent to waste or returned back to source
- Large consumption of water
- Source example: river, lake, well
SECTION 3

WATER PIPING AND PUMPS

Water Distribution Systems
1-Pipe Distribution System

- **Typical Heating Terminal**
- **Boiler**
- **System Pump**
- **Main Piping Loop Supply and Return (1 size throughout)**
- **Monoflow® Fitting**

Section 3 – Water Distribution Systems
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3-Pipe Distribution System

Distributes hot and cold water simultaneously

- Typical Heating and Cooling Terminal
- Chilled Water Supply
- Hot Water Supply
- Boiler
- Chiller
- System Pumps
- Common Return Piping with Mixed Hot and Cold Water
- Special 3-pipe Water Control

Section 3 – Water Distribution Systems
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4-Pipe Distribution System

Distributes hot and cold water simultaneously

- **4-Pipe Heating and Cooling Terminal**
- **Chilled Water Supply**
- **Hot Water Supply**
- **Boiler**
- **Chiller**
- **System Pumps**

---

Section 3 – Water Distribution Systems
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SECTION 4

WATER PIPING AND PUMPS

Direct and Reverse Return Systems
• Water enters Unit-1 from supply
• Water leaves Unit-1 and returns directly to source
• The first unit supplied is the first returned
• Unequal circuit pressure drops result
• Circuit pressure drop through Unit-1 < Unit-2 < Unit-3 < Unit-4 < Unit-5
• Balancing valves are a necessity
Direct Return Vertical Distribution

Return

Supply

Balancing Valves

Unit-1

Unit-2

Unit-3

Unit-4

Unit-5

Unit-6
Return header flow is same direction as supply flow.

Water leaves Unit-1 and goes all the way around in returning to source.

The first unit supplied is the last returned.

Circuit pressure drop through Unit-1 = Unit-2 = Unit-3 = Unit-4 = Unit-5.

Balancing valves may be eliminated.
Reverse Return

Supply and return headers at bottom

Supply and return headers at bottom
Reverse Return

- Reverse return at each set of units
- Supply header at bottom
- Reverse return header at top
- Single vertical return to bottom
SECTION 5

WATER PIPING AND PUMPS

Water Piping Components and Accessories
Typical Materials:

≥ 2 ½-in. Schedule 40 black steel
≤ 2-in. Schedule 40 black steel or Type L copper
Weld & Threaded Joints

Weld

Beveled Edge to Accept Weld

Thread Joint

Male Thread

Female Thread
Sweat or Solvent Joint

- Male Tube
- Capillary Space (exaggerated)
- Solder or Solvent
- Female Connection Fitting
Mechanical Groove Joint

Coupling Clamp
Various Fittings

- 45° Elbow
- 90° Short Radius Elbow
- Saddle Tee
- Cap
- Concentric Reducer
- Tee
- Flange
Butterfly Valve (General Purpose)

- Used on larger pipe sizes (2½ in. and larger)
- Used for shutoff and throttling duty
- Low cost, low pressure drop
- Durable design, suitable for frequent operation (opening and closing)

Components:
- Spring Lever/Notched Plate
- Soft Seat
- Threaded Lug
- Disc
Gate valves are also known as stop valves.

Not used for throttling duty.

Waterflow
Globe Valve (Balancing Duty)

- Handwheel
- Stem
- Gland
- Packing
- Plug
- Body Seat Ring
- Body

Waterflow
Angle valves can replace an elbow fitting

This is the same basic design as a globe valve
“Y” Type Valve (Balancing Duty)

Wheel

Stem

Bushing

Bonnet

Seat

Packing

Body

Plug

Waterflow
Plug valves are used for balancing duty on smaller flow applications.
Ball Valve (Open/Close Service)

- Low cost
- High capacity
- Low leakage
- Tight sealing

Waterflow
Swing Check Valve

Service Cap

Body

Waterflow

Horizontal use or vertical upward flow use only

Swing Mechanism

Plug

Seat
Lift Check Valve

Waterflow

Lift Mechanism
Control Valves

3-Way Diverting
2 outlets 1 inlet

2-Way Modulating

Valve Actuator

3-Way Mixing
2 inlets 1 outlet
Circuit Setters™ allow for pre-set balancing of airflow
Triple Duty Valve™

Triple Duty Valve™ on pump discharge

Combines shutoff, balancing, and check valve into one assembly
### Relative Valve Comparison Chart

<table>
<thead>
<tr>
<th>Size</th>
<th>Ball¹</th>
<th>Gate²</th>
<th>Globe²</th>
<th>Swing Check¹</th>
<th>Wafer Butterfly³</th>
<th>Lug Butterfly³</th>
</tr>
</thead>
<tbody>
<tr>
<td>¼</td>
<td>6</td>
<td>40</td>
<td>50</td>
<td>40</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>½</td>
<td>6</td>
<td>30</td>
<td>50</td>
<td>40</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>1</td>
<td>15</td>
<td>50</td>
<td>75</td>
<td>60</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>2</td>
<td>40</td>
<td>100</td>
<td>215</td>
<td>150</td>
<td>100</td>
<td>120</td>
</tr>
<tr>
<td>3</td>
<td>210</td>
<td>310</td>
<td>1100</td>
<td>500</td>
<td>120</td>
<td>140</td>
</tr>
<tr>
<td>4</td>
<td>250</td>
<td>600</td>
<td>1300</td>
<td>–</td>
<td>140</td>
<td>160</td>
</tr>
<tr>
<td>6</td>
<td>375</td>
<td>1000</td>
<td>2500</td>
<td>–</td>
<td>220</td>
<td>260</td>
</tr>
</tbody>
</table>

Notes:
1. All sizes threaded bronze body
2. Sizes ¼ to 2-in. threaded bronze body; sizes 3 to 6-in. threaded iron body
3. All sizes cast iron body
Hydronic System Components

- Strainers
- Expansion Tanks
- Air Separators
- Air Vents
- Thermometers, Gauges, Pete’s Plugs
- Pipe Supports
- Volume Tanks
“Y” Strainer

Strainers are most important in open loop systems.

Mesh Strainer

Waterflow one direction only
**Expansion Tanks**

**Open Tank**
- Open to air
- Air-water interface

**Closed Tank**
- Very popular
- Captured air space
- Air-water interface

**Closed Diaphragm Tank**
- Flexible membrane
- No air-water interface
- Very popular
Diaphragm Expansion Tank

- System Connection
- Charging Valve
- Diaphragm
- Lifting Ring
- Drain (Not Shown)

- Very Popular
- Most Cost Effective
Air Separator

- **Inlet**: Tangential flow-thru design
- **Baffle**
- **Vessel Shell**: (3 times the nominal inlet/outlet pipe diameter)
- **Stainless Steel Air Collector Tube**
- **Outlet**: NPT, Grooved or Flanged Connections
- **Vertical Strainer with Bottom Access**

Section 5 – Water Piping Components and Accessories

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Air Vents

Manual or Automatic Air Vent

Locate at high points

Typical Locations:
- Risers
- Coils
- Terminals

From Terminal Coil → 4 Pipe Diameters → To Return Main

Service Valve
Thermometers, Gauges and Pete’s Plug

Pete’s Plugs:
Temperature and Pressure Ports

Locate thermometers and gauges at inlets and outlets of equipment
Pipe Hangers and Anchors

How many pipe hangers are needed and what is their support distance?

- Distance between hangers is 14 ft
- Number of hangers = \( \frac{100}{14} \) = 7

<table>
<thead>
<tr>
<th>Nominal Pipe Size (in.)</th>
<th>Distance Between Supports (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>¾ - 1¼</td>
<td>8</td>
</tr>
<tr>
<td>1½ - 2½</td>
<td>10</td>
</tr>
<tr>
<td>3 – 3½</td>
<td>12</td>
</tr>
<tr>
<td>4 – 6</td>
<td>14</td>
</tr>
<tr>
<td>8 - 12</td>
<td>16</td>
</tr>
<tr>
<td>14 - 24</td>
<td>20</td>
</tr>
</tbody>
</table>
Check for Volume Tank Requirements

Rule of thumb for chilled-water systems:

- 3 gallons per nominal ton of chiller for normal air-conditioning duty
- 6 to 10 gallons per nominal ton of chiller for process duty or low ambient unit operation

Suggested volume tank designs
Typical Piping Details at Equipment
Piping details may vary based on the equipment used and the application.

This TDP shows the details of commonly used methods. However, the methods shown do not reflect all specific project requirements.

Follow manufacturer’s installation literature.
Typical Piping Details

At Equipment:

- Water-Cooled Chiller
- Air-Cooled Chiller
- Coil Piping
- Pump Piping
- Expansion Tank and Air Separator
- Parallel and Series Chillers
- Single Chiller System
- Multiple Chiller Systems
- Primary-Secondary System
- Primary-Only Variable Flow System
Typical Water-Cooled Chiller Piping Detail

- **Supply**
- **Return**
- **Shutoff Valves**
- **Condenser Water**
- **Drain Valve**
- **Thermometer (Typical)**
- **Pressure Gauge (Typical)**
- **Flange (Typical)**
- **Strainer (if pump is on return side of chiller)**
- **Chilled Water**

Section 6 – Typical Piping Details at Equipment
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Typical Air-Cooled Chiller Piping Detail

Air-Cooled Chiller

- Drain Valve
- Shutoff Valve (Typical)
- Pressure Gauge (Typical)
- Supply
- Return
- Thermometer (Typical)
Typical Coil Piping Detail (Chilled-Water or Hot Water)

- **Supply**
  - Shutoff Valve
  - Bypass Line (used with 3-way mixing valve only)
  - Balancing Valve (used with mixing valve)
  - Flange or Union

- **Return**
  - Shutoff Valve
  - Control Valve (2-Position On/Off, 2-Way Modulating or 3-Way Mixing)
  - Balancing Valve
  - Pete’s Plug (Typical)
  - Drain Valve

**Air-Handling Unit Coil**
Typical Pump Piping Detail

Return (Suction)

- Long Radius Elbow
- Shutoff Valve
- Drain Valve

Flex Connectors

Supply (Discharge)

- Shutoff Valve
- Check Valve
- Balancing Valve or Multi-Purpose Valve

- Gauge or Pete’s Plug (typical)

Minimum of 5 pipe diameters for end suction pumps
Typical Expansion Tank & Air Separator Piping Detail

From Building Return

Pressure Reducing Valve w/Check

Air Vent

Air Separator

Shutoff Valve

Makeup Water

Expansion Tank

Blow Down Valve

Air Vent

Shutoff Valve

To System

Pump

Note:
Each manufacturer has a slightly different piping arrangement. Follow the manufacturer’s piping instructions for actual installation and pipe sizing.
SECTION 7

WATER PIPING AND PUMPS

System Piping Arrangements
System piping arrangements may vary based on the equipment used and the application.

The piping arrangements shown are schematics of commonly used methods. However, the methods shown do not reflect all specific project requirements.

Follow manufacturer’s installation literature.
System Piping Arrangements:

- Water-Cooled Chiller
- Air-Cooled Chiller
- Coil Piping
- Pump Piping
- Expansion Tank and Air Separator
- Parallel and Series Chillers
- Single Chiller System
- Multiple Chiller Systems
- Primary-Secondary System
- Primary-Only Variable Flow System
Parallel – (Typically 18° F drop or less)

Series – (Typically greater than 18° F drop)
Single Chiller

- Cooling Tower
- Condenser Water Pump
- Water-Cooled Chiller
- Chilled Water Pump
- Air Handling Unit

Section 7 – System Piping Arrangements
Copyright © Carrier Corp. 2005
Multiple Chiller Dedicated Pumps

1. Cooling Tower
2. Water Pump
3. Condenser Water Pump
4. Water-Cooled Chiller
5. Chilled Water Pump
6. Air Handling Units

Section 7 – System Piping Arrangements

Copyright © Carrier Corp. 2005
Multiple Chiller Manifolded Pumps

- Cooling Tower
- Equalization Line
- Condenser Water Pumps
- Water-Cooled Chiller
- Automatic Isolation Valves
- Water-Cooled Chiller
- Chilled Water Pumps
- Air Handling Units

Section 7 – System Piping Arrangements
Copyright © Carrier Corp. 2005
Multiple Chiller Series-Counterclockwise

<table>
<thead>
<tr>
<th>Chiller</th>
<th>Leaving Chilled Water Temperature</th>
<th>Leaving Condenser Water Temperature</th>
<th>Lift approx.</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH-1</td>
<td>52F</td>
<td>95F</td>
<td>43F</td>
</tr>
<tr>
<td>CH-2</td>
<td>44F</td>
<td>90F</td>
<td>46F</td>
</tr>
</tbody>
</table>
Primary-Secondary System

- Secondary pumping station
  - One pump active, the other standby (lead-lag)
  - Pumps are VFD-equipped if all coils are 2-way
  - Matches secondary flow to coil loads
- Hydraulic decoupler maintains constant primary flow
Primary-Only Variable-Flow

Automatic Isolation Valves

Control Valve, sized for minimum chiller flow

Bypass

Flow Meter

Variable Speed Primary Pumps

Section 7 – System Piping Arrangements
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Chiller Head Pressure Control with Diverting Valve

Method 1

 Cooling Tower

Water-Cooled Chiller

Condenser Water Pump

Diverting Valve
Chiller Head Pressure Control with 100% Condenser Flow

Section 7 – System Piping Arrangements
Copyright © Carrier Corp. 2005
Chiller Head Pressure Control with Modulating Valve

Method 3

- Cooling Tower
- Water-Cooled Chiller
- Condenser Water Pump
- Modulating Valve
SECTION 8

WATER PIPING AND PUMPS

Pump Basics and Types of Pumps
Pump Terms

- **Capacity:**
  - Volume flow measured in gallons per minute (gpm)

- **Head:**
  - Pressure at the base of a column of water is usually measured by the height of the water column in feet
Pumping Head

Closed System (evaporator)
- Suction head is $H_s$
- Discharge head is $H_d$
- $H_s = H_d$
- Pump must overcome friction loss of the piping circuit only

Open System (condenser)
- Discharge head = $H_d$
- Unbalanced head = $H_u$
- Suction head = $(H_d - H_u)$
- Pump overcomes friction losses plus $H_u$
A minimum positive pressure (P) at the pump suction flange is required to prevent cavitation, which is the formation of vapor bubbles.
Typical Pump Cross-Section

- Motor
- Coupler
- Bearings
- Mechanical Seal
- Centrifugal Impeller
- Suction
- Discharge
Flat Versus Steep Pump Curve

- Characterized by the slope of the pump curve
  - Flat or steep

- Flat pump curve
  - Head varies slightly as flow changes
  - More applicable on closed systems where variable flow may be used (chilled water circuit)

- Steep pump curve
  - Head varies significantly as flow changes
  - More applicable in open circuits (tower) where high head with constant flow may exist
Desirable Head - Capacity Curve

- Characterized by the slope of the pump curve
  - Flat or steep

- Flat pump curve
  - Head varies slightly as flow changes
  - More applicable on closed systems where variable flow may be used (chilled water circuit)

- Steep pump curve
  - Head varies significantly as flow changes
  - More applicable in open circuits (tower) where high head with constant flow may exist
Crossover Point of Pump and System Curves

- **Pump Curve**
- **System Curve**
- **Shutoff**
- **Full Flow**
- **Pipe Friction Head**
- **Static Head**

**Head - ft**

**Capacity - gpm**
Effect of Overestimating Pump Head

- Pump Head-Capacity Curve
- Design gpm against overestimated head
- System Head
- Actual gpm against actual head
- Actual bhp
- Estimated bhp

Section 8 – Pump Basics and Types of Pumps
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Parallel Pumps (Two Identical Pumps)

- Two identical pumps in parallel
- Resulting gpm doubles
- Plot result to obtain parallel pump curve
Series Pumps (Two Identical Pumps)

- Two identical pumps in series
- Resulting head doubles
- Plot result to obtain series pump curve
Variable Speed Pumping

- As control valves modulate, the differential pressure across supply and return lines rises sending signal to VFD to modulate pump speed
- Operating point moves along system curve to new rpm line (points A - B - C)
- According to the pump affinity laws the energy savings is a cubed function of the ratio of the pump speeds

\[ bhp_2 = bhp_1 \times \left(\frac{rpm_2}{rpm_1}\right)^3 \]

Where: \( bhp \) = brake horsepower

**Diagram:**

- System Curve
- Constant Speed Pump Curve

**Graph Axes:**
- Capacity - gpm
- Head - ft

**Equation:**

\[ bhp_2 = bhp_1 \times \left(\frac{rpm_2}{rpm_1}\right)^3 \]
Pump Selection Process

1. Determine cooling or heating loads to be pumped
2. Find load gpm from equipment selections
3. Find total pumping gpm
4. Establish most resistant pumping path in loop
5. Select pump from manufacturer’s data
6. Flat curved pumps for closed systems with control valves
7. Steep curved pumps for open systems
8. Find final operating point
9. Check for start-up conditions
10. Select motor accordingly
Electronic Pump Selection

Suction Size = 6”
Discharge Size = 5”
Max Imp Dia = 9”
Max Imp Dia = 11”
Cut Dia = 10.875”
Design Capacity = 1000.0
Design Head = 100.0 Feet
Motor Size = 40 HP

Screen Capture courtesy of:
ITT Bell & Gossett
8200 N. Austin
Morton Grove, Il 60053
In-Line Pump

Small capacity design

Motor

Pump Assembly
Close-Coupled Pump

Internal Self-Flushing Seal
Base-Mounted End Suction Pump

- Short Shaft
- Discharge
- Coupling Guard
- Motor
- Suction

Welded Steel Frame provides support and installation ease.
Double-Suction Vertical Split Case Pump

Vertical Suction and Discharge

Large-capacity designs for chillers and cooling towers
Double-Suction Horizontal Split Case Pump

Large-capacity design for chillers and cooling towers
## Pump Type Comparison

<table>
<thead>
<tr>
<th>Pump Type</th>
<th>Cost</th>
<th>Flow &amp; Head Capability</th>
<th>Space Required</th>
<th>Ease of Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>In Line</td>
<td>Least 1</td>
<td>200 gpm @ 55 ft</td>
<td>Least 1</td>
<td>Poor 5</td>
</tr>
<tr>
<td>Close-Coupled</td>
<td>2</td>
<td>2,300 gpm @ 400 ft</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>End Suction</td>
<td>3</td>
<td>4,000 gpm @ 500 ft</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Vertical Split Case</td>
<td>4</td>
<td>9,000 gpm @ 400 ft</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Horizontal Split Case</td>
<td>Highest 5</td>
<td>40,000 gpm @ 600 ft</td>
<td>Most 5</td>
<td>Good 3</td>
</tr>
</tbody>
</table>
Pump Sizing and Pump Selection Example
Pipe Sizing and Pump Selection Example

Given:

Chiller 100 Tons
12.4 ft Cooler Pressure Drop
11.0 ft Condenser Pressure Drop
22.6 gals, Cooler Water Volume

AHU-1 45-Ton Load
9.9 ft Pressure Drop

AHU-2 55-Ton Load
13.4 ft Pressure Drop

Entering Chilled Water 54° F
Leaving Chilled Water 44° F
Entering Condenser Water 85° F
Leaving Condenser Water 95° F
Air Separator Pressure Drop 1.3 ft

Find:

– Pipe Sizes
– Pump Head & Flow
– If a volume tank is required
### Recommended Water Velocities

<table>
<thead>
<tr>
<th>Service</th>
<th>Velocity Range (fps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pump discharge</td>
<td>8 to 12</td>
</tr>
<tr>
<td>Pump suction</td>
<td>4 to 7</td>
</tr>
<tr>
<td>Drain line</td>
<td>4 to 7</td>
</tr>
<tr>
<td>Header</td>
<td>4 to 15</td>
</tr>
<tr>
<td>Mains and Riser</td>
<td>3 to 10</td>
</tr>
<tr>
<td>Branches and Runouts</td>
<td>5 to 10</td>
</tr>
<tr>
<td>City water</td>
<td>3 to 07</td>
</tr>
</tbody>
</table>

**Step 1 - Determine Water Velocity in the Piping**
Step 2 – Determine Piping Friction Losses

**Chart 1** - Friction Loss for Closed-Loop System
Schedule 40 Steel Pipe

**Chart 2** - Friction Loss for Open-Loop System
Schedule 40 Steel

**Chart 3** - Friction Loss for Open and Closed
Copper Tubing System (Type M)

**Table 5** - Friction Loss of Valves

**Table 6** - Friction Loss of Pipe Fittings

**Table 7** - Friction Loss of Special Fittings

**Table 8** - Friction Loss Control Valves and Strainers
### Step 3 - Gather Specific Component Pressure Drops

<table>
<thead>
<tr>
<th>Component</th>
<th>Model/Source</th>
<th>Pressure Drop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chiller</td>
<td>30 Series</td>
<td>Cooler PD: 12.4 ft wg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Condenser PD: 11.0 ft wg</td>
</tr>
<tr>
<td>AHU-1</td>
<td>39 Series</td>
<td>Cooling Coil PD: 9.9 ft wg</td>
</tr>
<tr>
<td>AHU-2</td>
<td>39 Series</td>
<td>Cooling Coil PD: 13.4 ft wg</td>
</tr>
<tr>
<td>Tower</td>
<td>From BAC</td>
<td>Unbalanced head: 6.5 ft wg</td>
</tr>
<tr>
<td>Air Separator</td>
<td>From Bell and Gossett From Product Literature</td>
<td>Required Nozzle Pressure: 12.5 ft wg</td>
</tr>
</tbody>
</table>
Step 4 – Review Piping Layout and Calculate GPMs

Condenser Loop

Cooling Tower

Water-Cooled Chiller
Located on ground floor

150 gpm per pump

10'

5'

10'

37'

300 gpm

Section 9 – Pump Sizing and Pump Selection Example
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Step 5 – Size Pipe & Find Friction Rate for Condenser Water Loop

Using Chart 2, size the pipe and find the friction rate per 100 ft.
Step 6 – Find Longest Circuit Pressure Drop

Condenser Loop

Find longest circuit pressure drop by adding all fittings and pipe lengths

Water-Cooled Chiller
Located on ground floor

Section 9 – Pump Sizing and Pump Selection Example

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Step 7 – Sum Pressure Drops for Pump Selection

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Friction Head</td>
<td>36.0 ft wg</td>
</tr>
<tr>
<td>Unbalanced Head</td>
<td>6.5 ft</td>
</tr>
<tr>
<td>Pressure Drop-Thru Condenser</td>
<td>11.0 ft</td>
</tr>
<tr>
<td>Cooling Tower Nozzles</td>
<td>12.5 ft</td>
</tr>
<tr>
<td>Total Pump Head</td>
<td>66 ft @ 300 gpm</td>
</tr>
</tbody>
</table>

Each condenser pump handles 66 ft at 150 gpm
**Individual Pump Selection**

- **Pump Series:** 1510
- **Max Imp Dia:** 7”
- **Design Capacity:** 150.0
- **Suction Size:** 2.5”
- **Max Imp Dia:** 9.5”
- **Design Head:** 66.0
- **Discharge Size:** 2”
- **Cut Dia:** 8.375”
- **Motor Size:** 5 HP

Screen Capture courtesy of:

ITT Bell & Gossett
8200 N. Austin
Morton Grove, IL 60053
Parallel (2) Pump Selection

The Power and Eff. Curves shown are only for single pump operation.

Pump Series: 1510
Suction Size = 2.5”
Discharge Size = 2”
Max Imp Dia = 7”
Cut Dia = 8.375”
Max Imp Dia = 9.5”
Cut Dia = 8.375”
Design Capacity = 150.0
Design Head = 66.0
Motor Size = 5 HP

ITT Bell & Gossett
8200 N. Austin
Morton Grove, IL 60053

Screen Capture courtesy of:
Step 8 – Size Pipe & Find Friction Rate for Chilled Water Loop

- 240 gpm through 6-inch pipe
- 120 gpm through 4-inch pipe
- 3.4 ft/100 ft friction
- 3.5 ft/100 ft friction
Step 8 – Size the Chilled Water Loop

Chilled Water Loop

Air Handling Units

AHU-2
132 gpm

AHU-1
108 gpm

Water-Cooled Chiller

240 gpm

3-Way Mixing Valve

Air Separator

Section 9 – Pump Sizing and Pump Selection Example

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### Friction Head

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Friction Head</td>
<td>15.5 ft wg</td>
</tr>
<tr>
<td>Pressure Drop Thru Cooler</td>
<td>12.4 ft</td>
</tr>
<tr>
<td>Pressure Drop Thru Air Separator</td>
<td>1.3 ft</td>
</tr>
<tr>
<td>Pressure Drop Thru AHU #2</td>
<td>13.4 ft</td>
</tr>
<tr>
<td><strong>Total Pump Head</strong></td>
<td><strong>42.6 ft @ 240 gpm</strong></td>
</tr>
</tbody>
</table>

*Each chilled water pump handles 42.6 ft at 120 gpm*
Step 9 – Check Evaporator Loop Volume

100-ton chiller * 3 gallons/ton = 300 gallons required

Total number of gallons in the system = 112.6 (see text)

300 gallons required – 112.6 gallons = 187.4 gallon volume tank necessary
WATER PIPING AND PUMPS

Summary
Summary

- Compared the 3 types of piping systems
- Identified the 4 types of water distribution systems
- Differentiated between direct return and reverse return systems
- Identified the various valves and hydronic accessories available for use in piping systems
- Diagrammed typical piping hookups for chillers, pumps, and cooling towers
- Sized the piping for a closed and an open-loop system
- Identified the types of water pumps, their features, and the selection process
WATER PIPING AND PUMPS

Work Session

1. A chilled water system is a _________________ loop system.

2. A condenser water system with a cooling tower is a _________________ loop system.

3. What are the 4 types of valves that can be used for balancing/throttling?
   1. ___________________________________________
   2. ___________________________________________
   3. ___________________________________________
   4. ___________________________________________
Thank You

This completes the presentation.

TDP 502  Water Piping and Pumps

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