Steam System Design and Best Practices Related to Kiln Drying
What is Steam?

- Like other substances water can exist in the form of a solid, a liquid or a gas.

- Gaseous form of water is called STEAM
  - It’s **HOT**
  - It’s **Powerful**
  - It’s **Easy**
Why use Steam?

- Made from water, which is relatively inexpensive and plentiful commodity available throughout the world.

- Carries relatively large amounts of energy in a small mass.

- Temperature can be adjusted accurately by controlling its pressure using control valves.

- Environmental friendly.

- Relatively inexpensive to generate when firing with wood chips.
Steam - the best choice

Why other systems fail to measure up to steam?

1. Gas fired direct heating
   - Higher operating cost than wood fired boiler
   - More difficult to control
   - Higher Maintenance
   - Requires separate humidification systems

2. Electric heating
   - Very high cost to operate
   - Requires separate humidification systems

3. Hot water systems
   - Carries less than 1/5th (20%) the heat (Btu’s) of Steam
   - Higher system installation cost
   - Higher operating costs
Requirements for an Effective, Efficient and Safe Steam System

- Good initial system design
- High quality system equipment and components
- Good knowledge of system operational safeties and periodic testing of safety devices
- Good system operational knowledge and practices
- Regular tuning and maintenance
- Replacement of old or worn components
Steam System Sub-Systems

- Steam Generation
- Steam Distribution
- Steam Utilization
- Condensate Recovery
Steam Generation
Steam Generation – the Boiler House

- Steam Boiler – high or low pressure
- Boiler Feed Water Tank – minimum
- Condensate Surge Tank & DA Tank – ideal
- Water Softeners for make-up water
- Chemical Treatment System for boiler water
- Surface blow down (TDS) control system for boiler – recommended
- Flash steam and blow down heat recovery systems - optional
Generating Quality Steam

- Feed water with impurities
- Impurities - bottom ‘blow down’ to waste
- Build up of impurities in the boiler – surface blow down to drain or heat recovery
- Good quality steam to plant

Typical Simple Boiler Feed Water Tanks

Vent to Atmosphere
Condensate Returns

To Boiler
BF-1

Vent to Atmosphere
Condensate Return

OR

To Boiler
BF-2

Typical Deareator Tank

Direct condensate returns, pumped returns & make-up water

Low pressure steam supply to deareator

To Boiler

DEA-1
Surge and DA Tank Combination

Surge tank is vented to the atmosphere
Make-up water is usually added here and pre-heated

DA tank is pressurized with steam

Typical Condensate pump
Optional Heat Recovery Systems

Typical Blow down Heat Recovery System

Figure II-76
Typical Flash Steam Recovery Hook-up

Complex Flash Recovery System
The Steam Distribution System
Steam Distribution System

- Proper layout design & pipe sizing of mains
- Piping always pitched in the direction of flow
- Use of eccentric reducers to eliminate creation of condensate collection points (low spots) in piping
- Use of separators to eliminate wet steam
- Proper drip trap stations in all required locations
- Use of air vents at all end-of-main locations
- Make steam main branch take-offs from top of pipe
- Use of pressure reducing valves as needed or desired
- Put strainers before control valves, traps and pumps
Steam Distribution
Typical Steam Circuit
CRM-1 Condensate Pump enlargement

WAGNER HARDWOODS - OWEGO FACILITY
STEAM & CONDENSATE RETURN SYSTEM LAYOUT DRAWING
NEW KILNS INSTALLATION PROJECT

Typical Steam Distribution Header

BOILER STEAM DISTRIBUTION HEADER

Pipe Sizing

- Greater Heat Loss
- Greater Cost
- Greater Volume of Condensate Formed

- Greater System Pressure Drops
- Not Enough Volume of Steam
- Water Hammer and Erosion
Steam Volume

1 - 12 oz Can of Soda  
   0.012 cu ft.

2 - 4 Drawer Filing Cabinets - 
   20.10 cu ft @ 0 psig [1675:1]

1 - 4 Drawer Filing Cabinets - 
   11.18 cu ft @ 15 psig [867:1]

1 - Drawer of Filing Cabinet 
   2.97 cu ft @ 100 psig [243:1]
Steam Main
Relaying to Higher Level

Fall 1/250

Steam

Relay to high level

Drain Points

150 - 300 ft

Steam Flow

Steam Separators

How Separators Work

Wet Steam → S3 Separator → Dry Steam

Condensate Outlet
Proper Drip Trap Station

Correct

Incorrect

**Typical Steam Main Drip Station**

<table>
<thead>
<tr>
<th>Size of Main ‘D’</th>
<th>Collection Leg Diameter</th>
<th>Length of Collection Leg ‘H’</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2” to 6”</td>
<td>Same dia. as main ‘D’</td>
<td>Automatic Start up: ‘H’ to be 28” or More</td>
</tr>
<tr>
<td>6” &amp; larger</td>
<td>2 to 3 Pipe Sizes Smaller than Main, But Never Smaller than 6”</td>
<td>Supervised Start up: Length to be 1 1/2 times steam Main Diameter, but never shorter than 18”</td>
</tr>
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</table>
Steam Traps in a Typical Steam Circuit

Air Venting

Steam Main

Balanced Pressure Air Vent

Air

Thermodynamic Steam Trap Set

Branch Connections

Steam

Condensate

Incorrect

Correct

Strainers should be installed ahead of pressure reducing valves, control valves, flow meters and steam traps. All these components are susceptible to scale, dirt and debris. Screens of 60/100 mesh for valves and flow meters, 20 mesh for traps.

Note: Turn steam pipe line strainers 90° so the “Y” is parallel with the floor, not pointing down at it. This will eliminate the condensate pocket shown here.
Pressure Reduction
Why Reduce Pressure?

**PRO**
- It’s better to run boilers at higher pressure for effective system operation and best system response
- Steam should be used at lowest pressure to meet process system temperature requirements for highest efficiency and ease of control

**CON**
- Adds additional system devices such as pressure reducing valves and safety valves to be concerned with
- Lower pressures increase the size of piping and system components which add cost

*New England Kiln Drying Association – Steam Design & Best Practices – HerLine Technologies*
Pilot Operated PRV Cutaway
Pressure Reducing Station
Typical Pressure Reducing Stations

SINGLE VALVE PRESSURE REDUCING STATION

TWO VALVE PARALLEL PRESSURE REDUCING STATION
- used for large load variation systems with load variations greater than 10:1
Typical Pressure Reducing Stations

TWO VALVE SERIES PRESSURE REDUCING STATION
-used for large pressure reduction systems where pressure reduction is greater than 10:1

FOUR VALVE SERIES PARALLEL PRESSURE REDUCING STATION
-used for large pressure reduction and load variation systems where pressure reduction is greater than 10:1 and load variation is greater than 10:1
Steam Main Piping

- Use schedule 40 carbon steel pipe
- Size for proper velocity at operating pressure
- Size for current and future needs
- Pitch in the direction of flow
- Use eccentric reducers to prevent condensate collection pools
- Install proper drainable drip legs with allowance for dirt legs and trap stations
- Locate trap stations at 150’ min and 300’ max on long linear runs
- Locate trap stations at all changes in elevation, at the bottom of drop lines and at the end of mains
- All branch take offs should be from the top of the main where dry steam is available
- Air vents are also recommended at the ends of the main
- Insulate all steam piping
Steam Utilization
Steam Utilization

- Is the ultimate goal of any steam system and it includes all the heat transfer systems and functions.

- In the case of Kiln Drying, it would provide the heat for drying and the steam for humidification.
# Selection from Steam Tables

<table>
<thead>
<tr>
<th>GAUGE PRESSURE</th>
<th>ABSOLUTE TEMP</th>
<th>SENSIBLE</th>
<th>LATENT</th>
<th>TOTAL</th>
<th>VOLUME</th>
<th>LATENT SENSIBLE</th>
<th>PRESSURE</th>
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<tr>
<td></td>
<td>PRESSURE</td>
<td>TEMP</td>
<td>Heat</td>
<td>Heat</td>
<td>Heat</td>
<td>Steam</td>
<td>Ratio</td>
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<td></td>
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<th>VOLUME</th>
<th>LATENT SENSIBLE</th>
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<td>PRESSURE</td>
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<td>178</td>
<td>972</td>
<td>1150</td>
<td>28</td>
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Differential Pressure:
• Is the difference between the inlet pressure and the outlet pressure acting upon any steam component such as a trap, valve, etc.

Elevation Changes

Flow

HIGH  →  LOW

ONLY!!!

LIFT

LOSE 1/2 PSI PER FOOT (APPROX.)

GAIN 1/2 PSI PER FOOT (APPROX.)

DROP
Kiln Typical Steam & Condensate System

Control Valves
Vacuum Breakers
Air Vents
Drip Traps
Coil Traps
Condensate Pump
Typical Kiln Air Coil Steam Control Layout
Pre-Dryer Control Layout at AMF Bowling Products

AMF Bowling Products (this drawing is typical for each side of bldg)
Pre-Dryer Recommended Changes For:
- Air intake coils - add traps to each
- Wall radiation - add vacuum breaker & air vents
- Electric condensate pump - add flash tank with larger vent line or add radiation to condensate return lines and electric pump to remain as is.

Barriers to Heat Transfer

When steam comes into contact with a cooler surface, it gives up its latent heat and condenses.
Effective Efficient Heat Transfer

- **Good quality dry steam**
  - Use separators if necessary

- **Remove air from steam and coils**
  - Use air vents on mains and particularly on coils before traps

- **Remove condensate completely**
  - Use properly sized F&T traps on coils – not too small & don’t go too large
  - Provide for 12” minimum drop to trap
  - Make sure traps are gravity draining without any lift in piping
  - Install vacuum breakers on the inlet of each coil to break vacuum lock which impedes drainage
  - Trap each coil section independently, don’t group coils on a single trap

- **Keep coil fin and tube area as clean as possible**
  - Power wash occasionally as necessary

- **Use only the highest quality control components**
Use High Quality Industrial Grade Valves

- Pneumatic Actuated—least expensive and most reliable

- Use Positioners when possible—better accuracy and control

- Use high pressure air when possible—keeps cost of actuators down

- Hardened stainless steel trim-plug & seat

- Good live loaded packing stem seals
Vacuum Breakers

Simple ball check types are the best and most reliable type.
Air Vents

Thermostatic Air Vents for Steam Systems
Float Trap with Thermostatic Air Vent

Water Level Increases, the Float Rises and the Valve Opens
Proper System Design Makes a Difference...

- Accurate reliable control
- Air Venting
- Condensate Removal

= equals

- Thermal Efficiency
- Reliability
Steam Traps
What is a Steam Trap?

- **Definition:**

  A steam trap is an *automatic valve* designed to stop the flow of steam so that heat energy can be transferred, and the condensate and air can be discharged as required.
Why Steam Traps are required?
Steam traps are automatic devices for:

- Air Venting
- Condensate Removal
- Thermal Efficiency
- System Reliability
Types of Steam Traps

- **Mechanical Traps**
  - Float & thermostatic traps
  - Inverted bucket traps

- **Kinetic Energy Traps**
  - Thermodynamic or disk traps

- **Thermostatic Traps**
  - Balanced pressure traps
  - Liquid Expansion
  - Bimetallic traps

- **Ventures & Orifices (these are not traps)**
Steam Traps Types
Float Trap with Thermostatic Air Vent
Float Trap with Thermostatic Air Vent

Air Vent Open
Float Trap with Thermostatic Air Vent

Water Level Increases, the Float Rises and the Valve Opens
Operation of Inverted Bucket Trap
Operation of Inverted Bucket Trap
Operation of Inverted Bucket Trap
Typical Thermodynamic Steam Trap

IN

OUT

Operation of a Thermodynamic Steam Trap
Operation of a Thermodynamic Steam Trap

IN

OUT
Operation of a Thermodynamic Steam Trap
Balanced Pressure Capsule
Balanced Pressure Capsule
Response of Balanced Pressure Trap

Steam Saturation Curve

Response of Balanced Pressure Trap

Liquid Expansion Thermostatic Trap
Liquid Expansion Thermostatic Trap

A
B
C
D
E
F
G
Bimetallic Type

Cold

Hot

Heat
Bimetallic Trap With Valve On Outlet

Valve Open
Fixed Orifice Device
It’s *Not* a Steam Trap and is not an effective controller of condensate flow

Orifice Plate
Swivel Connector Traps

- Gasket mating faces in same material to eliminate galvanic corrosion
- Welded construction with no gasketed joint to ASM IX
- Flange rotation to suit pipeline connector
- 2 bolts for minimum downtime
- Screwed, socket weld, butt weld or flanged connections
- High integrity, spirally wound gasket
Thermodynamic Trap

UTD30, UTD30A
UTD30H, UTD30HA

UTD52L
Balanced Pressure Trap

UBP30
Inverted Bucket Trap

UIB30, UIB30H
User Benefits

- Minimum maintenance costs and plant downtime
- Only two bolts involved in replacement or removal
- Variety of trap types available to suit wide range of applications
- Common pipeline connector suits all trap types
- 360° independent trap alignment offers flexible installation
- Ideal for unattended plant or inaccessible places
- Stainless Steel construction and gaskets minimises corrosion, maximises product life and eliminates blow-out
- Available with the option of one or two integral isolation valves.
# Steam Traps Selection

## Table 11: Steam Trap Selection Guide

As the USA’s leading provider of steam system solutions, Spirax Sarco recognizes that no two steam trapping systems are identical. Because of the wide array of steam trap applications with inherently different characteristics, choosing the correct steam trap for optimum performance is difficult. Waterhammer, superheat, corrosive condensate, or other damaging operating characteristics dramatically affect performance of a steam trap. With over 85 years of experience in steam technology, Spirax Sarco is committed to helping its customers design, operate and maintain an efficient steam system. You have our word on it!

<table>
<thead>
<tr>
<th>Application</th>
<th>1st Choice</th>
<th>2nd Choice</th>
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<tbody>
<tr>
<td>Steam Mexico</td>
<td></td>
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<tr>
<td>up to 30 psig</td>
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<td>30-800 psig</td>
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<td>900-1200 psig</td>
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<td>1300-2000 psig</td>
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<td>with Separators</td>
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<td>Separators</td>
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<td>Steam Tracers Critical</td>
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<td>Non-Critical</td>
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<tr>
<td>Heating Equipment</td>
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<td>Radiators</td>
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<td>to 30 psig</td>
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<td>to 200 psig</td>
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<td>to 695 psig</td>
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<td>to 900 psig</td>
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<tr>
<td>to 2000 psig</td>
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<td>Hospital Equipment</td>
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<td>Autoclaves</td>
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<td>Fuel Oil Heating</td>
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<td>Bulk Storage Tanks</td>
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<td>Line Heaters</td>
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<td>Tanks &amp; Vats</td>
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<td>Bulk Storage Tanks</td>
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<td>Process Vals</td>
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<td>Reboilers</td>
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<td>Rotating Cylinders</td>
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<tr>
<td>Freeze Protection</td>
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General Trap Recommendations

- **High and medium pressure main drip applications**
  - ½” or ¾” reduced port thermodynamic traps (TD type)

- **Low pressure (15 psig or less) main drip applications**
  - ½” or ¾” float & thermostatic (F&T) trap (FTI & FT type)

- **Steam heating coil with modulating control valve**
  - F&T trap that is properly sized for condensing load (FTI & FT type)
Steam Traps Sizing

Considerations…

1. Condensate Load
2. Safety Factor
3. Available Differential Pressure:
   - System Pressure
   - Total Backpressure
     - Condensate Lift
     - Return System Pressure
# Steam Trap Sizing Guidelines

<table>
<thead>
<tr>
<th>HVAC Industry</th>
<th>Process Industry</th>
</tr>
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<tbody>
<tr>
<td>• Non-modulating control systems have traps selected with a 2 times factor at full pressure differential.</td>
<td>• Non-modulating control systems have traps selected with a 2 times factor at full pressure differential.</td>
</tr>
<tr>
<td>• Modulating control systems with less than 30 psig inlet pressure have traps selected for full-load at 1/2 psi pressure differential, provide 18 to 24&quot; drip leg for condensate to drain freely to 0 psi gravity return. (With drip legs less than 18&quot;, consult a Spirax Sarco representative.)</td>
<td>• Modulating controls systems with less than 30 psig inlet pressure have traps selected for full load at 1/2 psi pressure differential, provide 18 to 24&quot; drip leg for condensate to drain freely to gravity return at 0 psi. (With drip legs less than 18&quot;, consult a Spirax Sarco representative.)</td>
</tr>
<tr>
<td>• Modulating control systems with greater than 30 psig inlet pressure have traps selected with a 3 times factor at full pressure differential for all preheat coils, and a 2 times factor for others.</td>
<td>• Modulating control systems have traps selected with a 3 times factor at full pressure differential.</td>
</tr>
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### Steam Traps Sizing

**Cast Iron Float & Thermostatic Steam Traps**

**FT, FTI and FTB Capacities**

<table>
<thead>
<tr>
<th>CAPACITIES in lb/hr HOT CONDENSATE</th>
<th>FT-150</th>
<th>FT-200</th>
<th>FTB-20</th>
<th>FTB-35</th>
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*For use multiply by 4.5*
Why do steam traps fail?

- Normal wear and tear
- Carryover creates scale which can block the trap
- Poor strainer maintenance - small trap orifices and parts can block or jam due to scale or rust.
- Acidic condensate can cause corrosion
- Waterhammer
- Freezing
- Incorrect sizing and selection
- Incorrect installation
- Inadequate maintenance
Problems Caused by Leaking Traps

If a Trap Fails Open:

- Wasted Steam = Wasted Fuel = Wasted Money
- High velocity in plant equipment
- Steam in condensate line
- Pressurisation of condensate line
- Excessive back pressures acting on other traps
- Failure to maintain constant pressure / temperature
- Reduced pressure differential across good traps
- Unsightly escaping steam
Problems Caused by Waterlogged Traps

If a Trap Fails Closed

- Water logging
- Irregular Temperature Control
- Product Spoilage
- Decrease in Heat Output
- Damage to Plant Equipment
- Waterhammer (Carryover in Mains)
Troubleshooting Steam Traps

- What is the problem? Trap Failed Closed, Failed Open, “Stalled”
- Potential “Stall” Situation – Is a Vacuum Breaker installed?
- Is there enough Installation Head available?
- Is there enough Differential Pressure available?
- Dirt - Is a strainer installed upstream and is it blown down regularly?
- Type of the steam trap used – Proper Application?
Troubleshooting Steam Traps

- Is the steam trap installed correctly? Direction of flow, Float Movement, etc.
- Is the steam trap large enough?
- Air Binding of a steam Trap – Use of a separate Air Vent
- Water logging – Number of steam traps at appropriate locations
- Steam Locking – Steam Lock Release
Steam Trap Maintenance

Frequency of maintenance:

- Quality of Steam – wet steam, carryover
- Life of the system – Initial blowdown, Corrosion
- Criticality of the Application
- Steam Distribution Practices
- General Maintenance Practices – e.g. Blowing down strainers regularly
Condensate Return Systems
FLASH STEAM

FLASH STEAM occurs when hot condensate at high pressure is released to a lower pressure. At the lower pressure, the heat content (SENSIBLE HEAT) of the water (hot condensate) cannot exist in that form. A portion of the water ‘boils off’ and becomes FLASH STEAM.

Flash Steam contains valuable BTU’s / lb. of heat which can be utilized for lower pressure applications.
SURPLUS HEAT CAUSES FLASH STEAM FORMATION DUE TO PRESSURE DROP ACROSS A STEAM TRAP

TRAP WITH NO LIFT AFTER TRAP

100 psig 338°F

0 psig 212°F

FLASH STEAM 90-95%

TO ATMOSPHERIC RETURN SYSTEM (0 PSIG)

CONDENSATE 5-10%

TRAP WITH 10' LIFT AFTER TRAP

100 psig 338°F

5 psig 227°F

10 FOOT RISE

5 psig/227°F

CONDENSATE

0 psig/212°F

TO ATMOSPHERE RETURN SYSTEM (0 PSIG)
Pressurized Condensate Return

Typical of trap discharge lines prior to draining to pump receivers or dedicated pressurized returns prior to surge or DA tank.

**Flash Steam**
- Mass = 100 lb
- 99.5% of Total Volume

**Condensate**
- Mass = 900 lb
- 0.5% of Total Volume

1000 lb/hour
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Percent flash for various initial steam pressures and flash tank pressures.
Typical Vertical Flash Tank

Condensate in

Flash steam out

Condensate out
Simple Flash Steam Recovery System

Figure II-76
Typical Flash Steam Recovery Hook-up
Complex Flash Recovery System
Electric Condensate Pump
Electric Condensate Pump Typical Hook-up for Low Pressure Condensate
Electric Condensate Pump Typical Hook-up for HP Condensate

High Pressure/Temperature Condensate with separate Flash Steam Vent Tank

Figure II-75
Electric Pump Lifting Condensate from Vented Receiver to Higher Pressure or Elevation

1. If there is sufficient filling head, inlet check valve opens and pump begins to fill and exhaust.

2. Filling action causes float to rise.

Exhaust valve open, inlet valve shut.

Inlet check valve open.
PPP Discharge Stroke

1. Float rising triggers valve mechanism; opens steam valve and closes exhaust valve.

2. Pump body pressurizes and resistance at outlet check valve (back pressure) is overcome.

3. Pump empties.

Steam inlet valve open exhaust valve shut.

Outlet check valve open.

Pressure Powered Pump Typical Hook-up for an Open Venting System

(multiple sources of condensate with possible varying pressures)
Summary – Best Practices - System Problems & Solutions
Best Practices - Common Steam System Problems

- Improper system design
- Improper installations
- Improper operation
- Improper chemical treatment
- Inattention to maintenance
- Worn and/or failed components
Best Practices – Most Common Problems

- Wet steam
- Water hammer
- Pressure in the return system
- Failed traps
- Failed pumps
- Failed valves
- Premature component failures
- Premature coil and piping failures
Best Practices – Most Common Problems

How do They Manifest Themselves

- Condensate tank or pump receiver vents blowing excessively
- Constant banging or pounding in steam mains
- Constant banging or pounding in condensate return lines
- Slow heat ups
- Overheating
- Difficulty with temperature and humidity control
- Electric condensate pumps cavitating and constantly leaking
- Premature failure of major components such as valves, traps, pumps, coils and piping
Killers of a steam system

**Dirt**
- Damage the valves and seats
- Obstruction to tight sealing resulting in leakage

**Water**
- Reduced heat content
- Barrier for effective heat transfer
- Water hammer - dangerous
- Wire-drawing of valves
- Water logging of traps and valves

**Air**
- Barrier for effective heat transfer
- Air binding of process vessels, traps, valves, pumps etc.
What is the solution?

Dirty Steam?
Strainers and blow downs

Wet Steam?
Good practices in steam distribution – design, layout, pipe sizes
Moisture separators
Steam traps – sufficient number, appropriate type, correct sizes

Longer Heating Cycles?
Good practices in steam distribution – design, layout, pipe sizes
Vacuum breakers – on heat transfer equipment
Air vents – on steam mains & heat transfer equipment
Proper type & size of steam traps – in good operating condition
Best Practices - Safety, Energy & Maintenance

- Water hammer
  - Go slow with boiler start-ups and opening isolation valves into cold systems
  - Make sure all low points in the piping are drained properly by trap stations
  - Make sure you have proper drip legs and trap stations

- Pressure relief – make sure you have safety valves to protect the system from over pressure

- Condensate pump overflows- install overflows on pump receivers to prevent system flooding

- Insulation – minimally, insulate steam lines, if outside make sure jackets are water tight

- Fix all steam leaks

- Watch your vents for blowing traps

- Flash steam recovery if feasible

- Boiler blowdown heat recovery

- Boiler surface & bottom blow downs per mfr. recommendation & have good chemical treatment

- Blow down strainers and dirt legs periodically

- Keep your control valves in good repair-inspect heads & seats periodically

- Traps-track down problems and repair or replace as needed

- Fix leaking and non-functional pumps

- Test condensate return PH periodically – acid destroys systems

**Best Practices - Words to the Wise**

- **Quality Counts!!!**
  - Not all steam components are created equal
  - You get what you pay for
  - Pay me now or pay me later (Fram)

- **Don’t hesitate to ask questions!!!**
  - It may be appropriate to challenge “conventional wisdom”, the way we’ve always done it may not be best
  - Follow the manufacturer’s recommendations
  - Utilize your resources

- **Some systems and components work better than others!!!** – it’s not a generic world out there

- **Get the best advice!!!** – from people you can trust

- **Avoid orifice traps!!!**
Trap Testing Tools

Infrared or Contact Thermometer

Ultrasonic Leak Detector
The End
Common Steam Terms

**Water Hammer**
Shock caused in piping & equipment due to rapid displacement of water by expanding or flowing steam.

**Latent Heat or Heat of Vaporization**
The extra heat that has to be added to each pound of water to turn it into steam.

**Dry Steam**
It is steam that is fully evaporated, thereby containing no entrained moisture.

**Flash Steam**
It is created when high temperature condensate (water above 212°F @ atmospheric pressure) crosses from an area of high pressure to an area of lower pressure, as through a steam trap. The excess heat that is released, will boiler a percentage of the condensate back into steam.
Steam/Water in Pipe
Waterhammer

Sagging Main

Condensate

Slug of water from condensate

Vibration and noise caused by waterhammer
Waterhammer

Result of a drip trap being removed, that was draining a 100 psig line, before a valve

SHOCKING FACTS REGARDING THE PHYSICS OF STEAM

- Steam is **not** compressed air – it does not maintain pressure without temperature !!
- Steam expands as it cools (reduces in pressure)!!
- Steam systems are dynamic – dynamic means constantly changing – **not** static !!
- Pressure flows from high to low – **not** low to high !!
- Steam & water do **not** mix well !!
- On Earth we have gravity !!
- Water does **not** flow up hill !!
- Vacuums will form in “pressurized” steam systems !!
- Vacuums can overcome gravity !!
- Negative pressure (vacuum) will lower the boiling point of water !!
- When thinking of a steam system visualize wind & water !!
- Drainage is everything !!
Don’t Stress Your Boilers

• Keep your boilers in good repair and keep them tuned up for efficient operation
• Perform safe slow start-ups
• If you have capacity problems, use back pressure regulators to throttle non-critical loads
• Use separators to solve wet steam problems
• Insulate steam mains
• Fix leaks
• Repair or replace wet insulation—it’s worse than no insulation
• Repair or replace blowing traps
• Distribute steam at high pressure and reduce at point of use
• Return condensate
• Maximize boiler feed water temperatures
• Control boiler blowdown and consider heat recovery