

Small Drip Legs Cause Big Problems

Correct sizing eliminates water hammer, pipe erosion, and long startup times

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At first glance it would seem that creating a drip leg is simply a matter of connecting piping or equipment to a correctly sized steam trap. But, an analysis of the varying conditions inside a steam system reveals that the location and sizing of drip legs are much more complex than first meets the eye.

Condensate moves in a combination of ways, depending on the type of system under consideration. At startup, low pressure and a relatively high load create a gravity flow condition. High condensate loads, combined with moderate steam velocities, cause condensate to flow along the perimeter of piping. Under high-velocity, low-load conditions, condensate actually becomes entrained in steam. Drip legs must be located and designed to remove condensate from steam lines throughout the operation cycle, regardless of condensate flow conditions.

Many problems mistakenly thought of as inevitable in the operation of a “typical” steam system are avoidable. Occurrences such as water hammer, steam leaks resulting from pipe

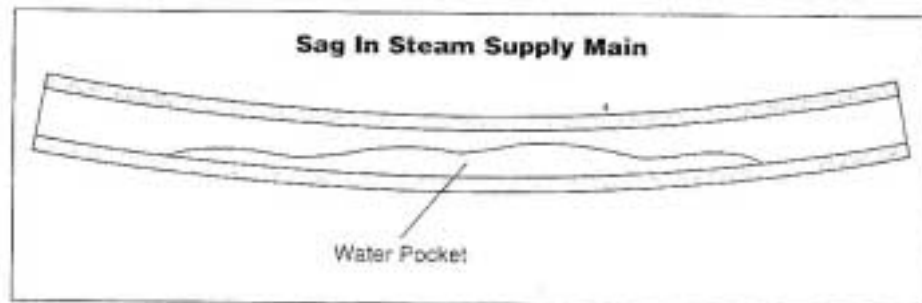
erosion, short equipment life, reduced heat transfer, and long startup times are often reduced or eliminated by the proper placement and sizing of drip legs.

Drip Leg Location

According to Section I, Paragraph 118 (a) of the American Standard Code for Pressure Piping, “Suitable drains or drips shall be provided wherever necessary to drain the condensate from all sections of the piping and equipment where it may collect...” Taking a few simple precautions when laying out steam lines minimizes the number of collection points.

- Ensure that steam mains are well supported. This is one of the most important, but often overlooked, precautions. A pocket of condensate can be trapped in a section of main that is sagging due to insufficient support (Fig. 1).
- Use eccentric fittings to provide a continuous path along the bottom of distribution piping (Fig. 2).

Fig. 1 Condensate collects in low areas that are created by the sagging of poorly supported piping.



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- Pitch steam mains down, in the direction of flow, not less than 1 in. for every 20 ft. of run.
- Always trap each drip leg with a separate trap. Even the slight pressure drop found between two adjacent drip legs is enough to short circuit the system.
- Properly insulate piping to minimize the amount of condensate generated in a distribution line.

Along with these general precautions, there are several specific recommendations that should be followed for the proper placement of drip legs. Drip legs should be located at about 300-ft intervals along steam mains, and never at intervals greater than 500 ft. In addition, drip legs should be placed at risers, preferably beyond the point of change in direction, at the

end of mains, ahead of expansion joints or bends, and ahead of valves or regulators.

After choosing the proper location, drip legs must be designed so condensate freely enters throughout the operating cycle of the system. During normal operation, any steam system is subject to one or more conditions that must be taken into account in the sizing of drip legs to avoid problems.

Startup Conditions

During startup, high condensate loads are created when steam condenses after encountering cool piping and equipment. At the same time, the high condensing rate leaves little steam pressure in the piping. If the system is well designed, gravity pulls condensate into the drip leg. On supervised startups, a valve is manually opened to drain and gravity alone is adequate to drain condensate.

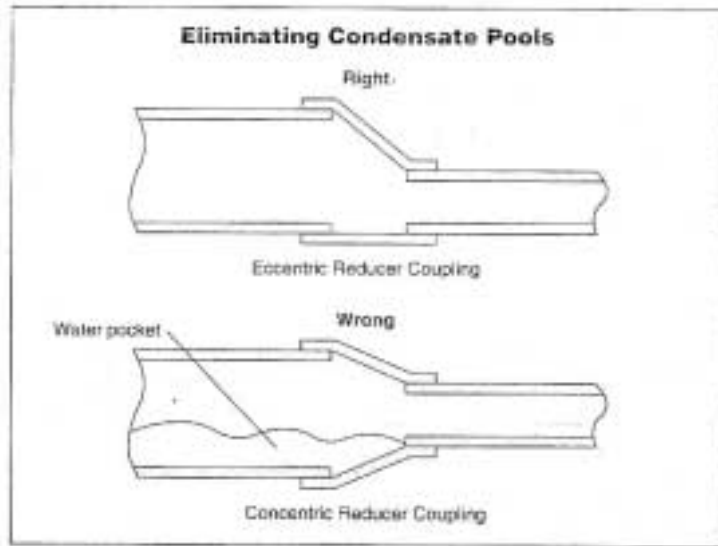


Fig. 2 An eccentric reducer precludes the forming of a condensate pool that can form behind a concentric reducer.

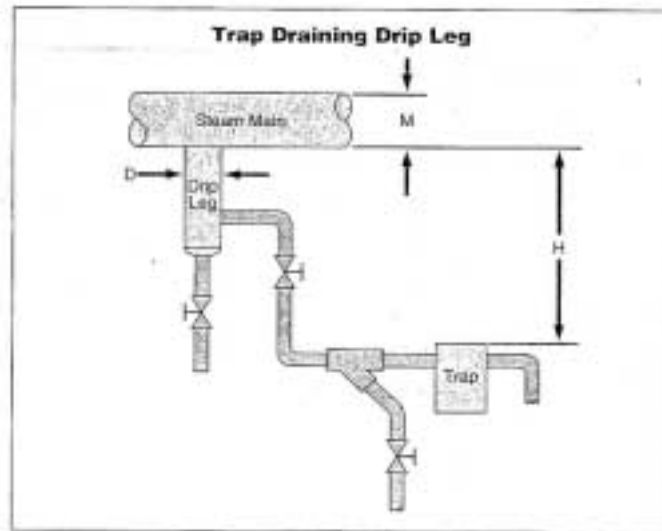
On automatic startups, however, there may not be sufficient differential pressure to provide flow through a steam trap orifice. In these cases, the drip leg must be sufficiently long to provide the necessary static head (dimension H, Fig. 3) to push condensate through the trap.

There are applications where condensate must be lifted. The drip leg must provide ample volume for water to accumulate until there is sufficient pressure to elevate condensate to the

level of the return (about 1 psi for every 2 ft. of lift).

If the system is not properly drained, it takes an excessive amount of time to reach operating temperature, increasing operating costs. Insufficient drainage during startup can result in live steam being injected into pockets of cool condensate, creating thermal shock, a form of water hammer.

Fig. 3 Typical trap-draining drip leg is installed on steam main. Values for M, D, and H are provided in the table on the next page.



Perimeter Flow Conditions

With relatively large condensate loads and lower velocities, commonly found in low pressure, modulated heating systems or upstream of any control valves, condensate flow usually takes place on inside pipe walls. Steam constantly condenses on the wall of the pipe and flows by gravity to the bottom where it forms a stream that is pushed along by the forces of gravity and friction with gas flowing over its surface. The drip leg must be sized so the entire stream is drained away as it flows over the top of the opening. Partial drainage is likely when the common practice of “hot tapping” a small pipe into the steam main is used to provide a drip leg (Fig. 4).

As the condensate stream flows past each drip station, it accumulates and robs the pipe of steam space and the steam of some of its heat, increasing operating cost. If the condensate stream is allowed to build to sufficient levels in the pipe, waves are formed on the surface by gases passing above at a relatively high velocity. These waves can rise and block the entire pipe. With system pressure upstream of this slug, and collapsing steam downstream, the slug is accelerated in the pipe and can reach velocities as high as 90 mph. A great deal of damage can be done to piping and equipment when a slug is forced to stop or change direction.

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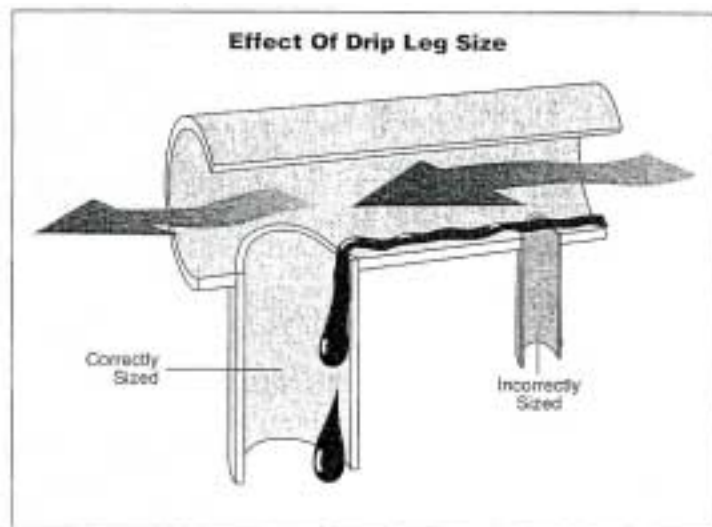
Entrained Flow Conditions

In low-load, velocity service, most of the condensate is picked up by the passing gas stream as it forms on pipe walls. These water droplets are carried along, mixed with steam at velocities that can exceed 100 mph. To separate the condensate from high-velocity steam, the drip leg must be large enough to provide expansion in the flow area, reducing gas velocity

and allowing condensate to drop out. If the drip leg is not large enough, the pressure drop created at the interface of the steam line and the drip leg draws condensate out of the drip leg and steam trap. In applications where dry steam is essential, it is preferable to use a steam separator to provide flow reduction, and drain with an adequate drip leg.

Recommended Steam Main and Branch Line Drip Leg Sizing			
M	D	H	
Steam Main Size, in.	Drip Leg Diameter, in.	Drip Leg Length, Min., in.	
		Supervised Warm-Up	Automatic Warm-Up
1/2	1/2	10	28
3/4	3/4	10	28
1	1	10	28
2	2	10	28
3	3	10	28
4	4	10	28
6	4	10	28
8	4	12	28
10	6	15	28
12	6	18	28
14	8	21	28
16	8	24	28
18	10	27	28
20	10	30	30
24	12	36	36

Fig. 4 Drip legs must be large enough to allow condensate to drop out of the stream at the pipe bottom



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If condensate accumulates in the flowing steam, it reduces steam quality. This reduces the amount of heat transferred from the steam delivered downstream and increases operating costs. The erosive force of condensate droplets being whipped along at 100 mph is roughly analogous to a major hurricane. As pipe walls and heat exchanger surfaces are eroded by the water blast, they begin to leak or fail. Control valves, ends of mains, and expansion loops also become eroded and eventually fail when subjected to these forces.

Drip Leg Design

Given these three flow dynamics, it is obvious that, to be effective, a drip leg must be as carefully designed as the rest of the steam system. Following a few simple sizing guidelines enables the steam trap to drain condensate from the main throughout the operating cycle of any steam system.

In general, for steam mains up to 4 in. in diameter, the drip leg should be constructed from the same size pipe as the main. For steam mains larger than 4 in., the drip leg

should be half of diameter of the main but never less than 4 in. The distance from the bottom of the main to the top of the trap, in inches, divided by 28 yields the amount of static head, in psi, available to push condensate through the trap on startup. The accompanying table gives recommendations for sizing of steam mains and branch drip legs when the trap discharges to a gravity return.

On automatic startup, when return lines are elevated or pressurized, special precautions should be taken to prevent flooding. The best method is to collect the trap discharge in a nonpressurized receiver and use a pump or a pumping trap to raise condensate or overcome back pressure.

Please visit the Fluid Controls Institute website at www.fluidcontrolsinstitute.org for a list of Steam Trap member companies. The FCI Steam Trap members are the industry leaders in manufacturing and technical expertise and they can assist you in selecting the best type of steam trap for your application.

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